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

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

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

THURSDAY, MAY 2, 1907.

THE ENIGMA OF LIFE.

(1) *The Evolution of Life.* By Dr. H. Charlton Bastian, F.R.S. Pp. xviii+319; with diagrams and many photomicrographs. (London: Methuen and Co., n.d.) Price 7*s.* 6*d.* net.

(2) *The Nature and Origin of Life in the Light of New Knowledge.* By Prof. Felix Le Dantec. An introductory preface by Robert K. Duncan, author of "The New Knowledge." Pp. xvi+250; 21 figures. (London: Hodder and Stoughton, 1907.) Price 6*s.* net.

(1) DR. H. CHARLTON BASTIAN re-affirms his conviction that living organisms continue to arise from not-living material. It is a long time since, in his "Beginnings of Life" (1872), Bastian sought to establish the reality of this "archebiosis" and also of heterogenesis—that strange process by which organisms or parts of organisms of definite kind give rise to organisms of a quite different kind, as when the ovum of the rotifer Hydatina produces the infusorian Otostoma. In 1876–7 there was a notable and useful controversy between Bastian, on the one side, Tyndall and Pasteur on the other, the issue of which seemed to most experts to be that Bastian failed to make good his case for the present-day occurrence of spontaneous generation. The claims of professional work forced the heretic to renounce his investigations for about twenty years, but he has recently been able to return with unabated vigour to the study of both heterogenesis and abiogenesis. His "Studies in Heterogenesis" and his work on "The Nature and Origin of Living Matter" have been already reviewed in NATURE, and we have now before us an account of his recent researches on "archebiosis" and a clear exposition of his views as to "The Evolution of Life." It is impossible not to admire the author's strong desire to get at the truth, the courage of his convictions, and his incomparable good humour.

Dr. Bastian begins by indicating some of the objections to the term "spontaneous generation," which is almost as bad as "generatio equivoca"; he advocates the use of the word "archebiosis"—the past or present origination of living things from not-living material—and he contrasts it with "heterogenetic reproduction," which presupposes pre-existing organisms. In the first part of his book he points out that inorganic evolution (recently studied in ways not a little upsetting) has not stopped, and argues against the dogmatism of those who, while admitting that archebiosis probably occurred very long ago, refuse to discuss the possibility of its occurrence now. Because it has been shown that maggots are not really produced by the flesh in which they crawl, it does not follow that minute specks of living matter may not arise *de novo* in suitable not-living fluids, and to base the formula *omne vivum ex vivo* on the "past experience of mankind" is ridiculously naïve. It has become the fashion to call "spontaneous generation" a "chimera," and the study of it a search for a mare's nest. But "neither Darwin, Huxley, nor Spencer ever undertook any experimental work on this subject themselves," and as for Tyndall and Pasteur, both were convinced beforehand. The whole story is gone over again (pp. 95–228), and it is (psychologically, at least) very instructive. Since 1878, Dr. Bastian had not, before the present work, published anything on the subject of archebiosis, save one chapter in his 1905 volume, and it is interesting to read his retrospect of a famous controversy and his undismayed conclusions in spite of all.

"Mere observation," the author points out, "can never settle the question whether Archebiosis does or does not take place at the present day." In a fluid believed to be quite not-living, minute living creatures appear, but observation cannot decide whether they arise from invisible germs of pre-existing organisms, or "whether they have come into being in the mother liquid as a result of life-giving synthetic processes." Therefore we must resort to experiment, and the fallacies to be guarded against are two. The heat employed in the sterilising process must be adequate to kill all pre-existing living things within the experimental vessels, and there must be no subsequent contamination with atmospheric germs. Therefore Bastian heated his fluids to 115° C. or 130° C., and hermetically sealed the tubes. But these precautions involve disadvantages; the degrading effect of the initial purifying heat process may render the medium unfit for the occurrence of future processes that may lead to life-origination, and the glass of the hermetically sealed vessel in which the fluid is contained partially excludes actinic rays which might be potential, or at least helpful, in bringing about the combinations in question. In spite of these disadvantages, Dr. Bastian found living creatures—" Bacilli, Vibriones, Cocci, Streptococci, Torulæ, and other germs of Fungi "—in saline solutions within tubes that had been heated at 115° C. to 130° C. for from ten to twenty minutes, and the present subdirector of the Pasteur Institute has declared, in regard to spores of bacilli in all such fluids, that "a temperature of 115° C. sterilises them completely and most rapidly." Some of the photomicrographic figures of "organisms" are not very like organisms at all, but others are. The alternative interpretations are (1) that Dr. Bastian's methods were not rigorous enough; (2) that the fatal temperature has been estimated at too low a figure; (3) that contamination occurred during the preparation of the photographed slides, or (*d*) that archebiosis actually takes place. Personally, we are not disposed to accept the last interpretation until every possibility of error has been excluded, and we are not convinced by Dr. Bastian's " final decisive experiments." We suspect that the sterilisation was imperfect; we suspect that there were " germs "—where we have often seen them—on the slides and cover-slips; we suspect everything to a degree that Dr. Bastian—with a tolerant smile—would say outrages common sense. For we belong to the prejudiced, illogical, conservative sect of St. Thomas who doubt and doubt. The whole business is so analogous to belief in " spooks " that no amount of argument is of any use until we have seen for ourselves. Why, then, Dr. Bastian says, will you not experiment? And why will you not, in the name of St. Thomas, point out precisely where my experiments are fallacious? As to the first question, we think the answer is that we regard archebiosis as so great a miracle that we do not expect to see it repeated. As to the second question, we do not know what to answer, unless it be that the sterilisation was inadequate, or that the preparations were contaminated before the photographs were taken. At the same time, recent physicochemical discoveries centred around the fact of radio-activity warn us that dogmatism as to possibilities is far from being consistent with the truly scientific mood.

Harking back to heterogenesis, perhaps it may be useful to say that Dr. Bastian was good enough to show us the mummy of an Otostoma reposing within the egg-case of Hydatina. There can be no doubt about it. But what remains unproved is that the organisation of a Hydatina ovum gives rise by heterogenesis to the organisation of the infusorian Otostoma. We suspected parasitism, and we watched many ova of Hydatina. But neither the expected nor the unexpected happened. On one occasion, however, Dr. John Rennie, lecturer on parasitology in the University of Aberdeen, an expert investigator who was good enough to assist in watching for the advent of Otostoma, observed two (not identified) infusorians moving inside the rotifer's egg, but he did not regard the phenomenon as a proof of heterogenesis. As a matter of fact, the egg-envelope showed a small split, through which the infusorians soon passed out, doubtless following the path by which they formerly entered.

(2) Prof. Felix Le Dantec has entitled his book "The Nature and Origin of Life," but with a humour which we appreciate he has entirely shirked the question of *origin*, only referring to it in a casual, half-hearted sort of way on the last page, where he tells us that " the time will come when methodic analysis will allow of a reasoned synthesis " of protoplasm. It is probable that the solution will be found in the study of diastases.

" When the effective synthesis is obtained, it will have no surprises in it—and it will be utterly useless. With the new knowledge acquired by science, the enlightened mind no longer needs to see the fabrication of protoplasm in order to be convinced of the absence of all essential difference and all absolute discontinuity between living and not-living matter."

Prof. Le Dantec's book—which discusses the nature of life—ranges over the whole field of biology from bacteria to the nervous system, from karyokinesis to mutations, from tropisms to natural selection, and he leaves one with the general impression that even " in the light of new knowledge " the riddle of " life " remains very obscure. In a popular elusive manner, with abundant concrete illustrations, the author seeks to show that the living creature is a mechanism and nothing more, and that " the study of life belongs to chemical physics." " A higher animal such as man is *a mechanism of mechanisms of mechanisms*." This rather cryptic conclusion is expanded into the statement that man is an anatomical mechanism of colloid mechanisms of chemical mechanisms. The wonder is that they all hold together. " More and more the living being appears to us a superposition of dead things." But it is a fell superposition. " A rat trap would be alive if, while exercising its normal function of loosing its spring, it should impress on its constituent substances a chemical activity whose result would be a tension of the spring tighter than before." This seems to us rather a clap-trap theory of life. We mean that the author gives the problem a false simplicity; he conveys the impression that we can really give a mechanical re-description of the development, the growth, the reproduction, the behaviour, the evolution—the life of living creatures. But he does not go thoroughly enough into any single instance to win conviction, and he is continually retreating into the mystery of colloids. Some of his utterances strike us as rather intemperate, as when he tells us that " life is an aquatic phenomenon," or that " Life is only a surface accident in the history of the thermic evolution of the globe," or that "*The fact of being conscious* does not intervene in the slightest degree in directing vital movements." Yet when we were conscious of this sentence we turned back several pages and re-read the preface, where the editor takes an optimistic view of mechanistic theories.

The author has full faith in the theory of *epiphenomenal* consciousness; it is a negligible shadow. He prefers to keep to the purely objective, *e.g.* the mechanism of colloids and the polarities of the cell. He is very strong on bipolarity. "The living cell is a bipolar apparatus, since it needs a cytoplasm and a nucleus." "In each bipolar element of protoplasm there is a male pole and a female pole." "Maturation is explained by the disappearance in cytoplasm and nucleus of all elements of the *sex opposed* to that of the mature element finally obtained." "Fecundation is the operation in which the spermatozooid, introduced by sexual attraction into the ovule, completes by means of its male poles the female poles of the ovule's elements, which are incomplete." "Assimilation is a bipolar phenomenon," and "alternating generation is also related with the bipolarity of the living elements." All this is "in the light of new knowledge," as is also the conclusion that "strictly speaking there is never any hereditary transmission except of acquired characters." The author corrects some of the errors of Claude Bernard, Darwin, and Weismann.

The book has been translated by Stoddard Dewey, and it is just possible that the original may have suffered a little. "If the hen fabricates the egg, the egg in its turn will fabricate the hen. We shall not therefore be astonished when we come to verify the marvellous phenomenon which governs the entire evolution of living beings: the heredity of acquired characters." "Lichens result from the association of seaweed and mushrooms." This lacks precision. "The embryology of an animal reproduces its genealogy." This lacks elegance. Speaking of crabs and lobsters, he says, "All variation, all modification is limited in such animals to this phenomenon of moulting." This lacks clearness.

J. A. T.

ZOOLOGY OF THE INDIAN OCEAN.

(1) *The Fauna and Geography of the Maldive and Laccadive Archipelagoes.* By J. Stanley Gardiner. Vol. ii. Part iv. and Supplements i. and ii., with index. Pp. 807–1079; 34 plates and figures in the text. (Cambridge: University Press, 1905 and 1906.)

(2) *An Account of the Alcyonarians collected by the Royal Indian Marine Survey Ship "Investigator" in the Indian Ocean.* I. *The Alcyonarians of the Deep Sea.* By J. Arthur Thomson and W. D. Henderson. Pp. xvi+132; 10 plates, with colours. (Calcutta: The Indian Museum, 1906.)

THE memoirs contained in the above-named publications belong, if taken alone, to that large class of scientific papers which are commonly said to be "of interest only to specialists," but in reality they betoken much more than this, since they denote a great activity in the investigation of the biological problems presented by the Indian Ocean. Far from overlapping, they are complementary to each other and to a third piece of contemporary work which does not fall within the scope of this notice—the Ceylon pearl-oyster report.

The research conducted by Mr. Stanley Gardiner upon the bionomical conditions or "biocœnosis" of the Maldive and Laccadive Archipelagoes, the earlier parts of which have been already reviewed in NATURE, is now brought to a close with the completion of the second volume, and, as Mr. Gardiner points out in his concluding remarks, the whole report contains fifty-four separate papers by thirty-two different authors. It is not easy to estimate the value of this unique work, which will remain indispensable to all who are interested in Indian marine zoology and in coral reefs. Perhaps the best tribute that can be paid to it, as a whole, is conveyed in that accorded to one portion of it by Prof. H. Coutière, the author of a report in vol. ii., part iv., upon the Alpheidæ, a family of Crustacea frequenting coral reefs and other suitable localities in the tropics:—

"La collection comprend 76 espèces et variétés, soit près de la moitié des formes actuellement connues d'Alpheidæ, et, parmi ces formes, 48 sont nouvelles. Aucune expédition n'a jamais atteint, même de loin, un semblable résultat. Si la localité choisie s'est montrée exceptionnellement riche, il faut aussi que son exploration ait été conduite avec une méthode et une science de la recherche des espèces marines qu'on ne saurait trop mettre en relief."

Every naturalist who has worked along shores where corals grow is familiar with some members of the family Alpheidæ, for which a satisfactory English equivalent seems not to have been invented. These crustacea are so remarkable that a common expression calculated to convey some idea of their properties is to be desired, and the name of trigger shrimps may be suggested. Upon placing them in a glass jar, one is likely to be startled by a sudden report, often so loud as apparently to threaten the fracture of the vessel. The noise is made by the snapping of one of their pincers of peculiar construction.

Although mainly systematic, Prof. Coutière's memoir will be welcomed by those who take an interest in the forms of animal life, not only because of his method of treatment, but especially on account of the admirably clear illustrations, which are reproduced from the author's drawings on eighteen plates, besides text-figures. These are models of what such illustrations should be, and one shudders to think of the paper without them. There is something wrong with Figs. 127 and 128 on pp. 855–6, the letters of the former not corresponding with the description, and the number of joints in the shaft of the outer antennular flagellum of male and female respectively not coinciding with the statement in the text—small blemishes of no account to the specialist, who can endure much. This work does not include a bibliography, and such references as are given are not always to the point, *e.g. Ann. des Sc.* (6), 1899; the series should be (8) and the volume ix.

The same number (vol. ii., part iv.) contains the third instalment of Prof. Hickson's report on the Alcyonaria of the Maldives, with descriptions of fifteen (including two Briareidæ described previously) species of Gorgonacea and one Pennatulid. The depths at which the material was obtained ranged from 0–43 fathoms, generally between 20 and 30 fathoms; two specimens of the Pennatulid (*Pennatula murrayi*) were taken at 43 fathoms in the Suvadiva Lagoon. A general feature of many of the sublittoral Alcyonaria is their extreme variability.

Other papers to which space does not permit us to do justice beyond mentioning them are by Major Alcock on Paguridæ (hermit-crabs), recording twenty-six species, of which nine are new to the Indian Ocean, five new to science; Mr. L. A. Borradaile on Hydroids, twenty-three species; Mr. A. E. Shipley on two parasites; and Mr. W. L. Distant enumerates twenty species of Rhynchota.

The first supplement contains reports by Messrs. A. O. Walker (Amphipoda), J. Stanley Gardiner (Madreporaria), E. T. Browne (Scyphomedusæ), D. Sharp (Coleoptera), W. E. Hoyle (Cephalopoda), and R. Norris Wolfenden (Copepoda). Dr. Hoyle describes a rare squid, *Ancistrochirus lesueuri*, which has luminous organs; one specimen only, the second on record, was found floating dead off one of the atolls. Dr. Wolfenden, whose paper is illustrated by folding plates, compares the oceanic copepods of the Indian Ocean with those of the Atlantic, an intermixture of species between these two great oceans being hindered by the water barrier formed by the Agulhas Current; the author also points to an extraordinary difference between the Copepod fauna of the Maldive Group and that of the Gulf of Manaar, owing to the paucity of littoral forms in the former area.

The second supplement contains an article by Mr. R. I. Pocock (Myriopoda), an excellent systematic index, a subject-index, and Mr. Stanley Gardiner's concluding remarks. From his notes on the habits and distribution of the land animals, we learn that the mammals of the Maldives are three, the fruit bat or flying fox, *Pteropus medius* (not found in Minikoi), the musk shrew, *Crocidura murina*, and the rat, *Mus rattus*; the absence of insectivorous bats is noted as a singular deficiency. The study of the land fauna has confirmed his conclusion, previously based on geological grounds, "that the Maldives and Laccadives are recent lands."

As is known, Mr. Gardiner has crowned his labours in the Maldives by another expedition to the western part of the Indian Ocean, and when these results are made known the importance of his individual contribution to Indian oceanography will doubtless be fully appreciated.

The sumptuous monograph of the Indian Alcyonarians of the deep sea, by Prof. J. A. Thomson and Mr. W. D. Henderson, is a revelation of a wealth of new forms depicted in a manner which, for this class of illustration, is beyond praise. The authors are alive to the æsthetic possibilities of their subjects, and although these are to some extent prejudiced by inevitable *post-mortem* changes, enough remains to delight the eye and attest the beauty that is hidden in the depths of the sea. Of the eighty-six species included in the collection, sixty-one are new; only nine belong to the Alcyonacea (leathery corals, chiefly shallow-water forms); eight of these are new, and two of them are made the types of new genera. There are forty-one species of Gorgonacea ("sea-fans") and twenty-eight species of Pennatulacea ("sea-pens" or "sea-feathers"), thus displaying a very great contrast with the shallow-water fauna of the Maldives. Two genera, Sympodium of the Stolonifera and Umbellula of the Pennatulacea, contain a multiplicity of specific forms which the authors admit may be only mutations. In view of this possibility, it is hard to accept so many names on an equal footing with those of undoubted and striking types.

Several comparative tables of the species of various genera are introduced in the course of the work, and these should prove of great service to future investigators. This method of tabulation is the right one, and is capable of improvement until a degree of perfection is attained. In written descriptions it happens frequently that the most obvious distinction between allied species is a difference of verbiage. Such banalities can be eliminated from tables; thus it is not much to learn that whereas the axis of *Umbellula durissima* is "nearly cylindrical," that of *Umbellula dura* is "almost cylindrical." The quotation of an isolated example of this kind is not meant to detract in any way from the total value of the tables.

A special property of many deep-sea Alcyonarians is their viviparity. The authors have found embryos in eight different species belonging to the three principal sections, Alcyonacea, Gorgonacea, and Pennatulacea. A full bibliography completes the present monograph, and one dealing with the littoral forms is promised later.

MEDICAL MEDITATIONS.

Principia Therapeutica. By Dr. Harrington Sainsbury. Pp. xi+244. (London: Methuen and Co., n.d.) Price 7*s.* 6*d.* net.

IN the biological sphere, to attain by means of scientific analysis to generalisations of such a breadth as to justify the term of "Principia" is an arduous task, even for generations of men, and is one which is far beyond us at present. The attainment of principles can only be by the long and fallible ways of observation, verified by the experimental method; and—in medicine at any rate—we can claim to have surveyed and mapped out no very wide areas as yet. Now if this be true of pathology, of therapeutics it is grievously truer, although on the lines of pharmacology much "triangulation" is now going forward. It is almost needless to guard these remarks by adding that no one probably is more aware of these limits of our knowledge than the thoughtful writer of the book before us; he no doubt would be among the first to admit that his "Principia" are for the most part rather of the nature of ripe reflections on medicine—well-balanced cogitations by a wise, experienced, and instructed physician, regarding his art, as it were, from a height. Such thoughts obtain their generality rather by selection and proportion than by the slow accumulations of "induction." For our own part, we should have been disposed to prefer for this book some such a title as "Contemplations on Medicine."

Yet if we are indisposed to accept Dr. Sainsbury's mature reflections as "principia" in the sense of scientific theory, we are far from saying that it is useless to step thus backwards, or upwards, occasionally, so as to take more comprehensive glances of our science and art, and to delineate its larger features, so far as a slight sketch may go. By standing clear for a moment of the multiplicity of detail we gain a better sense of the proportions of the parts. The danger of this method is, of course, lest we mistake mere generalities for laws, dialectic for analysis of origins, and axioms of provisional service for verified and permanent conceptions. And it would be too much to say that Dr. Sainsbury has wholly escaped this danger; in some chapters his broad and detached way of looking at things is significant and illuminating, in others the attenuation of detail tends to vapidity, and thought is diluted until it becomes somewhat artificial and prosy. On the other hand, it may be just to say that no one could perhaps have penetrated farther in his way than Dr. Sainsbury does, and we have admitted that the change of attitude is needed occasionally to guide us and to give us wider bearings.

It would not be appropriate, then, to enter upon controversies with the author on matters of detail. It would not be difficult or unjust to do so, in many details, if the point of view were in itself more particular; but the author would be justified in answering that his reflections must be judged, not by items, but by the truth of the general point of view, and his answer would have weight. We forbear, then, from picking out from the joints of his edifice mortar which in not a few places seems to us to be unsound. Many a queried paragraph we may pass over in silence, as we must refrain from quoting many a happy one.

To turn to the larger aspects of the subjects, those general thoughts which the author had in view are often very well put; such as his conception of "compensation" as but part of the adaptation of stable moving equilibriums to their environments, so that cardiac "compensation," for instance, too often conceived with more than a spice of teleology, is a readaptation of the same general kind as immunity to bacterial and other poisons, and so forth. The whole of chapter vi. is interesting, perhaps the best in the book; the relative incidence of remedies in time is dwelt upon, and the potentialities of combinations of drugs—a practice in recent years much neglected—are fully discussed, their mutual enhancements or cross-purposes considered, and an explanation given of the chemical room left in the body for additional drugs as these may be in a solution saturated by one or more previously dissolved. Pp. 126–9, which deal with this part of the subject, are felicitous, and also the few pages following. Many sentences, too, are happily put, as, for instance, on p. 40:—"It may here be noted how it is that the organism as a whole secures its excretory stability, namely, by not carrying to the extreme the process of differentiation through which the higher types of tissue have arisen," &c. In another paragraph Dr. Sainsbury estimates in general terms the relative vigour of the communal and individual life of several parts. The chapter on diet, again, is good, especially the discussion on alcohol.

We must be forgiven if, in conclusion, we express the opinion that, in one respect at any rate, the author has not been watchful, namely, to counteract that tendency to flatness or dilution of thought which we have said is almost inseparable from speculative contemplations, and to endeavour to prevent prosiness and vagueness, by apt and penetrating phrases and instances. The quotations, which are made with some profusion, many of them bits of Latin, should have been fresh and "inevitable," but Dr. Sainsbury has not gone out of his way to seek for telling quotations. Almost all of them are well-worn "tags"; some are stale indeed. A common sentiment gains nothing by reiteration in Latin; *modus operandi* is no better than "mode of operation," and *non pane solo vivit homo* sounds to us better in our mother tongue. These points may receive attention in the new edition which the book deserves. The volume is well printed, and light in the hand.

T. C. A.

OPTICAL INSTRUMENTS.

Leitfaden der praktischen Optik. By Dr. Alexander Gleichen. Pp. viii+221. (Leipzig: S. Hirzel, 1906.) Price 5.60 marks.

Of the making of German optical text-books there is no end, and there are perhaps few which do not constitute valuable additions to optical literature. The present volume, however, does not pretend to furnish new material, and it is improbable that it will be found of any special interest to opticians in this country. It is, indeed, not easy to gather for what class of reader the work has been designed. The preface suggests that the mathematical knowledge assumed in the ordinary treatises on optical instruments is usually lacking to the practical optician, and that it seemed a not altogether useless task to explain the principles of the theory of optical instruments, their construction and design, on the basis of an acquaintance with mathematics not extending beyond the first elements of algebra. Thus should the practical optician be provided with matter he could digest and the student with a stepping-stone to the treatises aforesaid, not the least useful among which are the author's own "Lehrbuch der geometrischen Optik" and his text-books on special departments of optics.

It would seem to us, accepting the writer's own account of his intention, that the requirements neither of the student nor of the practical optician have been kept sufficiently clearly in view. It is probably rather to the amateur who wishes to acquire an intelligent appreciation of the main principles of construction of the more important optical instruments that the book will appeal. The practical optician is daily confronted with problems towards the solution of which he will here find little help, while the student who looks for an introduction to the subject will scarcely do well to acquire the elements of optics from a work in which the necessary mathematics are so entirely kept out of sight. For the general reader the volume presents many excellent features, yet even to him we would prefer to recommend Moritz von Rohr's admirable little book, "Die optischen Instrumente," which provides for the non-mathematician a very considerable amount of information in the smallest compass.

For the rest, the matter is carefully arranged and the explanations of technical points clearly and simply given. The usual portions of the subject are included—the elementary theory of mirrors, prisms and lenses, the optics of the eye, the microscope, telescope, and the photographic lens. There is a chapter also on stereoscopy, in which some of the modern developments are shortly treated. The variable power telescope receives rather more attention than is usual. Tables are given for the calculation of achromatic lenses and of prism combinations, and throughout the book attention has been paid to the furnishing of numerical data. These, however, might easily be rendered more complete—*e.g.* particulars as to the field of view obtainable at various powers in telescopes of different pattern would be of value. Complete data are provided for the construction of certain well-known combinations, direct-vision prisms, eyepieces, microscope objectives, photographic lenses, &c. The provision of numerical information is, indeed, the most characteristic feature of the book, and will render it of value for occasional reference to some who are already familiar with the author's presentment of the optical theory.

OUR BOOK SHELF.

Die Eisenindustrie. By Oskar Simmersbach. Pp. x+322. (Leipzig and Berlin: B. G. Teubner, 1906.) Price 7.20 marks.

IN German technical literature there are excellent exhaustive treatises on the metallurgy of iron, and students' manuals exist in abundance, but Mr. Simmersbach's work on the economics of the iron trade opens up an entirely new field. The leading principles and practices of the German iron trade are made clear, and a careful study of the information set forth cannot fail to prevent much waste of time and misapplication of energy in the conduct of business. The various chapters are well worthy of attentive study, and the book should find a place in the library of all who have any connection with the iron industry.

The first eight chapters give a concise introduction to the technology of iron and steel. They deal respectively with iron and its alloys, raw materials, blast-furnace practice, steelworks practice, rolling mills, testing of iron and steel, foundry practice, and the testing of cast iron and cast steel. The remaining seven chapters, dealing with the economics of iron and steel, are of greater interest. A general sketch of the importance of the world's iron trade is followed by chapters on the world's ore trade, the world's coal and coke trade, the world's pig-iron trade, the world's trade in castings, and the world's trade in malleable iron and steel. The final chapter deals with labour conditions and customs tariffs. The author takes an exceedingly optimistic view of the German coal and iron-ore resources. Germany is, he thinks, richer in iron ores than the rest of the Continental countries put together, and he explains the annual importation of more than six million tons of foreign ores as being the outcome of high railway charges. At the present rate of coal consumption there is, he believes, enough coal in Germany still unworked to last for 3520 years. These figures contrast strongly with his pessimistic views of the available resources of other countries. Prophecies as to the future of the world's iron trade are, however, of little moment.

The chief value of the author's work is in the abundance of admirably arranged statistical material regarding the present condition of the iron and steel industries, and in the evidence amply afforded of the manner in which science has superseded the old rule-of-thumb methods of carrying on operations at iron and steel works. A chapter on trusts, cartels, and syndicates would have been a useful addition to the work, and the absence of an index is to be deplored.

A Text-book of Fungi. By G. Massee. Pp. xi+427. (London: Duckworth and Co., 1906.) Price 6*s.* net.

THE fungi constitute numerically the most extensive group of plants, and at the same time they present the largest number of unsolved problems; this, too, despite the fact that, as the author says, our knowledge has increased by leaps and bounds.

Mr. Massee plunges at once *in medias res*, and proceeds to describe modern cytological developments, their legitimate and strained applications, and certain lines of inquiry pursued by Marshall Ward. Recent work has widened our knowledge of conidia, spores of various kinds, and other methods of reproduction. The author has introduced the salient facts both of sexual and asexual reproduction, but fails to offer a logical definition or a practical limitation of the terms spore, sporophore, &c. The chapter on sexual reproduction contains useful summaries of Blakeslee's account of the Mucorineæ, Thaxter's investigations of the Laboulbeniaceæ, as well as Dangeard's and Blackman's researches. The author's views on parasitism in fungi are set forth, and reference is made to experiments on similar lines by Miss Gibson and Mr. E. S. Salmon, the latter of whom has contributed the chapter on "biologic forms." Closely allied with the spread of disease, which provides the opportunity for noting the insidious danger of hibernating mycelium, is the subject of legislation. Mr. Massee enunciates his arguments, which are mainly to show that, unless it is exceedingly drastic, legislation to prevent the introduction of plant diseases through imported plants and seeds would be useless.

On the subject of classification, the opinion of the author as an acknowledged exponent is especially valuable, and the reader will find clear, and we think convincing, reasoning in favour of the acceptation of Brefeld's main groupings. The personal views on phylogeny appearing earlier in the book should be consulted in this connection. The treatment of the families is necessarily brief, but a good working basis for amplification is provided, and the last four sections, dealing with the anomalous order of Deuteromycetes, will be particularly useful to economic botanists.

The author claims to have provided an introduction to new lines of research. This is modestly expressed, for it will be found that, besides furnishing such an introduction, he has performed the additional service of discussing in a broad spirit their significance and interpretation; further, he has touched on most aspects of fungology, although not on the association of fungi in lichens, and has outlined the taxonomy of the group with a view to practical utility. In fact, Mr. Massee has supplied a serviceable and much required text-book on the present state of fungology which is embellished with numerous artistic and practical illustrations.

Douglas English Nature Books. No. 1, *One Hundred Photographs from Life of the Shrew-mouse, the Dormouse, the House-mouse, the Field-mouse, the Meadow-mouse, and the Harvest-mouse.* By Douglas English. Pp. 93. No. 2, *One Hundred Photographs of Bird Life.* By R. B. Lodge. Pp. 95. Illustrated (London: S. H. Bousfield and Co., Ltd., 1907.) Price 1s. each.

SINCE no less than sixty-four out of the ninety odd pages which go to form each of these volumes are devoted to reproductions of photographs of mammals and birds in their native haunts, the lover of animal life has a rich entertainment at a very small cost. As we learn from the introduction to the first, this series of books is intended for the pocket of the field-naturalist, and it is hoped that while the illustrations (which are almost beyond praise) will aid in the recognition of species, the letterpress will be of service alike in confirming previous observations and in suggesting new lines of inquiry. The series is intended to be comprehensive in scope. In the first part, which is devoted to some of the smaller British mammals, it is satisfactory to find a reversion to the use of popular names like water-rat, field-mouse, and shrew-mouse, in place of the spurious terms water-vole, field-vole, and shrew. In the second number Mr. R. B. Lodge gives one hundred photographs of bird-life, with appropriate notes. Since, however, the illustrations include species like the glossy ibis, little egret, and spoonbill, it is rather difficult to see what they have to do with the ordinary field-naturalist. R. L.

Gold Mining Machinery: its Selection, Arrangement, and Installation. By W. H. Tinney. Pp. xii+308. (London: Crosby Lockwood and Son, 1906.)

THIS book professes to be "a practical handbook for the use of mine-managers and engineers" to assist them in the "selection, arrangement and installation" of gold-mining machinery. Such a work properly executed would doubtless perform a useful function; but Mr. Tinney's production fails in its purpose, for it is out of date and superficial. For example, winding machinery, which should surely be one of the most important sections of a work such as this purports to be, is dealt with in seven pages of letterpress, and, as may well be imagined, the modern high-class winding engine finds no place in it. Deep winding, the greatest problem at present engaging the attention of the mechanical engineers of the Witwatersrand goldfields, is passed over in silence. Again, the electrical transmission of power, a subject of vast and ever-growing importance to the miner, is dismissed in four pages of letterpress.

It may well be asked, of what are the 300 pages of this book made up? The work appears to consist of a jumble of extracts from the note-book of the author (whose experience of the gold mines of the world would seem to have been somewhat limited), together with specifications of machinery makers, illustrated by a selection of photographs from their catalogues. To this *olla podrida* has been added a number of workshop receipts and various elementary tables, such as "the sizes of drawing paper," and formulæ for calculating the areas of a circle, a triangle, a square, &c., and the volume of a cube, a sphere, a cylinder, &c. One of the tables gives the "names, common and chemical," of a list of substances, beginning with "aqua fortis" and ending with oil of vitriol, and including such rare materials as chalk, iron pyrites, rust, slaked lime, salt, and soda.

Memories of the Months. Fourth Series. By the Right Hon. Sir Herbert Maxwell, Bart., F.R.S. Pp. x+319. (London: Edward Arnold, 1907.) Price 7s. 6d.

SIR HERBERT MAXWELL'S new volume will be welcomed by the many readers of his previous series of "memories." The ability to combine literary grace with scientific accuracy, and the power to interest and at the same time to impart useful information, is unfortunately rare, and we are grateful to Sir Herbert Maxwell for placing his gifts at the disposal of a large audience by means of these pages. Readers will be able to share with the author of the memories his "delight in the open field, the woodland, and the riverside," and if they prove willing disciples they may in time experience the joy of original observation for themselves—at least they will learn to study and appreciate the boundless beauties of nature.

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 intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

On the Relationship of Lemurs and Apes.

ACCORDING to the report published in NATURE (April 11, p. 574), Mr. H. F. Standing recently presented a memoir to the Zoological Society in which he described certain extinct lemuroids from Madagascar as being, "in many respects, intermediate between existing lemurs and monkeys," and, as the result of this interpretation of the anatomy of these animals, he expressed the view "that it was not possible to separate the Primates, as hitherto, into the two suborders Lemuroidea and Anthropoidea."

At the suggestion of Dr. A. Smith Woodward, Mr. Standing kindly sent me casts of the cranial cavities of three of the Prosimiæ found by him, and in January last I sent him a report in which their outstanding features and the inferences to be drawn from them were set forth. My conclusions not only lent no support to the above-quoted summary of Mr. Standing's opinions, but are in direct conflict with them. But I would not have deemed it necessary to repeat these statements, already made in my report (which I presume will be published along with Mr. Standing's memoir), had it not been for the fact that, since my report was written, further investigations (chiefly histological studies in the structure of the neopallium of Tarsius, Loris, Nycticebus, Perodicticus, Lemur, Propithecus, Hapale, Cebus, and Cercopithecus) have revealed important facts that enable me to speak more emphatically on the old problem once more raised for discussion by Mr. Standing, and also incline me to suggest a modification of my previously expressed views.

The evidence afforded by the cranial casts is very precise and unmistakable. One of them does not differ in any essential feature, excepting size, from the form exhibited by the brain in the living species of the genus Lemur; a second is an almost exact replica of the cranial cast of Indris; and the third, so far from affording any evidence of affinity to monkeys, presents highly specialised features, which enable us to place the animal (and also Nesopithecus, Megaladapis, and possibly Chiromys) within the fringe of the Indrisinæ. As these lemuroids are the most diversely modified members of the most highly specialised family of the Prosimiæ—which means that they are furthest removed from (and presumably have retained least resemblance to) the very early and remote ancestor from which both lemurs and apes could have sprung—it follows that these, the most aberrant and outlying branches of the prosimian phylum, are the least likely to supply us with any evidence bearing on the relationship of lemurs to apes; and the facts elucidated by the actual examination of these specimens quite bear out this *a priori* supposition.

I am the more anxious to make my position absolutely clear in regard to this matter for the reason that, some four years ago (Linn. Soc. Journal—Zool., vol. xxix., p. 83), in protesting against Hubrecht's suggested exclusion of all Prosimiæ (except Tarsius) from the Primates, I may have unduly minimised the differences in structure that indicate the wide separation of the Lemuroidea and the Anthropoidea.

The organisation of every part of the body proclaims the kinship of lemurs and monkeys, distant though it be; this has been so often summarised (see Earle, "On the Affinities of Tarsius," the *American Naturalist*, 1897, pp. 569 and 680) that it does not need repetition. I might direct attention to the fact that the lemurs are the only mammals that exhibit the true Sylvian fissure such as we find in the Anthropoidea or Simiæ; that the true central (Rolando's) sulcus is present in Perodicticus and in no non-Primate mammal, although there are distinct evidences in many prosimian families of the tendency toward the development of this caudal-limiting sulcus of the motor area; that the motor area presents histological features like those of the lowlier monkeys, and has a similar topographical distribution; that the calcarine sulcus and the distribution of the visual cortex (area striata) conform essentially to the Primate type, although in certain respects the structure of this cortex and its relation to sulci more nearly resembles the condition found in certain primitive Carnivora; and that the organisation of the other parts of the cerebral hemisphere and of the brain-stem and cerebellum resembles that of the corresponding parts of the brain in monkeys much more nearly than that of the Carnivora and Edentata, in which there are some analogies to the Prosimiæ.

But if the facts of cerebral anatomy establish the claim of the Prosimiæ to be included in the Primates, they afford equally emphatic evidence of the sharp line of demarcation between the diversely specialised suborders Lemuroidea (Lemures) and Anthropoidea (Simiæ) and the degraded rank of the former. In attempting to formulate the contrasts between these two suborders, Tarsius comes to occupy such an enigmatical position that it must be put into a category by itself, the suborder Tarsii (Gadow), the other Lemuroidea then forming the suborder Lemures (Hubrecht).

The Lemures are macrosmatic, and (excluding Megaladapis) have a sessile olfactory bulb, whereas the Simiæ are microsmatic, and have an elongated olfactory peduncle. Tarsius has a sessile olfactory bulb like the Lemures, and in form exactly like that of the Galaginæ and Lorisinæ, but it is much smaller than that of any lemur, and at the same time is bigger than that of a monkey.

The cerebral hemisphere in the Simiæ is prolonged backward to cover the cerebellum, carrying with it a diverticulum of the lateral ventricle to form a posterior cornu, the walls of which are composed to a large extent of very highly specialised striate cortex differing markedly in structure from the homologous area of other mammalian orders. In Lemures the occipital prolongation is not so extensive; there is no posterior cornu, and the cortex of the area striata approximates in structure to that of the Carnivora more nearly than to that of the apes. In Tarsius the extent of the occipital pole and its form most nearly resemble the condition found in the brain of the Galaginæ, but there is an extensive posterior cornu as in the apes, and the structure of the area striata presents a marked contrast to that of the lemurs, and resembles that found in Hapale and Cebus.

In the lemurs the frontal, temporal, and parietal association areas are much smaller than in monkeys.

The lateral hemispheres of the cerebellum exhibit a much greater expansion in the Simiæ than in the Lemures, although there is a very close resemblance between the patterns exposed in mesial section in the two suborders.

In many respects the structure of the brain in Tarsius departs widely from that of all the other Primates, both Lemures and Simiæ. Most of these features, such as the form and proportions of the corpus callosum and the architecture of the cerebellum, are indicative of a very primitive generalised condition, such as we find in the insectivore Gymnura.

All these considerations, and the mass of facts elucidated by Burmeister, Turner, Hubrecht, Mivart, Leche, Eugen Fischer, and the writer among many others, can, I think, find a rational explanation only by admitting that the Primates consist of three divergent phyla, which have all departed in varying degrees and in different ways from their original common ancestor, which must have been a creature in many respects like Tarsius, but more macrosmatic, and possessed of a smaller and less highly specialised visual cortex.

G. ELLIOT SMITH.

The School of Medicine, Cairo, April 22.

Radium and Geology.

Two points of special interest have come to light in recent investigations which I have made in connection with this subject.

(1) Typical rocks from the Simplon Tunnel contain quantities of radium considerably in excess of the average of igneous rocks. The Simplon rocks are altered sediments, for the most part, from Archæan to Jura-Lias age. There appears to be sufficient radium to account for the excessive temperatures met with in boring the tunnel, and the practical suggestion is allowable that engineers will do well to estimate the distribution of this substance before embarking on similar projects in the future.

The investigation suggests that radium, accumulating in great thicknesses of sedimentary deposits, may enter as a factor in mountain building by raising the temperature at the base of the accumulated mass. This would lead to a lessened resistance to compressive stress and pressure from beneath. In short, it will be for future investigation to explore how far radium (and uranium) in the surface materials has proved a source of *instability* in geological history, its transport by denudation being, in fact, not a transport of matter only, but a convection of energy.

(2) A sample of red clay from a depth of 2740 fathoms in the North Atlantic contained sixteen times as much radium as the average of igneous rocks as determined by the Hon. R. J. Strutt, and a specimen of globigerina ooze from a depth of 1990 fathoms in the South Atlantic about six times this average. These materials I owe to the kindness of Sir John Murray.

Here the question will arise, Whence all this radium? Sir John Murray's cosmic dust, of course, at once comes to mind, and, taking all the facts into account, I venture to regard these results as further evidence in favour of the extra-terrestrial origin of some portion of the radium we find upon the earth.

The above results are obtained by measurement of the emanation, with every precaution against error.

The point as to what constituent of the oceanic deposits is responsible for the radium is under investigation.

J. JOLY.

Geological Laboratory, Trinity College, Dublin, April 29.

THE ASTRONOMICAL AND ARCHÆOLOGICAL VALUE OF THE WELSH GORSEDD.

As a common term *Gorsedd* is used for "throne"; as a specific term it means (1) the stone circle, and (2) the bardic assembly at the circle. The proper Welsh for "throne" is *gorsedd-vaingc*, "*gorsedd*—seat or bench"; so the Welsh idea of a throne is the place of honour in a stone circle. That was once literally the case. Though the chief bard has always been the master of the Gorsedd ceremonies, the assemblies were held by the authority of the chieftain, lord, or king, and the business and festal features of the assembly were personally controlled by the lord of the land.

Perhaps the most satisfactory translation is "High Court." From the twelfth century to the present the Gorsedd has been the High Court of the Bards. We never hear of any other business transacted except matters that affected the bardic fraternity. But even such a circumscribed Gorsedd was never legal without the lord's authority.

There are many lines along which it would be easy to show the genuine antiquity of the Gorsedd traditions, and had I nothing more than this to say, I could with confidence invite archæologists to study them. When, however, Sir Norman Lockyer's "Stonehenge" came to my hand, some very obvious facts about the Gorsedd appeared at once to the point, and it has been my delight for the last six months to gather such facts together and apply to them the useful instructions given in the work mentioned. The present Gorsedd circle consists of twelve stones, 30° apart, with a larger stone in the centre. Outside, on the east, three stones are placed to indicate the solstices and equinoxes to an observer at the centre stone. A reader of "Stonehenge" would at once see that such an arrangement does not look very ancient. The silence of the bards about the February-May-August-November year suggested that something had been omitted in the instructions. All the old plans of a Gorsedd I have seen give 30° or so between the sunrise stones, and invariably the plans are contradicted by the verbal instructions accompanying them, in which a solstitial arrangement is insisted upon. Mr. T. H. Thomas, of Cardiff, to whom all Welshmen are grateful for what he has done towards setting the Gorsedd aright, kindly sent me a tracing of a Gorsedd plan preserved among the Iolo MSS. at Llanover, Mon.

It was the perfect plan that I had been searching for. It was accompanied by another, less perfect. As usual, the verbal explanations contradict the plans. In the perfect plan, which gives both the solstitial and the May years, the directions 30° or so north and south of east are stated to be the solstices, while no verbal explanation is given of the solstice stones. In the other plan the distance between the east stone and the winter solstice stone is stated to be "30 degrees south." Delightful blunders both!

Plan of a Gorsedd.

The plan was evidently prepared for the engraver, and the draughtsman signs his name as "T. Jones, Merthyr Tydvil, Sculpsit." The numbers given in the plan are not properly explained. A portion of the page is torn, and we have the fragmentary explanations:—"1 Alha—, 2 Alba (also underneath) Alb—, 3 Alban—, 4 y mai(n)—Cadlas neu Cylch C—.' Nos. 5, 6, and 7 are not explained. What Alban No. 1 represents is difficult to make out. In the above tracing I affixed No. 1 to the north stone, by way of directing attention to the fact that for a stone there we have an elaborated north sign. No. 1 was probably intended to mark the Alban Eilir and Elfed (the equinox stones). No. 2 fronts the Alban Hevin (summer solstice stones), but that name is written across the head of the May stones. No. 3 fronts the May stones, though on the margin it is "3 Alba—." No. 4 fronts the November stones, but across the head of that alignment is written "Alban Elfed," the bardic name for the autumnal equinox, while on the margin No. 4 is explained by words which seem to be names for the whole group of sunrise stones. The easternmost stone is described as "Alban Artban," the name of the winter solstice. Between the May and November alignments we have two names, one, "y meini gwynion neu'r Cylch Cyngrair," "the Holy Stones or the Stones of Testimony," the name, in fact, of the circle; the other name is "y Cyntedd," "the Court," the name of the space or gap formed on the east of the circle by the "sun stones." Accompanying another plan, in which names and measurements are also misplaced, we have the following explanatory remarks, which are perfectly correct:—

"The stones forming the circle are termed *White Stones* or *Stones of Testimony*—the circle itself is sometimes called the *white circle*.

"The middle stone, or altar, is termed *Maen Gorsedd*, i.e. *Presidial stone*.

"The stones pointing at the Equinoxes and Solstices are called *Stones of the Sun*. The Bards stand unshod and uncovered within the circle, the Presiding Bard, who must be of the *Primitive Order*, stands by the *presidial stone*. All the other Bards attend around, standing near the *white stones* or periphery of the circle."

This is the bard's English, in which language he used to hold his own in the presence of the great Pitt, Dr. Johnson, and the notabilities of his time. My references to the sources of these Gorsedd plans are "Llanover Iolo MSS., vol. x., p. 267, and vol. xix., p 160." "Holy," not "white," is the meaning of *gwyn* as applied to the Gorsedd circle.—J. G.

The writer, Edward Williams (Iolo Morgannwg), who died in 1826, did not quite understand the plans, but to his honesty as a copyist we are indebted for a very valuable document.

In what I venture to call the perfect plan, the place of honour is given to the May year, the solstitial stones taking a second place. This is the case still in Wales. The chief dates still in our rural life are May Day and All Hallows. The gap in the direction of the sunrise stones suggests a comparison with other circles which show a gap in that direction.

It is evident that our bards give us plans which they seem not to understand. They have not invented them. So far as I know, there is no megalithic monument in Britain exactly like a proper Welsh Gorsedd, that is, it is no copy of any existing monument. On the other hand, the similarity between it and existing circles is most striking. There is a circle of nineteen stones, with one stone much larger inside, at Boscawen-un, and nineteen is rather a common figure in such circles in Cornwall. A circle of twelve stones roughly divided the year into months, and one of twenty-four into "fifteen-nights," as the Welsh for "fortnight" signifies, with a gap left in the east to welcome the sun on the chief days of the year, for the nineteen stones are separated, except on the east, by 15°. I have noted that when the stones of a circle are separated, in the plans, by 30°, the circle is complete, as space is provided for a May-November alignment. But providing a splayed avenue for a solstitial arrangement necessitated a reduction in a circle of twenty-four stones to nineteen, and in the two plans I have referred to, where the circle consists of nineteen stones, there is no inner circle of twelve stones described. It is significant that in the conventional instructions the number of stones forming a Gorsedd circle is not definitely fixed. The most remarkable thing in the Welsh Gorsedd is its similarity to our prehistoric circles, while the evidence at no point suggests that it is a mere archæological "restoration" of the primitive circle.

Since the subjugation of Wales to the English throne, an all-round Gorsedd has never been practicable. The Tudor sovereigns issued commissions for Gorsedds, but with power only to set the bardic order aright. In the bardic traditions, however, we have descriptions of a Gorsedd as the High Court of Parliament of every State unit. The unit of government was the *cwmwd*, comot, corresponding roughly to some large country parishes. Places called Gorsedd, Eisteddva, Henllan, often Llan and Eglwys, were such local Gorsedds. There was also a High Court for all the units which formed a lordship or principality, and we read of stated places of inter-State Gorsedds, when Wales was divided into three principalities, namely, North Wales, South Wales, and Mid-Wales.

But such an all-round State Gorsedd became impossible about the time the straight history of Wales begins, just as the earliest codes extant of the Welsh laws take us back to the time when they were rapidly becoming obsolete. The bardic traditions, however, describe such impossible things, even to minute details. So the laws give us much of the history of Wales that is otherwise nebulous.

Even more than the ancient codes of Welsh laws, the bardic traditions of the Gorsedd are the most formally authenticated of any Welsh literature. Since the tenth century the former have had to take care of themselves, apparently, but the bardic traditions were always recited at every proper Gorsedd. From the twelfth century to the first quarter of the nineteenth we have accounts of a series of great Gorsedds (or Eisteddvod, the same thing), every one of which was convened for the chief purpose of re-codifying or otherwise dealing with the bardic traditions. The voluminous body of traditions in question grew out of such assemblies. There was usually one bard head and shoulders above the others, who, of his own accord or by request, would prepare a statement which would be approved at a Gorsedd convened by the lord, as at Caerwys by Queen Elizabeth, and become afterwards the law of the fraternity. After long intervals, and especially after great disturbances in civil government, such revising Gorsedds became necessary, and that they were held for such a purpose, in very adverse circumstances, witness the conservatism, persistence, and vitality which are still much in evidence in the Welsh bardic order. We have nothing so well and faithfully guarded in Welsh literature as our bardic traditions.

The very latest instructions which our present bards observe in erecting a Gorsedd circle were recorded at a time when some said the winter solstice was on December 9 and some on December 10. I mention this because some would have it that these instructions were invented by a Glamorgan bard about the beginning of the last century, who knew the solstice to occur on December 21!

True or false, there is no question of the formal authentication of these traditions, and that is a great step gained. But could these traditions be deliberate inventions after all, guarded and handed down by the bards as such? There is nothing to warrant such a remark. To invent such things the bards would have to be expert historians and archæologists. They were neither the one nor the other, and in their time scientific history and archæology were hardly in existence. Sometimes the bard-redactor indulges in history, and he always blunders in names and dates. But even the poor bits of history are found to be genuine traditions, and may be true enough except as to names, places, and dates. For instance, we are told that the bardic order, and every other order, was established by a man named Prydain (Britain), who was born on the vernal equinox, and every New Year's Day was Prydain's birthday. Students of Rome and Egypt will note this, though, I believe, some in the past have looked upon this tradition as a conclusive proof of the utter worthlessness of bardic history.

As to archæology, it is some study of that science which led me to look into these traditions for collateral evidence. The following are instances. We are told that Arthur caused the system of the Round Table (the Gorsedd, in fact) to be written on plates of tin and brass, and deposited at Gelliwig (Pendennis?) in Cornwall. I am not aware that such bronze tablets have been found there, and it is a mystery how the bards knew of such a medium of writing. But such plates have been found in ancient Gaul on which the Coligny Calendar is inscribed, dating about the beginning of the Christian era.

The bards tell us of an important festival which has wholly disappeared, except possibly in the form of "house-warming," the Hob Feast, *Gwyl Bentan*, "the feast of a fire back, which takes place when five fire back stones have been raised, so as to constitute a dwelling station."

There is one feature of the bardic lore that invites confidence apart from historical and archæological allusions. It is a fine unconsciousness, such as is never found, I believe, in faked, forged, or invented histories. It betrays itself in two ways. On the one hand, the necessity of proving or defending whatever history or tradition he records never occurs to the bardic scribe. From period to period we have simply a record, stamped by a Gorsedd authority, of accepted truth or sound lore. On the other hand, he never troubles himself about Druidism as such. He tells us, in passing, that there was something of the kind in the time of Julius Cæsar. Very seldom the term Druidism is used, and then not for what Cæsar knew as such, but for the actual teaching of the bards. He never troubles himself over the question of a Druidical succession from Cæsar's time to the present. It is over-consciousness in handling the bardic traditions that has worked havoc with them within the last century. Fortunately, however, our materials have a downward limit of date to the sixteenth century, before hardly anybody thought of arguing the matter.

Within the last fifty years a special effort has been made to "restore" the Gorsedd. Until lately its preservation was very much a local matter, in which the bards of Glamorgan have been most faithful. Now, however, it is a distinctly national institution.

JOHN GRIFFITH.

CLIMATOLOGY OF THE UNITED STATES.

PREPARED by Prof. A. J. Henry, under the direction of Prof. Willis L. Moore, chief of the United States Weather Bureau, a volume[1] of 1012 pages has recently been published dealing with the climate of the United States. This most valuable contribution to meteorological science will be welcomed by all who wish for the advancement of this subject, and the Department of Agriculture is to be congratulated on publishing in this form the climatic statistics for the different portions of the United States.

Americans are nothing if not practical, and the issue of the volume before us is an excellent example of this. Thus, in the introduction, we are told first that the "need of such a volume has been felt for some time, particularly within the Department." Further, and this is where Great Britain might take a hint with regard to furthering the agricultural needs of her colonies, "During the last few years the Bureau of Plant Industry has introduced a number of seeds and plants new to this country, as well as new varieties of plants and grains already well established. In order that the best results may be obtained, it is essential that the new plant or seed be placed in a climate closely resembling that of its original habitat. The Pomologist has likewise felt the need of more generalised climatic data than is afforded by the scattered publications of the Weather Service, and this is true in other lines of research that are being prosecuted by the Department."

The above quotation is another instance, if one is required, that the American Government carefully fosters the study of meteorology, and thereby increases its revenue.

The data on which the statistics here given are based may be said to be taken from three sets of observations. Thus the first is due to the Medical Department of the Army, the observations being made at military posts during the period 1820–1890. The second is the result of observations made by the cooperating observers of the Smithsonian Institution, and extends from 1849–1874. The third and last set is due to the Signal Service and the Weather Bureau, and commenced in 1870 and is continued up to date.

In spite, however, of the fact that several records cover a great number of years, only a few records exceeding fifteen years in length are inserted in this volume. The reason for this, as stated, is that it is only within the last ten or twelve years that uniformity, both in observing and recording climatological data, has been attained.

The book before us may be considered as divided into three sections. The first portion consists of an admirable summary of the main features of the United States climate (pp. 7–84), supplemented with numerous maps and charts. The second part (pp. 85–118) consists of general tables of temperature, humidity, and wind, followed by a list and map of the climatological stations which appear in the report. The remaining but greater portion of the volume (pp. 119–1012) is composed of the contributions of the district forecaster or section director of each State. This, as a rule, takes the form of a general description in words of the climate of the State as a whole, then a State summary in tabular form regarding temperature, frost, and precipitation, and, lastly, the monthly, seasonal, and annual means for temperature and precipitation for each station, together with such data as description of locality, instrumental equipment, and positions of instruments. When it be mentioned that no less than 690 stations are referred to, and the data for each station occupy a page, some idea of the amount of material dealt with can be obtained.

[1] "Climatology of the United States." By A. J. Henry. U.S. Department of Agriculture. Weather Bureau, Bulletin Q (Washington, 1906.)

Reference has been made above to Prof. Henry's admirable summary of the broader features of American climate. This portion of the work should be read with great interest, because it brings together in clear and concise language an account of the general conditions of atmospheric circulation which occur over this large stretch of country. Justice to this essay could only be done by occupying considerable space, so remarks will be limited simply to one or two points which seem to be of more special interest. The first of these describes the conditions which accompany "cold waves," which occasionally pass over the country and envelop it in Arctic weather. The fall of temperature to justify one of these waves must, as is stated, be at least 20° F. in twenty-four hours, except along the Gulf Coast, where a drop of 16° F. or more constitutes a cold wave. Cold waves follow in the wake of cyclones under the influence of which the temperature has risen. The lowest isotherms are nearly coincident with the highest reading isobars in the anticyclonic system which follows the cyclone. The isotherms, other than the lowest, only very generally follow the trend of the isobars, and spread much further south over the United States than the isobars would suggest. The cause of these cold waves is due, not merely to the prevalence of the cold north-west winds which follow the passage of the low-pressure area, but more particularly to the radiation from the ground in the clear dry air in the rear of the cyclone. The cold of radiation is communicated to a greater stratum of air, and the effect of solar radiation is reduced, since the surface layers are being constantly renewed by colder air from higher latitudes. With little horizontal air movement in the anticyclone, the night temperatures are low, and there is a tendency for this cold air to collect in valleys and basins. January, February, and March are the months in which the waves chiefly occur, and in the eastern part of the United States the average number a year is three or four.

Prof. Henry gives some very instructive maps illustrating the barometric and thermometric conditions during some of the more intense waves that have been recorded.

Hot waves, or "heated terms" as he calls them, are more briefly dealt with, and some idea of their effect on humanity may be gathered from the statement that "during the three weeks that ended August 22, 1896, there were 2036 known deaths in the United States directly attributable to sunstroke. Large as this number is, it doubtless falls far short of the actual number of cases."

In the same thorough way in which the above waves of heat and cold have been discussed, Prof. Henry deals with precipitation, sunshine, wind (including thunderstorms and tornadoes), &c. The concluding section is devoted to seasonal variations from year to year. It will be remembered that at the beginning of the present year, when Europe was enveloped in a cold wave, Iceland, with a much more northern latitude, was revelling in warm weather. Similar inversions occur in the United States. Thus we read that, during the severe weather of March, 1906, when temperatures 10° F. to 20° F. below zero prevailed in the northern Rocky Mountain region, including the southern portions of Alberta, Assiniboia, and Winnipeg, the weather in Alaska, far away to the north, was warm and pleasant, with temperatures above freezing in the lower Yukon Valley, and about freezing in the vicinity of Eagle (longitude 141° W.).

The primary object of the present work was to present in a form for easy reference comparative statistics for the different parts of the United States. This object has been very successfully attained in this volume so far as existing homogeneous observations allow, but the data for many stations will have to be revised when means can be formed for a greater number of years. Nevertheless, the volume is a valuable contribution to the meteorology of the portion of the world with which it deals, and will serve probably to stimulate the directors of some other meteorological services to bring together masses of existing material which are for the most part lying dormant.

DEDICATION OF THE CARNEGIE INSTITUTE.

THE trustees of the Carnegie Institute had permitted their European guests to select the steamers that suited them, and had taken quarters for them in the new and luxurious Hotel Belmont, 42nd Street, New York. On Wednesday morning, April 10, two special pulmans and a luncheon car were provided to take the party to Pittsburg, and one or two of the trustees were on board to welcome the guests and to make them known to one another. Amongst the party were Baron d'Estournelles de Constant and M. Paul Doumer, representing the Institut and various French universities; M. Leonce Benedite, director of the Luxembourg; and M. Camille Enlart, director of the Trocadéro Museum, Paris; their Excellencies T. von Moeller, Minister of State, and Lieut.-General von Loewenfeld, Adjutant-General, represented the German Emperor; Privy Councillor Dr. Koser, chief director of the Prussian State Archives and member of the Academy of Sciences, and F. S. Archenhold, director of the Treptow Observatory, represented scientific Germany; Sir Robert Ball, F.R.S., and Dr. Roberts, the Vice-Chancellor, represented the University of Cambridge; Dr. John Rhys represented Oxford University; whilst there were also present Sir Edward Elgar, Sir William Preece, F.R.S., and Dr. Chalmers Mitchell, F.R.S.

Continued snowstorms made it impossible to see much of the wild scenery of the Alleghenies, and the famous horse-shoe curve of the Pennsylvania Railroad was traversed in a regular blizzard. The party reached Pittsburg about 8 p.m., and at the Hotel Schenley, situated in the Schenley Park, a few yards from the Carnegie Institute, found assembled a very large number of Americans representing nearly all the scientific institutions and universities of the United States and from Canada, Principal Peterson and Dr. Bovey from the McGill University, Montreal, and Dr. Galbraith from Toronto.

The proceedings began on Thursday morning, April 11, with a reception of the guests in the founder's room by Mr. Frew, president of the board of trustees, who above all others has been responsible for the translation of Mr. Carnegie's generosity into the actual buildings. This was followed by a reception in the grand foyer of the institute, at which the guests were presented to Mr. and Mrs. Carnegie. After luncheon there was a procession of the guests in uniform or academic costume through lines of cheering students, from the hotel to the institute. At 2 o'clock nominally, actually about 3.30 p.m., the dedication took place. The Cambridge Vice-Chancellor delivered an "invocation," modelled on the university "bidding prayer"; Principal Rhys read a scripture lesson (Proverbs, iii., 9–27), Mr. Carnegie delivered a long address, and M. d'Estournelles de Constant and Theodor von Moeller presented official congratulations from France and Germany.

It was notable, and somewhat humiliating to the English visitors, how elaborately Germany had made official arrangements for showing the sympathy of its Government. At each function Germany was to the fore; there was a personal cable from the Emperor, the Emperor's high representatives appeared with their staff in brilliant uniform, and a special gift of German State records and Blue-books, and the formal return gift from Mr. Carnegie of a cast of Diplodocus, were only characteristic examples of the German activity. The high position and exquisite tact of Baron d'Estournelles de Constant, together with the public announcement made by him a few days later at New York, that the French Government had commissioned him to bestow the Grand Cross of the Legion of Honour on Mr. Carnegie, supported the prestige of France, but although the British subjects who were present ably upheld the position of England in their individual capacities, there was no one formally commissioned to represent the English Government.

On Friday, April 12, there was an informal reception at the technical institute, and a presentation of addresses in the large hall from the various universities and learned bodies throughout the world. There were in addition a number of addresses delivered in whole or in part by the European guests; Sir Robert Ball took as his subject "The Solution of a Great Scientific Difficulty," stating the difficulty in the old supposition that the contraction of its sphere could be the source of the energy radiated out by the sun, and suggesting that the presence of radium offered a solution. Sir W. H. Preece spoke on the connection between science and engineering, tracing the extent to which the art of the engineer had been indebted to the researches of pure science. Dr. Chalmers Mitchell discussed international cooperation in zoology, dealing specially with the necessity for unity in nomenclature and with progress in the international recording of zoological literature. In the evening there was a large banquet, and the proceedings ended on Saturday morning with the ceremony of the conferring of honorary degrees by the Western University of Pennsylvania. The English recipients were as follows:—LL.D., Sir Robert Ball, Sir Robert Cranston, Sir Edward Elgar, Dr. P. Chalmers Mitchell, Sir W. H. Preece, Dr. John Rhys, the Rev. Dr. E. S. Roberts, Dr. John Ross; Litt.D., Mr. C. Moberly Bell and Mr. W. T. Stead.

The Carnegie Institute, the area of which is nearly four acres, and the adjacent technical schools, which when completed will cover with their workshops and yards nearly thirty-two acres, are the "gifts of Andrew Carnegie to the people of Pittsburg," and are dedicated to "literature, science, and art." The total cost, together with a recent endowment for maintenance of more than a million pounds, has been about four million pounds. The management is vested in a board of trustees consisting of local representative men, under whom Dr. W. J. Holland is director of the museum, Mr. John W. Beatty director of the fine arts department, Mr. A. A. Hamerschlag director of the technical schools, whilst Mr. A. H. Hopkins is chief librarian. The exterior of the institute proper is unpretentious, the structure being of steel faced with grey sandstone in a simplified Corinthian style. The interior is a series of gorgeous halls and corridors in marble and gilding, decorated with a striking series of mural paintings by Mr. J. W. Alexander, a young American artist. The library contains special rooms for the reference collection, for the lending library, and for children, and at present consists of nearly 1,500,000 volumes, 800,000 of which find place in an eleven-story book-stack. There is a very large music-hall with a fine organ and a magnificent foyer. The fine arts department contains nine galleries, with a floor space of more than 44,000 square feet, and in addition a hall of sculpture and a hall of architecture. The galleries contain a good permanent collection, specially rich in the works of modern artists, with a special section for an annual international exhibition.

The museum, to which there is attached a fine lecture hall, an excellent special library, and a well-equipped series of research rooms, has a floor space of more than 100,000 square feet, arranged in three tiers, of open courts and galleries. On the ground floor there are special collections of gems and coins, particularly rich in specimens from China, India, and Korea, the gifts of John J. Lewis, William Thaw, and Mr. Carnegie. The main hall of the museum is devoted to mineralogy and geology. There is an almost complete collection of local minerals, and a fine series of huge relief maps of the district. The palæontological department is dominated by Diplodocus, but contains many other interesting specimens, in particular a very fine series of Oreodont mammals. The second floor contains galleries devoted to economic botany and to general zoology. There is a large and well-mounted showcase of Steller's sea-lions, and a capital group of Rocky Mountain goats. The bird series is as yet disappointing, but the arrangement of the galleries has only begun. The third floor is devoted to entomology, and Dr. Holland's fine collection of Coleoptera and Lepidoptera has now found a home worthy of its zoological importance. The chief assistants of Dr. Holland are Mr. Douglas Stewart, in the department of mineralogy; Dr. A. E. Ortmann, with P. E. Raymond, Earl Douglass, and O. A. Peterson, in palæontology; Prof. C. V. Hartman, in ethnology; Mr. O. Jennings, in botany; Mr. W. E. C. Todd, in ornithology; and Mr. H. Kahl, in entomology. The chief assistant in the setting up of fossils is Mr. A. S. Coggshall, whilst Mr. F. S. Webster is the taxidermist and Mr. Th. A. Mills the modeller. With such a staff and the ample endowments at his disposal, Dr. Holland has a magnificent opportunity of which he may be expected to take full advantage.

A full description of the technical schools would require many pages. In equipment and staff they are magnificent, and are adapted for the teaching of almost every form of the mechanical arts.

ARCHÆOLOGY AND THE ASSOUAN DAM.

A DESPATCH from the Earl of Cromer, just issued as a White Paper (Cd. 3397), deals with the question of increasing the water supply of Egypt by constructing a new dam or raising the present dam at Assouan. Notes are included by Sir William Garstin, Sir Benjamin Baker, Mr. A. L. Webb, and Captain Lyons, in which the various plans are considered. After examining all possible sites, the opinion expressed is that no alternative exists but that of raising the Assouan dam. Unfortunately, this means the almost complete submersion, during a portion of the year, of the temples at Philæ; and it is therefore important to know what the Egyptian Government intends to do with regard to the Nubian monuments affected by the proposed works.

Captain Lyons points out in his note that since in an arid climate the flood plains are almost the only region where civilisation has been able to develop, a thorough investigation of the monuments in the district to be affected should be made before the water-level is raised. His principal suggestions are summarised as follows:—

> An archæological survey of Nubia should be carried out, at the expense of the Government, and every effort should be made to render it as complete as possible. The different archæological societies in Europe should be invited to cooperate with the Egyptian authorities in this work, by sending representatives to assist in these researches. Wherever possible, the foundations of the monuments submerged should be reconstructed and consolidated, as was done in the case of the Philæ temples. Such repairs as may be considered necessary to insure the stability of their superstructure should also be undertaken. A thorough and complete examination of all the ancient sites, settlements, and cemeteries which will fall within the limits of the raised water-levels should be carried out, and drawings or photographs sufficient to preserve a complete record must be made by competent artists. Lastly, the results of these investigations must be published to the world.

Sir William Garstin does not hesitate to say that this programme will be adopted, and that "the funds necessary for such an object will not be grudged by the Government." If the raising of the dam is preceded by an exact scientific survey, archæology will benefit by an increase of knowledge, while Egypt will gain by an increase of water supply. There ought, however, to be a definite undertaking that the work will be carried out by the Egyptian Government in a reasonable time. We should be glad to know what has been done with regard to the complete archæological survey of the region already submerged. When the proposal was made in 1894 to build a dam at Assouan with its crest 114 metres above mean sea-level, the archæological societies of Europe protested against it in the strongest terms, and the result was the adoption of a modified scheme in which the crest of the dam is eight metres (26 feet) lower than that of the original project. This was of the nature of a compromise, and the Egyptian Government on its part undertook "to carry out an archæological and scientific investigation of the whole of Nubia."

From Captain Lyons's note in the present White Paper we understand that a topographical basis for such a survey has been prepared, but the systematic study of the submerged portion of the Nile valley, from an archæological point of view, has still to be made. As this is a matter for the Egyptian Government, the responsibility for the survey must not be thrown upon archæologists (who not only are not paid, but have to pay for their exploration), but should be borne by the Government.

By the scheme now proposed, the future maximum water-level will stand seven metres (very nearly 23 feet) higher than is the case at present, so that the dam now contemplated will have practically the same height as that of the original project against which archæological societies strongly protested. It is therefore desirable to insist that the promised investigations should be undertaken seriously by the Egyptian Government without delay, and that adequate provision be made for the systematic survey of the region. Unless all records of the earlier civilisation of the region are carefully and accurately collected and studied, as suggested by Captain Lyons, the claims of archæology are likely to be forgotten when the engineering scheme has been approved and the works are in progress.

MAY METEORS.

IN Spring months meteoric observers can hardly expect very productive results. The weather is often fine and pleasant, it is true, but meteors are usually scarce, and an average night will not present more than about four or five per hour. In 1886, during the month of May, I counted 127 meteors in twenty-five hours of observation. In 1903, May, I saw seventy-two meteors in $18\frac{3}{4}$ hours, and, if allowance is made for time engaged in recording paths, the deduced horary number was about five.

I have noticed that at this season of the year there are comparatively few meteors leaving definite streaks. In July (last half) and August there are, however, a large proportion of streak-producing meteors, but the majority of these are obviously Perseids belonging to the great July-August shower. Some years ago I counted out the number of meteors with streaks seen by me in June and July (1873–1901), and the relative figures were:—

June, of 252 meteors, thirty-one had streaks, proportion 8 to 1.

July, of 641 meteors, 141 had streaks, proportion $4\frac{1}{2}$ to 1.

It cannot be held that May offers any special inducement to meteoric observers, but some very interesting showers are visible. In the early part of the month there are the Aquarids, supposed to be connected with Halley's comet. At about the middle of May the Coronids are often active from radiants at about $231^\circ+27^\circ$ (near α Coronæ) and $246^\circ+31^\circ$ (ζ Herculis), and at the close there are the η Pegasids from $330^\circ+26^\circ$, maximum on May 30.

There are many other showers from Hercules, Draco, Libra, Serpens, Scorpio, &c. Fireballs are tolerably numerous during the month, and they are apparently directed from a number of different radiants.

This epoch is likely well to repay investigation, as it has never been amply studied in past years. More observations should therefore be obtained, so that the leading showers of the present day may be ascertained.

Though the majority of streams are probably of annual occurrence, a few of them are undoubtedly periodical, giving perhaps only one pretty rich exhibition once in a long series of years. The latter class of shower would escape notice unless observations were maintained with great assiduity and regularity. As an instance of a rich periodical shower of this kind, I may mention that on 1879 August 21–25 I witnessed the flight of fifty-six bright meteors from a radiant at $291^\circ+60^\circ$, near the star o Draconis, but though I frequently endeavoured to re-observe this display, it never returned except under a very feeble aspect.

W. F. DENNING.

NOTES.

THE annual conversazione of the Royal Society will be held at Burlington House on Wednesday next, May 8.

SIR JAMES DEWAR, F.R.S., has been elected a foreign member of the National Academy of Sciences, Washington.

THE Société chemique de France will celebrate its fifty years' jubilee by special meetings on May 16–18.

REUTER messages from Messina report that a violent eruption of Stromboli occurred at 10 p.m. on April 27. It was accompanied by a strong shock of earthquake, which shattered windows and caused other damage in the vicinity. The cable between the Lipari and Stromboli islands has been broken.

THE Meteorological Committee has appointed Mr. Ernest Gold, fellow of St. John's College, Cambridge, superintendent of instruments in the Meteorological Office, to the readership in dynamical meteorology established for three years from October 1. The readership is constituted from funds contributed by Dr. Arthur Schuster, F.R.S., and is tenable, under certain conditions, at any university in the United Kingdom.

THE exposition which is to be held at Berlin in connection with the fourteenth International Congress for Hygiene and Demography, on September 23–29, promises to be an interesting one. The fight against infectious diseases, principally colonial and tropical diseases, hygiene work of the State and municipality, especially the care of infants, provision of good drinking water, removal of waste, and the hygiene in schools, will be represented by many exhibits. In consideration of the importance of hygiene to private and public life, it has been resolved to keep open the exposition, which is to be held in the "Reichstag," to the end of September.

THE Destructive Insects and Pests Bill was read a second time in the House of Lords on Monday. The Bill is intended to grapple with several matters of importance to the agricultural world, and in particular with the disease called the gooseberry mildew. It provides that the Board of Agriculture may make such orders as are thought fit to prevent the introduction or spread of any particular insect, fungus, or other pest destructive to agricultural or horticultural crops, or to trees or bushes. The Bill gives the Board power to regulate the landing of plants and to authorise the removal or destruction of any diseased plant. Local authorities are empowered to pay compensation for any crops or trees so destroyed.

AT a special general meeting of the Geological Society, to be held on Wednesday, May 15, a new section of the bye-laws, providing for the election of women as associates, will be considered and voted upon. The first clause of the proposed new section reads as follows:—"Any woman who has distinguished herself as a geological investigator, or who has shown herself able and willing. to communicate to the Society original and important geological information, or who has exercised signal liberality towards the Society, and is desirous of being elected, provided she be a British subject, or be domiciled in the British dominions or their dependencies, may, subject to the provisions hereinafter contained, be elected an Associate, the number elected being limited to forty."

AT the second National Poultry Conference, to be held at Reading on July 8–11, the discussions have been arranged under six sections, dealing respectively with poultry farming and production, breeding, hygiene and disease, women and the poultry industry, education and research, and commercial subjects. Among papers to be read at the conference we notice the following:—the Mendelian laws and their application to poultry breeding, by Mr. C. C. Hurst; hybridisation experiments with Ceylon jungle fowl (*Gallus stanleyii*), by Dr. J. Llewellyn Thomas; the economic values of external characters, by M. Louis van der Snickt; parasitic liver disease in poultry, by Prof. F. V. Theobald; the influence of heredity upon the diseases and deformities of poultry, by Dr. H. B. Greene; methods of instruction in poultry-keeping, (*a*) in the United Kingdom, by Mr. F. W. Parton, (*b*) in Australia, by Mr. W. H. Clarke; results of experimental work, (*a*) in the United Kingdom—(*b*) in America, by

Prof. J. E. Rice. Full particulars of the conference can be obtained from the honorary secretary, Mr. Edward Brown, 12 Hanover Square, W.

The annual conversazione of the Selborne Society was held in the theatre and halls of the Civil Service Commission, Burlington Gardens, on Friday, April 26, and between five hundred and six hundred guests were present. Lord Avebury presided, and was supported by the Earl of Stamford and the Hon. Walter Rothschild. During the course of his presidential address, which dealt with the study and appreciation of nature, Lord Avebury said:—"To the wise and good, indeed, Nature is divine, but to understand her we must love her, we must feel that we are one with her. People often talk of the supernatural. This is, no doubt, mainly a matter of definition. To me, Nature is all-sufficient and all-covering. What they regard as supernatural seems to me either natural or non-existent. Whatever exists is part of Nature. It is not that those who hold these views wish to lower the so-called supernatural, but that those who hold the opposite opinion seem to us to limit and lower Nature. Nature is infinite. Every fresh discovery reveals new sources of wonder; every problem that is solved opens others. The telescope and microscope create for us new worlds; the spectroscope has answered questions which Comte thought were obviously beyond the range of human ken." During the evening Mr. E. J. Bedford, one of the first to apply photography to the study of birds, gave an illustrated lecture on "Bird Architecture." Among the exhibits were the original manuscript of Gilbert White's "Natural History of Selborne," and the original letters of Mulso to Gilbert White.

To vol. lxxxvi., part ii., of the *Zeitschrift für wissenschaftliche Zoologie*, Mr. W. S. Marshall, of Madison, Wisconsin, contributes an elaborate account of the development and structure of the cellular elements of the ovary in two species of insects, based on investigations recently conducted by himself in Berlin. The wasp known as *Polistes pallipes* forms the subject of the first paper, in which, after reviewing previous work, the author discusses the developmental history of the three types of cells—oöcytes, nurse-cells, and epithelial cells—throughout the whole or the greater part of their existence. In the second paper, where *Platyphylax designatus* is the species discussed, the author opens up newer ground, since very little is known as to the details of the developmental history of the Phryganeidæ.

We have received three publications from the Bergen Museum, the *Aarsberetning* for 1906, together with the third part of the *Aarbog* for 1906 and the first part for 1907. From the first of these we learn that attention continues to be directed to extending the educational value of the museum, especially as regards the fauna of the country, several new groups of Norwegian animals having been added to the exhibited series. In the third part of the *Aarbog* for 1906 Mr. J. A. Grieg continues his description of the echinoderms collected in the late cruise of the *Michael Sars*, dealing in this instance with the starfishes, while the bryozoans obtained on the same expedition form the subject of an article by Mr. O. Nordgaard in the issue for the current year. The stone-implements of western Norway are discussed by Dr. A. W. Brögger in the last-named part.

Prof. A. J. Ewart contributes to the Proceedings of the Royal Society of Victoria, vol. xix., part ii., a list of identifications of Australian plants, several of them being corrections of previously recorded names. A new genus of the Compositæ, Bellida, founded on a West Australian species, is described and figured. Two new species, *Daviesia mesophylla* and *Eriostemon intermedius*, are recorded, and the characters of *Romulea cruciata*, a native Irid known as onion grass, allied to *Romulea bulbocodium*, are noted.

In Florida the growers of citrus fruits are troubled with the whitefly, *Aleyrodes citri*. A Bulletin, No. 88, of the Florida Agricultural Station, prepared by Dr. E. W. Berger, deals with the methods of combating the pest. Special value is attached to the efficacy of fungi parasitic on the whitefly, of which a red fungus, *Aschersonia Aleyrodes*, a yellow species of Aschersonia, and a brown fungus are known. It is recommended to scatter spores of the fungi by spraying, or to introduce cultures on leaves or trees.

As a consequence of the shortage in the Indian jute supply, the Government of India delegated Mr. R. S. Finlow, attached to the Agricultural Department as a jute specialist, to ascertain whether new localities suitable as to soil and climate could be discovered outside the ordinary area of jute cultivation that lies along the lower courses of the Ganges and Brahmaputra rivers. In Mr. Finlow's report, issued as Bulletin No. 3 of the Agricultural Research Institute, Pusa, it is stated that jute growing promises to be successful in Bihar, where it will take to some degree the place of indigo. With regard to districts inspected in Madras, Bombay, and Central Provinces, the prospects are less certain, and it will be necessary to await the results of experimental cultivation.

No branch of botany received more attention from Prof. Errera and his pupils than the examination of organic compounds in plants. The late professor was therefore essentially qualified to prepare a practical course on the microscopical identification of such compounds in plant tissues. A small brochure, consisting of the notes on this subject drafted by him for the benefit of students taking botany for a doctorate in science at the University of Brussels, has been published by Dr. J. Massart. Some of the reactions are based on researches made in Brussels, others are taken from the writings of Macallum, Gilson, and Moll.

A general review of the evolution of scientific methods for improving the sugar-cane by hybridisation is presented in the paper published in the *West Indian Bulletin*, vol. vii., No. 4, under the joint authorship of Sir Daniel Morris and Mr. F. A. Stockdale. The possibility of raising seedling canes was authenticated by Harrison and Bovell in 1888; this was shortly followed by the production of numerous seedlings, some of which have proved greatly superior to previously existing strains. Success was thus obtained, but the results were quite fortuitous, and the parentage of the seedlings could not be determined. Finally, the somewhat difficult task of removing the anthers from young flowers and pollinating with pollen from a known type was performed by Lewton-Brain in 1904. The paper also furnishes an indication of future lines of work and a summary of results already obtained. Coloured illustrations of six of the best known West Indian varieties are given.

Up to the present time no deposit of coal has been discovered in the Sahara and in the whole of North Africa. An attempt to ascertain whether coal really exists to the south of Algeria has been made by Mr. E. F. Gautier, and the results of his explorations have been communicated to the Société d'Encouragement (Bulletin, vol. cix., No. 3) by Mr. A. Carnot. No trace of coal was found, but an extensive Carboniferous area was traversed between Figuig and In Salah, and it is possible that coal exists concealed beneath the vast Cretaceous plateaux.

AT the meeting of the Institution of Civil Engineers on April 16, papers were read on the Pyrmont bridge, Sydney, New South Wales, by Mr. P. Allen, and on the swing bridge over the river Avon at Bristol, by Mr. W. H. B. Savile. The Pyrmont bridge across Darling Harbour is 1210 feet long. There are three 30-feet openings in the Sydney approach for vehicular traffic to wharves, while on the Pyrmont side the Darling Island railway passes under a steel bridge of 25-feet span. Electric motive power is used for working the swing span and for roadway gates and for lighting, the whole being operated by one man from a conning tower in the centre of the swing span. The Bristol bridge, which is 600 feet long, carries a carriage road and a double line of the Great Western Railway. The main feature is the swing span, which is 202 feet 6 inches long, pivoted on a pier in the river.

THE current issue of the Transactions of the English Ceramic Society (vol. vi., part i.) shows that much useful work in the discussion of subjects relating to the clay-working industries is being done by the society, which meets at Tunstall, Staffordshire. The contents comprise seven original memoirs, four of which are written by Dr. J. W. Mellor, the hon. secretary of the society, and deal respectively with the determination of the amount of soluble salts in clays, excess air in firing kilns, the sulphuring and feathering of glazes, and the influence of high temperatures on porcelain pyrometer tubes. In the other papers, Mr. W. Burton reviews the different methods of recording high temperatures, Mr. W. F. Murray discusses the pottery oven of the future, predicting that gas firing, at present unknown in the earthenware trade, will fifty years hence be universal, and Dr. F. Shufflebotham deals with the hygienic aspect of the pottery industry.

THE Bureau of Science of the Government of the Philippine Islands publishes the *Philippine Journal of Science* in three sections, dealing with:—A, general science; B, medical science; and C, botany. The numbers in each section appear as rapidly as material is available, and the latest number to hand (A, vol. ii., No. 1) shows that the papers attain a high standard of excellence. There are four original memoirs, on the terpene oils of *Manila elemi*, by Mr. A. M. Clover; on the action of sodium on acetone, by Mr. R. F. Bacon and Dr. P. C. Freer; on a new subspecies of Philippine Cicindelidæ, by Mr. W. Horn; and on the proximate analysis of Philippine coals, by Mr. A. J. Cox. In the last-mentioned paper the author shows that the directions for coal analyses recommended by the American Chemical Society are inapplicable to certain Philippine coals. These coals are easily detected by the shower of incandescent carbon particles which are driven off when the sample is subjected to rapid heating. This mechanical loss can be overcome by expelling the volatile matter very slowly so that the escaping gases do not ignite. This smoking-off method approaches the conditions existing in a coke-oven.

AN interesting account of the Blue Grotto at Capri has been published by Mr. F. Furchheim, of Vienna, 2 Seilerstätte, District I., for private circulation. It is reprinted from the *Deutsche Rundschau fur Geographie und Statistik* (January), and deals with the changes which have taken place in the grotto, considered particularly in reference to variations of sea-level, from the times of the ancients down to the present day, as revealed by historic documents and references.

THE *Revue scientifique* (April 13) publishes an interesting account of graphic methods of calculation in the form of an inaugural address by Prof. Maurice d'Ocagne. As is well known, Prof. d'Ocagne introduced the method of "nomography," in which calculations are performed by drawing lines across a diagram with a ruler. His use of the method for solving algebraic equations is well known. That a piece of squared paper forms an excellent substitute for a slide rule when used in this way is so simple and obvious that it is surprising how often the fact is overlooked.

THE relations of science to questions of national interest forms the subject of a number of the papers in the current issue of *Science Progress*. Mr. James Johnstone discusses the international fishery investigations, and directs attention to the unsatisfactory position of fishery statistics, particularly in connection with Great Britain. The relationship of mining to science, in the hands of Mr. W. E. Lishman, forms the basis for further reflections on England's neglect of science. Dr. John Wade replies to Prof. H. E. Armstrong's attacks on our present medical curriculum; and Prof. Armstrong contributes an address on "The Opportunity of the Agriculturist," and draws a timely moral from the efficiency of the United States Agricultural Bureau. Mr. R. H. Biffen also shows the need of agricultural research in his paper on modern plant-breeding methods. Mr. Shipley, in his paper on the danger of flies, puts in one good word for the motor-car, which, with all its faults, affords no nidus for flies.

IN a paper contributed to the *Physical Review* for March, Mr. W. R. Turnbull discusses the forms and stability of aëroplanes. The author describes laboratory experiments made with planes and singly and doubly curved surfaces, and draws curves showing the lift, drift, and coordinate of the centre of pressure expressed graphically in terms of the angle of inclination. He rightly directs attention to the supreme importance of longitudinal stability. This is a factor which is apt to be neglected by practical aëronauts whose main thought is to build flying machines in the hope of winning prizes. The data in question will afford useful material so far as they go, for studying the stability of various types. This stability depends, however, on other factors also, such as the moment of inertia and the position of the centre of gravity of the proposed apparatus. Another interesting note was recently contributed to the *Comptes rendus* by Captain Ferber, dealing with the forms of propellers calculated to give the maximum efficiency.

MR. F. W. ASTON writes in reply to Mr. A. A. Campbell Swinton's letter, which appeared in NATURE of April 18 (p. 583), to say that when Mr. Swinton has the opportunity of comparing the full text of the Royal Society paper with his own results of 1898 he will recognise the wide dissimilarity of conditions, effect, and explanation between them. The mica mill referred to in the abstract is designed to show that inside the dark space, under conditions of moderate pressure and continuous current, the mechanical energy flowing towards the kathode in the path of the kathode rays is far in excess of that flowing in the opposite direction, a phenomenon which, under the conditions of Mr. Swinton's experiments—very low pressure and discontinuous current—is actually reversed.

REFERENCE was made in NATURE of April 4 (p. 543) to a paper by Mr. C. E. Moss on the "Geographical Distribution of Vegetation in Somerset." The paper is published by the Royal Geographical Society, but did not appear in the *Geographical Journal.*

A CORRESPONDENT asks for a reference to the latest discussion of the stadium of Eratosthenes and the official or Royal Egyptian stadium mentioned in a recent review in NATURE (April 11, p. 553). The information required will be found in "Griechische und römische Metrologie," by F. Hultsch (Berlin, 1882), and in Dr. Dreyer's "History of the Planetary System" (Cambridge, 1906).

A SECOND edition of "The Textile Fibres: their Physical, Microscopical, and Chemical Properties," by Dr. J. Merritt Matthews, of the Philadelphia Textile School, has been published by Messrs. John Wiley and Sons, of New York, and Messrs. Chapman and Hall, Ltd., in this country. The book has been re-written, and is intended to bring together all the material available for the study of the textile fibres. The price of the volume is 17*s.* net.

MESSRS. WITHERBY AND CO. announce the forthcoming publication of a limited edition of a work on "The Vertebrate Fauna of North Wales," by Mr. H. E. Forrest. The work will be a history of the mammals, birds, reptiles, amphibians, and fishes to be found in that part of Wales lying north of the Dovey Estuary, illustrated with plates depicting notable haunts of typical species, portraits of Pennant and other former recorders, and a coloured map of the district.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY:—

May 1. 11h. Mars in conjunction with Uranus, Mars 0° 46′ S.
,, Mars. Apparent diameter = 12″·54.
1–6. Epoch of Aquarid meteors. Radiant 337° – 2°.
6. 10h. 31m. Minimum of Algol (β Persei).
16. 7h. 13m. to 10h. 27m. Transit of Jupiter's Sat. III. (Ganymede).
21. 12h. Jupiter in conjunction with Neptune. Jupiter 1° N.
26. 12h. 14m. Minimum of Algol (β Persei).
,, 16h. 6m. to 16h. 52m. Moon occults θ Libræ (mag. 4·3).

COMET 1907*b* (MELLISH).—An extension of the ephemeris given by Miss Lamson and Frederick, computed by Dr. Strömgren, appears in No. 4172 (April 20) of the *Astronomische Nachrichten*, and gives the calculated daily positions of the comet up to May 10. This object is now barely one-tenth as bright as when discovered, and, according to the elements, was nearest to the earth on April 10·98.

THE RING OF MINOR PLANETS.—Some very interesting facts are educed in a discussion, by Dr. P. Stroobant, which appears as an extract from the *Annales d'Observatoire Royal de Belgique*, vol. ix., part iii.; Dr. Stroobant's subject is the constitution of the ring of minor planets, and he considers the relative distribution, the masses, and the classification of the first 512 of these bodies. After giving a very abbreviated history of the discovery and study of asteroids, the paper discusses the *lacunae* in the grouping of the minor planets, and also the grouping in regard to their mean distances from the sun. A decided maximum occurs between the limits marked out by rings respectively 2·55 and 2·85 astronomical units from the sun, 199 of the asteroids considered revolving in this annulus.

From a discussion of the available data concerning the magnitudes and probable diameters of asteroids, it is found that nearly all the asteroidal matter is concentrated near to the middle of the ring in the neighbourhood of the mean solar distance of 2·7, whilst further analysis shows that, as a general law, the smaller asteroids are relatively less numerous in the richest zones. At the end of the paper Dr. Stroobant tabulates the 512 asteroids in order of their mean distances from the sun, and gives the mean movement, the mean distance, and other data for each.

POSITIONS OF PHŒBE, 1898–1904.—No. 3, vol. lx. (pp. 45–85), of the Harvard College Observatory Annals contains the measured positions of Phœbe, the ninth satellite of Saturn, during the period 1898–1904.

The places of the standard stars employed were taken from the C.P.D. for the epoch 1875·0, and, should greater accuracy be required, all the material for a second reduction is included in the present memoir; it will only be necessary for such a reduction to determine the places of the standard stars with greater accuracy.

OBSERVATIONS OF THIRTY-THREE VARIABLE STARS.—In Bulletin No. 110 of the Laws Observatory, University of Missouri, are published the preliminary results obtained from the observations of thirty-three variable stars, the light-curves and periods of which are as yet imperfectly known. The bulletin gives a list of the stars considered, with their places for 1855·0, followed by a brief discussion of the results yet obtained for each star. These results are compared with previously published elements, and in some cases the light-curves are reproduced.

THE ITALIAN PROMINENCE OBSERVATIONS, 1877–1883.—No. 5, vol. xxxvi. (p. 54, 1907), of the *Memorie della Società degli Spettroscopisti Italiani* contains a series of notes on the prominence observations made at Palermo and Rome from 1877 to 1883. These notes give the atmospheric conditions for each observing day, and brief remarks on any observation of especial interest, and should prove useful in any discussion of these valuable observations.

THE SPECTRUM OF MIRA.—A brief discussion of the spectrum of Mira, photographed at the Lowell Observatory on January 11, is published by Mr. V. M. Slipher in No. 3, vol. xxv. (p. 235, April), of the *Astrophysical Journal.* The region shown on the plate includes Hα, Hβ, Hγ, and Hδ, all of which are bright and increase in intensity in the order given. The series of absorption bands commences at λ 4584, possibly at λ 4463, and appears to extend beyond the region photographed, *i.e.* beyond λ 7000. Vanadium absorption is strongly represented. A comparison of this spectrum with that obtained by Stebbins, at Lick, in 1902, shows that Hβ (and probably Hα) was more intense during the more recent maximum. On the other hand, the series of dark bands appears to have been more intense, and to have extended further into the ultra-violet, in 1902.

THE HARVARD COLLEGE OBSERVATORY.—Prof. E. C. Pickering's report of the work done at the Harvard College Observatory during the year ending September 30, 1906, sounds a note of disappointment at the lack of financial support given to the schemes for astronomical work on well organised lines which he has formulated. The amount of meridian and photometric work accomplished was on the usual immense scale, and it is hoped that when the 60-inch Common telescope is completed the visual work will be greatly extended to the faintest stars.

On the Henry Draper memorial photographs Miss Cannon studied 691 stellar spectra and classified them. Three stars, H.P. 934, H.P. 3030 and +44°.3639, were found to show the second series of hydrogen lines. Mrs. Fleming also found numerous variable stars and stars having peculiar spectra on plates taken with the 8-inch Draper, the 8-inch Bache, and the 24-inch Bruce telescopes respectively. A great amount of work was also performed at the Arequipa station and at the Blue Hill Meteorological Observatory.

NORTH POLAR PROBLEMS.[1]

The deep North Polar Basin forms the northern termination of a series of depressions of the earth's crust extending north through the Norwegian Sea from the eastern side of the Atlantic, and dividing between the continental masses of the old and the new world. The eruption of the Jurassic basalts of Franz Josef Land and Spitsbergen may have had some connection with the sinking in of the North Polar Sea bottom, but the basin was probably to a great extent formed before that time. Newer volcanic rocks are not known hitherto from the edges of the North Polar Basin. On Bennett Island, De Long reports lava (or basalt), but we do not know its age.

It is most improbable that any block of land (horst) should have remained isolated in the middle of such a basin, surrounded by deep water on all sides, and without having any connection with the surrounding lands or continental shelves. It is, therefore, of essential importance to determine the edge of the continental shelf off the known coasts. But the edge of the North Polar continental shelf is only known exactly in two places—north-west of the New Siberian Islands and north of Spitsbergen—whilst in the region between these two places we know the deep sea to the north. In the remaining part of the North Polar Sea we know as yet very little about the edge of the continental shelf.

The rule that the continental shelves are generally much narrower outside high and mountainous coast than off flat and low lands holds good only where the mountain formations of the coast are in near relation to the trend of the coast and to the continental slope outside, and also where the mountainous coast is built up by primary rocks. This seems hardly to be the case on the northern coast of the American Arctic Archipelago and Greenland, although there are rather high promontories in some places. It is, therefore, difficult to say much about the extent of the continental shelf there. It is perhaps more the case along the north coast of Alaska, and therefore the continental shelf may possibly be narrower in that region; but even this is uncertain. The deeper soundings taken near the supposed edge of the shelf may simply indicate depths of submarine valleys, which may be numerous in this region, and many more and deeper soundings are required before we can say anything with certainty.

Dr. J. W. Spencer's conclusions as to the width of the continental shelf (*American Journal of Science*, vol. xix., No. 113, May, 1905), drawn from the great depths of the submarine fjords of the American Arctic Archipelago, are hardly well founded. Considerable depths of the submarine valleys and channels (fjords) do not point to a comparatively narrow shelf in regions where there has been glacial erosion. It ought also to be considered that, on the whole, the region of the American Arctic Archipelago exhibits geomorphological features which are exceptional. This region was probably near the heart of the great North American Ice age, and the land has been split up into islands and peninsulas, whatever the original cause of this dissection might have been.

It cannot, therefore, be said that the geomorphologic features of the known part of the Arctic regions exclude the possibility of a wide extension of the continental shelf, possibly with lands on it, into some parts of the Unknown North.

The Sea Currents and *the Drift of the Ice* seem to indicate that there is an extensive area of sea to the north of the *Fram's* track. Peary's experiences during his latest expedition also indicate that there is much sea to the north of Greenland. The ice-drift converges towards the opening between Greenland and Spitsbergen. Peary's observations of a rapid eastward ice-drift also indicate that there cannot have been much land to the east of his northward track; but as we do not know the depths over which Peary travelled, we cannot say much with regard to the possibility of land or continental shelf further north and east.

The drift of the *Jeanette* can hardly be said to indicate land to the north, as this drift was chiefly influenced by the winds.

My conclusions with regard to an actual current in the surface-layers of the North Polar Basin, pointing towards Franz Josef Land and Spitsbergen ("The Scientific *Fram* Report," vol. iii.), might seem to indicate that there was land to the north, and that the North Polar Basin is a long and narrow depression. For, owing to the earth's rotation, we might expect a surface-current of this kind to be deflected towards the coast on its right-hand side, *i.e.* towards the Greenland and American side. It is, however, probable that the winds and ice-drift in the unknown parts of the sea might have influenced the direction of our drift, and that therefore the results arrived at as to the direction of the current are not quite correct.

R. A. Harris's contention that the difference in the magnitude of the *tides* on Bennett Island and the coast of Alaska proves the existence of extensive land to the north is based on a much too scanty material of observations. On the northern coasts of Franz Josef Land I found a smaller tide than the *Jeanette* people on Bennett Island.

The possible differences shown by the *ice* in the Beaufort Sea, on the coast of Prince Patrick Island, north of Ellesmere Land and Greenland, and in the sea crossed by the *Fram*, cannot be said to point to the existence of land in the Unknown North.

The occurrence of *driftwood* on the northern coasts, and even on the floe-ice itself (north-west of Greenland), proves that this ice must have drifted across the unknown sea from Siberia or America. The great quantity of "*post-Glacial*" *driftwood*, found even at high elevations on the now ice-bound coasts in the north, points to a milder period in post-Glacial times with a more open North Polar Sea.

Methods of Exploration.—The drawback with sledge journeys across the Polar ice is that they do not give much opportunity of soundings and oceanographical work; but something could be done by a practical equipment. Determination of the edge of the continental shelf would be most important, but also some observations of the temperature and salinity of the deep-water strata of the deep sea beyond this edge would be of value.

A drift with a ship across the Unknown North from the sea north of Behring Straits or Western Alaska, and towards Greenland, would give important results, and could be done probably in five years, although the drift-cask of Bryant and Melville took nearly six years from Alaska to Iceland (from September 13, 1899, to June 7, 1905).

[1] Abridged from a paper by H.E. Dr. Fridtjof Nansen, G.C.V.O., read before the Royal Geographical Society on April 29.

SEISMOTECTONIC LINES.[1]

In studying the distribution of the towns and villages damaged by Calabrian earthquakes, Prof. Hobbs finds that they show a noteworthy tendency to grouping along series of essentially parallel straight lines (seismotectonic lines), which he believes are related to coast-lines, borders of mountain-masses, boundaries of geological formations, &c. The places most seriously damaged are generally situated at or near the intersections of indicated seismotectonic lines, while these lines often intersect lines of volcanoes (volcanotectonic lines) at volcanic vents. In the direction perpendicular to seismotectonic lines, he states that the destructive intensity of the waves falls off rapidly, having but little effect upon well-built houses more than a mile distant, except in the case of earthquakes of the first order of intensity. He therefore concludes that "the destructive violence of an earthquake is localised on vertical planes of fracture within the earth's crust; along which cracks the seismic waves are transmitted with the least loss of intensity."

The district chiefly affected by the Calabrian earthquakes is one in which the peculiar earth-sounds, known as brontidi, mistpoeffers, &c., frequently occur. Recent investigations by Cancani, Alippi, and others have shown

[1] (1) "On some Principles of Seismic Geology"; (2) "The Geotectonic and Geodynamic Aspects of Calabria and North-Eastern Sicily, a Study in Orientation." By William Herbert Hobbs. (*Beiträge zur Geophysik*, Bd. viii., pp. 219–362, and plates.)

that these sounds are closely connected with ordinary earthquake-sounds, and Prof. Hobbs finds that the Calabrian villages from which brontidi are reported are also those which have suffered most from disastrous earthquakes, and that they are ranged along the more prominent seismotectonic lines of the district.

In great detail Prof. Hobbs studies, not only the places damaged by the important earthquakes of 1638, 1659, 1783, 1894, and 1905, but also those at which numerous slight shocks were observed, for the latter, owing to their small disturbed areas, seem to be the most useful indices of the course of seismotectonic lines. The positions of more than 300 such lines in Calabria and north-eastern Sicily are estimated and drawn upon a series of maps, as well as the bearings of joint-planes, the trend of the volcanotectonic lines, and the distribution of brontidi.

It will be seen from this brief abstract that Prof. Hobbs's memoirs possess considerable interest. They are the result of extensive reading, and contain many useful references. But his wide generalisations seem to me to be based on insecure principles and insufficient data. Isoseismal lines, it is well known, are elongated in the direction of the originating faults, but the positions of a few places at which shocks are felt cannot determine a line of fracture. For instance, one of the British seismotectonic lines is located by the positions of four places, two of which are more than 200 miles apart. The seismotectonic lines revealed by the New England earthquake of 1870 are based on the positions of about a score of places distributed over an area reaching from Quebec to Newhaven, and on about a dozen apparent directions of the shock. When observed in houses, such directions are almost invariably perpendicular to the principal walls, but Prof. Hobbs assumes that they indicate that the shocks were transmitted along parallel seismotectonic lines. In Calabria, on the other hand, the damaged villages are so numerous that it would be strange if many of them were not collinear. Several of the seismotectonic lines plotted by Prof. Hobbs no doubt correspond with lines of fracture, but the existence of a very large number of his lines must, I think, be regarded as doubtful. Industrious as he has been in the collection of materials, he has tried within little more than a year to achieve results which the long-continued labours of many men might fail to establish.

C. DAVISON.

HYDRATES IN AQUEOUS SOLUTION.

A RECORD of researches which have been carried out by Prof. H. C. Jones with his students and confrères has recently been published by the Carnegie Institution.[1] The investigations which have been undertaken were to elucidate an observation made by Jones and Ota when studying the freezing points of solutions of double salts in order to ascertain whether in solution they remained as constituent molecules or were broken down. They found that concentrated solutions gave abnormally low freezing points, the molecular lowering of freezing point passing through a well-defined minimum as the concentration changed. Now according to the ionic theory as then expressed, the molecular lowering should decrease continuously as the concentration of the solution increased.

A very large number of solutions of salts, acids, and bases, and neutral organic substances have now been studied, and as a result it has been found that this excessive depression as the concentration increases is a general property of solutions. In order to explain this digression from the generally accepted rendering of the ionic theory, Jones postulates that "in solution a part of the solvent is combined with the dissolved substance and no longer plays the *rôle* of solvent, at least so far as the freezing point method is concerned."

By a determination of the freezing point, conductivity, and specific gravity of the solutions, it has been found possible to calculate approximately the total amount of water held in combination by the dissolved substance, and consequently the approximate amount combined with one molecule of the compound or of the ions resulting from it.

[1] "Hydrates in Aqueous Solution." By Harry C. Jones. Pp. viii+264. (Washington: Carnegie Institution, 1907.)

The theory proposed here differs from that suggested by Mendeléeff, who considered that such substances as sulphuric acid and calcium chloride form a few definite compounds with the water in which they are dissolved. But the present theory supposes that combination between the dissolved substance and water to be a general phenomenon. The compound forms, say, for example, calcium chloride, a complete series of hydrates extending from a few molecules of water to at least thirty, all the intermediate stages being represented.

The memoir commences with an introduction, in which the earlier work is reviewed and the freezing-point and conductivity apparatus used by the author are described. Then follows part i., dealing with the evidence for the existence of hydrates in aqueous solution and the approximate composition of the hydrates formed by a large number of electrolytes. The work here described was carried out by Getman and Bassett. Attention is directed to the effect of temperature on water of crystallisation, as bearing on the theory of hydrates in solution. It is shown that salts which on crystallisation contain water of crystallisation are able to combine when in solution at ordinary temperatures with a much larger quantity of water than they are able to bring with them out of solution on crystallisation. The results obtained are illustrated in many cases graphically by curves and in other cases by tables.

Part ii. is chiefly the work of Uhler, and deals with spectroscopic investigations. The spectrographic photographs which are given have been magnificently reproduced, and form quite a feature of the book. The colour changes produced, for example, by the addition of different salts to cobalt salts have been investigated quantitatively. That is to say, the absorption spectra of the substances, separately and when mixed in known quantities, have been observed with a direct-reading spectroscope, and thus the wave-lengths and absorption bands obtained. The special spectrograph which has been used to obtain the photographic record of the absorption bands is also described. The final section deals with non-aqueous solutions, the solution of substances in methyl and ethyl alcohol having been studied. The results seem to indicate that some substances at least, such as lithium chloride, bromide, and nitrate, combine to some extent with the solvent. However, this portion of the work is yet in its initial stage, and much yet remains to be done. We understand that the author is extending the work in this direction.

Altogether, the memoir is an extremely valuable contribution to the study of the subject, more especially in connection with concentrated solutions. It has often been urged, and with a considerable amount of truth, that the ionic theory is simply a specialised hypothesis, which is true only of dilute solutions. Prof. Jones has gone far to remove this reproach by broadening the basis of the theory and enlarging its scope. The publishers, the Carnegie Institution, must also be congratulated upon the splendid way in which the letterpress and diagrams have been got up.

F. M. P.

PRODUCTION AND DECAY OF MEDIÆVAL STAINED GLASS.[1]

THE earliest direct evidence as to the methods of mediæval glass-painting is contained in the treatise of Theophilus ("Diversarum Artium Schedula"), which dates back in all probability to the latter half of the twelfth century; here one finds detailed instructions for the making of the glass as well as for its formation into the flat sheets or "tables" in which it is required by the glass-painter.

This treatise makes it clear that at that time such window glass was for the most part made by what is generally known as the "muff" process. The process referred to is one of the three known methods of making window glass, namely:—

(1) Cast or plate glass, made by pouring molten glass on to a flat stone or metal slab.

(2) Muff or cylinder glass, in which the glass is worked

[1] Abstract of a paper read before the Society of Arts on March 13 by Mr. Noel Heaton.

into the form of a hollow cylinder by means of the blowpipe, which cylinder is subsequently opened out into a flat sheet.

(3) Spun or crown glass, in which a bulb-shaped mass of blown glass is converted into a disc by rotating it rapidly whilst in a plastic state.

The earliest known window glass, that of the Romans, was produced by the first of these methods; in fact, it has hitherto been supposed that the Romans knew no other way of making glass into sheets. A careful examination of the glass brought to light by the excavations at Silchester, however, leaves no room for doubt that the Romans were acquainted with the art of making blown window glass according to the "muff" process.

There are reasons for thinking that the making of window glass was not handed down from the Romans, but was re-discovered in the Middle Ages, and the author thinks it most probable (although evidence is too scanty to justify this as a statement of fact) that the glass of the earliest stained-glass windows, that is, those of the ninth and tenth centuries, was made in the same way as the cast window glass most generally employed by the Romans, this being the method that would most naturally suggest itself in the first place.

The composition of the glass described by Theophilus was quite different from that of the Romans, being produced, according to the treatise referred to, by heating a mixture of sand and the ashes of beechwood. It is probable, however, that the glass varied very considerably in composition at different times and in different places, owing to the impurity of the sand used and the varying nature of the wood ashes, which would in all probability be obtained by burning whatever species of timber came nearest to hand.

Considering these facts, mediæval glass would be expected to reveal on analysis a fairly complicated composition, and, whilst varying considerably, to show in general a richness in alkali (usually potash) and poorness in lime.

In order to obtain further information on this point, the author, in conjunction with Mr. Percy Williams, determined accurately the composition of some typical specimens of mediæval stained glass, of which a description is given in the paper. The following table is a summary of the results obtained:—

Composition of Mediaeval Glass.

Material	Sandiacre	Dale Abbey	Modern window glass
Silica	54·01	46·94	70
Phosphoric acid	4·18	4·11	—
Potash	13·20	16·96	15
Soda	1·70	0·12	
Lime	17·37	19·01	13
Magnesia	5·33	5·00	
Alumina	2·41	3·02	2
Iron	0·81	1·46	
Manganese	1·03	1·37	
Moisture due to decay	0·21	2·16	—

These results are of interest in several directions, chiefly, however, as revealing the presence of a considerable amount of phosphorus in the glass. The evidence this affords as to the making of the glass, and its effect on the nature of the glass, are discussed in the paper, and attention is directed to the disturbing influence this unlooked-for ingredient has on the process of analysis.

The importance of this point lies in the fact that if a partial analysis of the glass is made—with the view of determining the amount of alumina, for example—or if an analysis is attempted without the possibility of the presence of phosphorus being recognised, the results are liable to be seriously inaccurate. A summary of the method adopted by Mr. Williams for obtaining the analyses quoted follows, this being based on the removal of the phosphorus by silver carbonate.

The paper then passes on to discuss the phenomena of the decay of old stained glass in the light of the peculiar composition revealed by these analyses.

Mediæval glass decays in a very characteristic manner. Very commonly the glass becomes covered with little pits, for all the world like the worm-holes one often sees in an old oak cabinet.

The process of decay in glass is undoubtedly a parallel on a small scale to the change produced on a large scale by the action of time and weather on geological formations, such as chalk and sandstone—a combination of corrosion and internal change.

Corrosion of the surface of glass is produced by the long-continued action of moisture, which gradually extracts the

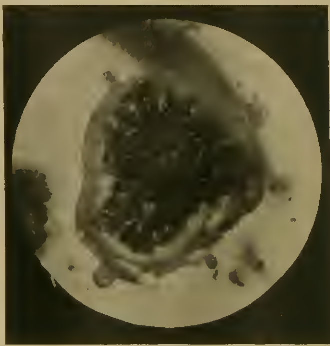

FIG. 1.—Photomicrograph of an area of decomposition in mediæval glass.

soluble silicates, leaving the insoluble silica in a thin film, the glass thereby becoming iridescent. Owing to the large proportion of lime it contains, however, mediæval glass does not become iridescent as the result of corrosion. On the extraction of the alkali by water this lime is left behind with the silica, and forms with it a hard, insoluble silicate of lime, which adheres to the corroded surface of the glass, forming an opaque scum or patina. In some cases this is so marked that the glass appears to be covered with a coat of cement.

The peculiar pitting of old stained glass is not, however,

FIG. 2.—Photomicrograph of similar structures produced experimentally in modern window glass.

in the author's opinion, due to corrosion at all, but to a change in the constitution of the glass. As is well known, glass changes its constitution and becomes crystalline if kept at a red heat for a length of time. What happens in a few hours when the glass is hot tends to take place on prolonged exposure to the atmosphere, with this difference, that when the glass is molten its molecules can freely move about, whereas when it is cold and rigid such freedom of movement is impossible; in consequence the definite formation of crystals cannot take place, and the result of the change is different. What happens is this. In the first place, molecules of the same kind tend to separate out from the homogeneous mixture and collect round a point, forming a centre of decomposition. Proceeding from this centre the glass is found decomposing into definite compounds in an ever-enlarging circle until it reaches a point at which the strain set up in the glass by this molecular movement results in a crack forming round the area of decomposition, and then the whole mass comes away, leaving behind it a little hole or pit in the surface of the glass.

Such are the two forces at work on the decay of glass—corrosion without and decomposition within—and, of course, they act simultaneously. As the pits are formed they are extended by corrosion, forming a resting place, in fact, for the water, until eventually the whole fabric of the glass is destroyed.

According to varying circumstances—the position of the window as affecting its degree of exposure, the climate in which it is placed, differences in composition and mechanical state of the glass—we get all sorts of variations in the precise effect of decay in particular instances.

It is a well recognised fact that glass containing a large proportion of earths, that is, lime, magnesia, and alumina, is especially liable to become crystalline. If, then, one is correct in thinking that the peculiar pitting of Gothic glass is due to a similar change of constitution, one would expect to find it excessively rich in these constituents, and we have already seen that this is, in fact, the case.

On the other hand, glass containing excess of alkali has an equally recognised tendency to go "blind," that is, to become covered with a film, due to corrosion. Finally, glass with a high content of silica, with earth and alkali equally balanced, may be looked upon as highly resistant in both directions. It is such glasses which decay slowly and with little tendency to devitrification, the surface being merely etched by corrosion, leaving the large proportion of silica in a coherent thin film, producing gorgeous effects of iridescence.

Besides the glass itself, a study of the materials used for producing the enamel with which the glass was painted to represent figures and subjects is a matter of some importance, which is fully discussed in the paper. After going thoroughly into the evidence afforded by those mediæval pay-rolls which have been preserved, dealing with the execution of stained-glass windows, the author comes to the conclusion that the enamel in question was prepared by making a fusible opaque black glass, technically known as "geet," probably because it resembled jet in appearance (the word jet being in writings of the period variously spelt jeat, ieat, geat, geet); this material would be used as a flux, and mixed with the oxides of iron and copper to make the paint. Experiment shows that an enamel prepared in this way is in every respect similar to that used in the finest examples of mediæval stained glass.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AN exhibition illustrating a course of lectures on Japanese education given under the auspices of the University of London by Baron Kikuchi, will be opened on Tuesday next at the Victoria and Albert Museum (Indian Section), South Kensington. The exhibition will remain open until the end of June.

RECENT statistics published by the French Minister of Public Instruction give the number of students attending courses of instruction in French universities and higher educational institutions. The total reaches 38,197, of whom 3434 are foreigners—a number much larger than usual owing to the temporary closing of certain Russian universities. Of the native students, 1364 are women. The number of students at some of the larger universities are as follows:—Paris, 15,789; Lyons, 2783; Toulouse, 2675; Bordeaux, 2496; Nancy, 1841; Montpellier, 1752; Lille, 1560; Rennes, 1498; and Aix-Marseilles, 1269. The Paris students are distributed among the different faculties and schools as follows:—law, 7032; medicine, 3369; letters, 2413; science, 2022; and pharmacy, 953. The total number of French university men students include in the various departments of learning:—law, 15,427; medicine, 7501; letters, 4605; science, 5881; and pharmacy, 2224.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 15, 1906.—"On the Effect of High Temperatures on Radium Emanation and its Products." By Walter **Makower** and Sidney **Russ.** Communicated by Prof. A. Schuster, F.R.S.

In a previous paper it was shown that the activity of radium emanation sealed in a quartz tube is temporarily changed by subjecting it for a short time to temperatures between 1000° C. and 1200° C. From the results obtained it seemed probable that this change was not due to any alteration of the emanation itself, but rather to a change of activity of one of the more quickly decaying products of the emanation with which it is in equilibrium. To settle this point measurements were made of the rate of decay of the emanation when kept at 1100° C. Subsequently experiments were made on the effect of high temperatures on the active deposit collected on a platinum wire by exposure to the emanation.

The results obtained were:—

(1) The change in activity noticed when radium emanation is subjected to a high temperature is not due to any alteration in the emanation itself, since its time period is unaltered when it is maintained at a temperature of 1100° C.

(2) The change is due *either* to a change in radium B *or* C, since the activity of a mixture of these two substances can be changed by heating.

(3) The change is *probably* due to some influence of temperature on radium C. This conclusion is in agreement with the statement made by Curie and Danne.

In a note the authors discuss some recent observations made by Dr. Bronson which appear at first sight difficult to reconcile with the above conclusions. As a result of his experiments, Dr. Bronson concludes that there is no change of activity in radium even when exposed to temperatures of 1600° C.

It is, however, pointed out by the authors that there are several important differences between Dr. Bronson's experiments and their own, the most important of which is that Dr. Bronson measured the activity of the radium while hot, whereas they always allowed the active deposit to cool before making measurements. It is on this account that the authors consider that the results of Dr. Bronson and their own are not necessarily contradictory.

Zoological Society, April 9.—Dr Henry Woodward, F.R.S., vice-president, in the chair.—A collection of fishes made in the eastern watershed of the Transvaal by Captain G. E. Bruce, and presented to the British Museum: G. A. **Boulenger.** The collection contained specimens of eighteen species, of which several had not been previously recorded from the Transvaal, and five were new.—The osteology of the oligomyodian and diacromyodian Passeres: W. P. **Pycraft.** After referring to his previous contribution (published in the Proceedings) on the osteology of the eurylæmid and tracheophone Passeres, the author remarked that there seemed little room for doubt but that the diacromyodian and oligomyodian Passeres must be regarded as divergent branches of a common stem. The latter suborder included the Tyranniformes, Phytotomidæ, and Pittidæ, while the former embraced the remaining Passeres. In the present communication some fourteen families were described, and these were divided into four groups, Hirundines, Muscicapæ, Laniinæ, and Gymnorhinæ. This arrangement was based, not on osteological characters alone, but also on the evidence of pterylosis and certain wing-muscles. The author proposed to include the Vireonidæ with the Muscicapæ, and the Vireolaniidæ with the Gymnorhinæ. With this last group he proposed, tentatively at any rate, to include the Paradiseidæ, inasmuch as there seemed good reason for continuing to regard these birds as near allies of the Corvidæ.—Anatomy of a Bornean frog of the genus Megalophrys, with references to other genera of Batrachia: F. E. **Beddard.**—The winter habits of the greater horseshoe and other cave-haunting bats: T. A. **Coward.** This paper contained the results of observations made in the Somersetshire caverns, where at the end of December and beginning of January the author found that the bats were not in profound sleep, but moved in the caves and went into the open for food. This food, the author showed, was not all taken when the bats were in flight, but was usually devoured when the bats were at rest. The manner of feeding was described, and information supplied about the food of the greater horseshoe and the parasites which infested this species and the lesser horseshoe.

Anthropological Institute, April 16.—Mr. A. L. Lewis, vice-president, in the chair.—*Exhibit.*—A selection of specimens of flint from Cornwall: Mr. **Lewis,** Mr. **Warren,** Mr. **Kendall,** and Mr. **Chandler.**—Note on some Palæolithic and Neolithic implements from East Lincolnshire: S. Hazzledine **Warren.** The Neolithic implements described were found by the author *in situ* in an undisturbed section of the fen deposit of the East Lincolnshire coast near Skegness. The lowest bed seen in the district was Boulder-clay; overlying this there are patches of fluviatile gravel; above this, again, comes the old surface soil of the buried forest; then the peat by which the forest was destroyed, and above this, again, a succession of warp clays with some subordinate peat beds. The exact horizon at which the Neolithic implements occurred was in the old surface soil beneath the lowest peat bed. Besides the neoliths, the author also found a palæolith *in situ* in one of the patches of fluviatile drift gravel between the submerged forest above and the Boulder-clay below. One or two other palæoliths were also found which had evidently been derived from one of these patches of post-Glacial drift. Apart from discoveries in caves, this is the most northerly point at which Palæolithic implements have yet been found in this country in any river drift gravel.

Geological Society, April 17.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—The toadstones of Derbyshire, their field-relations and petrography: H. H. **Arnold-Bemrose.** The district over which the toadstones are seen may be divided into three main areas of volcanic activity, between which there are no exposures of igneous rock:—(1) the north-western or Miller's Dale area; (2) the south-eastern or Matlock area; (3) the south-western or Tissington area. In each of these areas there are lava-flows, bedded tuffs, and volcanic vents, and in the Miller's Dale and Matlock areas several intrusive sills. In the Miller's Dale and Matlock areas the igneous rocks are, with the exception of the Hopton vent, entirely in the Mountain Limestone, but in the third area they are mostly in the Yoredale Shales, and lava plays only a subordinate part. In the Miller's-Dale area the upper lava is the thicker, and extends over a greater district than the lower, while in the Matlock area the converse is true. In the former area the lavas are separated by about 150 feet of limestone, in the latter by about 80 feet to 100 feet. The upper lava of Miller's Dale is on a lower horizon than the lower lava of Matlock, and the limestone above it contains at least two bands of interbedded tuff. The lavas are vesicular and amygdaloidal in structure, and often very much decomposed. They contain olivine, augite, and felspars, magnetite, and iron-oxide; the felspars are often present in two generations. The sills are, for the most part, ophitic olivine-dolerites, and pass from a very coarse-grained dolerite through the intervening stages into a fine-grained dolerite or basalt; they are similar in structure to certain Tertiary dolerites. The toadstones have all been mapped on the 6-inch scale, and petrological accounts of the different rocks are furnished.—Data bearing on the age of Niagara Falls: Prof. J. W. W. **Spencer.** The author has been engaged in investigations for a monograph on Niagara Falls, to be published by the Geological Survey of Canada. Soundings at all the points of great changes in the gorge have been successfully undertaken; borings were put down for the exploration of buried valleys, and instrumental surveys made of the original river-banks and the physics of the stream. The mean recession of the crest-line of the falls is found to be 4·2 feet a year under existing conditions, and this rate has approximately obtained for 227 years. But this rate will not give the age of the falls, on account of former great variations in the volume of the river and in the height of the falls themselves. The chief change in volume of water depends on the fact that originally Lake Erie alone was discharged over the falls, when the supply of water was only 15 per cent. of the present discharge. Lake Ontario, too, stood at a higher level, and thus the cutting-back from Queenstown to Foster's Flats was effected with a small water discharge and, at first, a low head. After an uplift, which raised the crest of the fall considerably above Lake Ontario, a slight depression followed which "drowned" part of the lower gorge. This cutting is calculated to have taken 35,500 years for a distance of 14,400 feet. Above Foster's Flats the sudden widening indicates the inflow of the other lakes into Erie, greater water discharge, and greatly increased rapidity of recession. The changes in height of the falls and resistance of the rocks are examined in detail, and the small influence of pre-Glacial filled channels estimated. The whirlpool is on the site where the recession broke down the partition separating the head of the Whirlpool-St. David's buried gorge, and began to empty out the contents of this valley. The cutting with the full power of the water of the four lakes varied at times according to the height of the fall, and is calculated to have occupied only 3500 years for the cutting-back of about four miles above the head of Foster's Flats. Thus the entire age of the falls is given as 39,000 years.

Royal Meteorological Society, April 17.—Dr. H. R. Mill, president, in the chair.—Phenomenal rainfall in Suva, Fiji, August 8, 1906: R. L. **Holmes.** This is an account of a very remarkable fall of rain which occurred during a thunderstorm at Suva, the capital of Fiji, on the night of August 8. Unfortunately, the exact amount had to be, in part, estimated, owing to the observer failing to measure the fall at intervals during the night. Very little rain fell before sunset, but from 6 p.m. it continued a ceaseless downpour until sunrise the next day. At 10 p.m. the assistant found the gauge overflowing with 12·50 inches of rain in it. Four hours later, at 2 a.m. on August 9, the gauge was again overflowing, and at 6 a.m. it was overflowing once more, that is, three times in twelve hours. Very little rain fell after 6 a.m. These measurements show more than 37 inches, without taking into account the overflowings, which are an unknown quantity. As the gauge was 25 feet above the ground, Mr. Holmes is of opinion that the rainfall should be increased by about 11 per cent., so that the total fall must have been fully 41 inches in about thirteen hours, which he thinks surpasses anything that has been recorded in any other part of the world in so short a space of time.—Temperature around the British Islands in relation to the Gulf Stream: R. **Strachan.** This paper was based on observations made in the year 1906 which have been published by the Meteorological Office. Around the British coasts the temperature of the air was lowest in February and highest in August; the temperature of the sea corresponded to these epochs with slight interruptions, having been lowest in January for the west and central, in March for the south, and highest in September for the north and in July for the east, positions. The water in the Strait of Florida was about 30° warmer than the sea at the north of Scotland.—Weather regarded as a function of climate: L. C. W. **Bonacina.**

MANCHESTER.

Literary and Philosophical Society, March 12.—Prof. W. Boyd Dawkins, F.R.S., in the chair.—The occurrence and significance of symbiotic corpuscles in the lower animals: Dr. F. W. **Gamble** and Dr. F. **Keeble.** The paper described the occurrence of symbiotic coloured corpuscles in the bodies of lower animals. It dealt in detail with a single case, that of the simple turbellarian worm

Convoluta roscoffensis, and discussed the evidence for describing the green cells of the animals as an "infection" by a flagellated vegetal organism. The nature and life-history of this organism were described, and the significance of the association of the organism and of the animal Convoluta was discussed.—Bones of the great auk from Funk Island, Newfoundland: F. **Nicholson.** The bones exhibited were those of the now probably extinct species of bird, the great auk, or gare-fowl, *Alca impennis* of Linnæus. There were seven bones in this collection, consisting of:—one base of skull, one clavicle, one sacral vertebra, two right humeri, two right tibiæ. The bones have been presented to the Manchester Museum at the Victoria University.

March 26.—Mr. Francis Nicholson in the chair.—An apparent case of gaseous absorption caused by the action of a few milligrams of radium bromide on the sides of a glass tube containing the radium: T. **Thorp.** At first there was an expansion, but later on, as the glass turned purple, a contraction took place to less than the original volume. Further investigations are being made, the results of which will be communicated to the society.—A collection of fishes, batrachians, and reptiles made by Mr. S. A. Neave in Rhodesia, north of the Zambezi, with field notes by the collector: G. A. **Boulenger.** Thirteen species of fish, one of which (*Barilius neavii*) was described as new, seven batrachians, and forty-four reptiles were obtained. The localities, dates of capture, and native names of the various forms were given in the paper.—A new class of organo-metallic compounds. Trimethylplatinimethyl hydroxide and its salts: W. J. **Pope** and S. J. **Peachey.** No alkyl compounds of metals belonging to groups 1 and 8 of the periodic table have hitherto been described. The authors find that the chlorides, or in some cases the oxides, of iron, cobalt, nickel, ruthenium, rhodium, palladium, osmium, iridium, and platinum, belonging to group 8, and of gold, belonging to group 1, react vigorously with magnesium methyl iodide. Trimethylplatinimethyl iodide, $(CH_3)_3Pt.I$, is formed by the action of platinic chloride dissolved in ether upon magnesium methyl iodide in ethereal benzene solution; after treating with water and extracting with benzene, the benzene solution yields the new compound on evaporation. On boiling for several hours with silver hydroxide in a moist mixture of benzene and acetone, it is converted into trimethylplatinimethyl hydroxide, $(CH_3)_3Pt.OH$. Trimethylplatinimethyl nitrate, $(CH_3)_3Pt.NO_3$, obtained by dissolving the hydroxide in nitric acid, crystallises in colourless plates, and is freely soluble in water. On adding an alkali chloride to its aqueous solution, trimethylplatinimethyl chloride,

$$(CH_3)_3Pt.Cl,$$

is precipitated. This salt crystallises from chloroform in colourless rhombic dodecahedra belonging to the cubic system. In a similar manner a number of other salts have been prepared, including the bromide and the cyanide; the latter is hydrolysed on heating with caustic potash with evolution of ammonia.

April 9.—Mr. Arthur McDougall in the chair.—Further notes on the adventitious flora of the sandhills of St. Annes-on-the-Sea: C. **Bailey.** The author summarised his observations on the alien plants which had appeared during his five years' residence at St. Annes-on-the-Sea. The number of these aliens was quite worthy of a large ballast-discharging port; altogether between forty and fifty species have occurred, as represented by herbarium examples exhibited at the meeting.

Paris.

Academy of Sciences, April 22.—M. A Chauveau in the chair.—Primitive tuberculosis of the lungs and bronchial and mediastinal ganglia communicated to young cattle by the ingestion of tuberculous virus of human origin: A. **Chauveau.** Tubercle of the lungs can arise directly from the ingestion of human tubercle virus by the digestive organs, and this is not necessarily accompanied by tuberculous lesions of the intestines, although such may sometimes be the case.—The earthquakes of April 15, 18, and 19, 1907, recorded at Paris: G. **Bigourdan.** The records of April 15 indicate that the epicentre was at a distance of 8500 kilometres to 9000 kilometres, about the distance from Paris to Mexico. It is known that there was a disastrous earthquake in Mexico on this day.—The direct hydrogenation of the isocyanic esters: Paul **Sabatier** and A. **Mailhe.** The vapours of ethyl isocyanate, carried off in a current of hydrogen in excess, were passed over a column of reduced nickel maintained at 180° C. to 190° C. The gases issuing from the apparatus contained a little ammonia and carbonic acid, but neither methane nor carbon monoxide. The chief product of the reduction was methylethylamine, small quantities of ethylamine, diethylamine, and triethylamine being also present. With phenyl isocyanate a little aniline was obtained, but the main product was diphenylurea.—Concerning the spectroheliograph: G. **Millochau.** On a question of priority as to the use of a second slit by M. Deslandres.—Differential equations of the second order and first degree the general integral of which has fixed critical points: B. **Gambier.**—Equations with reciprocal integrals: C. **Popovici.**—The theorem of Nernst and liquid chains with identical extremities: J. **Guyot.** An extension of the work of Negbauer and Nernst on solutions of binary electrolytes formed of univalent ions to solutions of electrolytes of polyvalent ions. The experimental results are compared with the figures calculated by Planck's method.—Positive light and Melde's experiment: P. **Villard.**—The phosphorescence of the rare earths: J. **de Kowalski** and C. **Garnier.** To the nitrate of calcium or strontium is added a weak solution of the nitrate of the rare earth (praseodymium, neodymium, erbium, or samarium), the whole precipitated as carbonate, and the latter heated to a red heat with sulphur. The proportions of rare earth giving a maximum phosphorescence were determined in each case.—The phosphorescence of manganiferous calcium compounds: L. **Bruninghaus.**—The triboluminescence of substances containing zinc: Adrien **Karl.**—Some complementary observations concerning a property of platinum amalgam discovered by M. Henri Moissan: Paul **Lebeau.** The property of platinum amalgam of forming a stable emulsion seems to be peculiar to that metal. Instead of shaking the amalgam with water, the author used a 5 per cent. solution of gelatin, capable of solidifying on cooling. Sections were taken of the solidified mass with the view of studying its microscopical structure.—Remarks on the constitution of the copper alloys: Léon **Guillet.**—A new silicide of tungsten, Si_2W: Ed. **Defacqz.** The new silicide is formed by the action of amorphous tungsten upon copper silicide (containing 50 per cent. of silicon) at the temperature of the electric furnace; the same compound is obtained by reducing a mixture of tungstic anhydride and silica with aluminium in the presence of sulphur.—The condensation of sodium derivatives of acyloines of the fatty series with acetic esters: L. **Bouveault** and René **Locquin.** The authors have given the name acyloines to compounds of the type

$$R.CH(OH).CO.R.$$

—Ethylidene-imine (aldehyde ammonia) and hexaethylidene-tetra-amine: Marcel **Delépine.** The author has previously given reasons for supposing that aldehyde-ammonia is not $CH_3.CH(OH).NH_2$, as usually supposed, but the hydrate of $(CH_3.CH:NH)_3$. In confirmation of this view the present paper describes the preparation and properties of the trinitroso-derivative.—The detection and estimation of ammonia in monomethylamine and the more volatile fatty amines: Maurice **François.** By the usual method of a Nessler's reagent of defined compositinn, two parts of ammonium chloride in 1000 of methylamine hydrochloride can be detected with certainty. A quantitative method is developed on this basis.—The composition and analysis of wolfram and hübnerite: Paul **Nicolardot.** A scheme for the rapid analysis of tungsten minerals, permitting of the determination of all the constituents.—The differentiation of the tissues of the stem and frond of Equisetum: C. **Queva.**—The experimental genesis of vital processes: J. **Kunstler.**—Some remarks on the food of the sardine: Casimir **Cépède.**—The functions of the hypophysis and the pineal gland: M. **de Cyon.**

Calcutta.

Asiatic Society of Bengal, April 3.—Specimens illustrating the fauna of certain brackish pools in the delta of the Ganges: Dr. N. **Annandale.** This fauna has become isolated recently, probably within the last half-century, and presents many features of interest. It includes typical fresh-water Entomostraca, as well as two cirripedes (*Balanus amphitrite* and *B. patellaris*), the larvæ of a mosquito (*Anopheles rossii*), numerous fresh-water fish and molluscs, a hydrozoon (*Irene ceylonensis*), and an actinian (*Metridium schillerianum*). The last is probably the most interesting form now occurring in the pools, as it appears to have undergone a very distinct change, both in structure and in habits, since it was described by the late Dr. F. Stoliczka thirty-nine years ago.—Note on the absorption of gases, vapours, and substances from solution by solids and amorphous substances: Dr. M. W. **Travers.** In this note attention is directed to the physical character of such phenomena as the absorption of moisture by organic materials. It has usually been considered that such absorption must be attributed either to surface condensation or to solid solution. It appears, however, that substances which absorb gases or vapours are invariably amorphous, and as amorphous substances must be referred to the liquid rather than to the solid phase, the use of the term solid solution is not permissible. It is the author's opinion that such phenomena as the absorption of water vapour by cotton or jute involve the formation of a simple solution, the supposed solid phase consisting really of a substance in the liquid phase, but possessing a high viscosity. The law of distribution in this particular case is exponential instead of linear, but it tends to become linear as the temperature rises.

DIARY OF SOCIETIES.

THURSDAY, May 2.

Royal Society, at 4.—Election of Fellows.—At 4.30.—The Spontaneous Crystallisation of Binary Mixtures. Experiments on Salol and Betol: Prof. H. A. Miers, F.R.S., and Miss F. Isaac.—On the Variation of the Pressure developed during the Explosion of Cordite in Closed Vessels: Prof. C. H. Lees, F.R.S., and J. E. Petavel.—Space described in a Given Time by a Projectile moving in Air: A. Mallock, F.R.S.

Society of Arts, at 4.30.—The Applicability to India of Italian Methods of Utilizing Silt: Sir Edward C. Buck, K.C.S.I.

Linnean Society, at 8.—The Fauna and Flora of Abyssinia compared with Those of West Africa: Prof. E. B. Poulton, F.R.S.—(1) Report on the Marine Biology of the Sudanese Red Sea (Communicated with an Introduction by the President); (2) Formation of the Shone Cliff near Alexandria; (3) Recent History of the Coral Reefs of the North-West Shores of the Red Sea: Cyril Crossland.—Polyplacophora collected by Mr. Cyril Crossland: E. R. Sykes.—On Chelonethi (Pseudoscorpions) from Asia and Australia: C. J. With.—Note on the Function of the Spiracle in certain Elasmobranchs: A. D. Darbishire.—*Exhibits*: (1) Probate of the Will of Richard Anthony Salisbury; (2) Manuscripts of Dr. W. J. Burchell, Presented to the University of Oxford by Francis A. Burchell, Rhodes University College, Grahamstown, Grand-nephew of the Great Naturalist and Explorer: Prof. E. B. Poulton, F.R.S.

Chemical Society, at 8.30.—(1) The Chemical Action of Exradio, Part I., Action on Distilled Water; (2) The Chemical Action of Exradio, Part II., Action on Copper Salts in Solution. Preliminary Note: Sir W. Ramsay.—Freezing Point Curves of the Menthyl Mandelates: A. Findlay and E. M. Hickmans.—The Constitution of Homo-eriodictyol. A Crystalline Substance from Eriodictyon Leaves: F. B. Power and F. Tutin.—The Relation between Valency and Heats of Combustion. Preliminary note: G. Le Bas.

Institution of Electrical Engineers, at 8.—The Use of Wooden Poles for Overhead Power Transmission: C. Wade.

FRIDAY, May 3.

Royal Institution, at 9.—Dexterity and the Bend Sinister: Sir James Crichton-Browne, F.R.S.

Geologists' Association, at 8.—The Igneous Rocks of the Bristol District: Prof. S. H. Reynolds.—The Carboniferous Limestone Sections of Burrington Combe and Cheddar: T. F. Sibly.—Recent Researches in the Lower Carboniferous Rocks: Dr. A. Vaughan.

SATURDAY, May 4.

Royal Institution, at 3.—Scientific Work in the Sea-Fisheries: Prof. W. C. McIntosh, F.R.S.

MONDAY, May 6.

Society of Chemical Industry, at 8.—The Works Chemist as Engineer: O. Guttmann.

TUESDAY, May 7.

Royal Institution, at 3.—Stimulation, Luminous and Chemical: Prof. William Stirling.

Zoological Society, at 8.30.

WEDNESDAY, May 8.

Society of Arts, at 8.—The Production of Coke and its Application in Domestic Fires: Paul Schlicht.

THURSDAY, May 9.

Royal Society, at 4.30.—*Prelable Papers*: The Anatomy of the Julianiaceæ considered from the Systematic Point of View: Dr. F. E. Fritsch.—The Ascent of Water in Trees, Second Paper: Prof. A. J. Ewart.—Increase in the Complement-Content of Fresh Blood-Serum: Dr. J. Henderson Smith.

Royal Institution, at 3.—Spectroscopic Phenomena in Stars, (1) Chemistry: H. F. Newall, F.R.S.

Institution of Electrical Engineers, at 8.—Telephonic Transmission Measurements: B. S. Cohen and G. M. Shepherd.

Iron and Steel Institute, at 10.30 a.m.—Presidential Address.—Electrically Driven Reversing Roller-Mills: D. Selby-Bigge.—(1) Steel Making from High Silicon Phosphoric Pig Iron by the Basic Bessemer Process; (2) Steel Making from Pig Iron containing Chromium, Nickel, and Cobalt: A. W. Richards.—The Use of Steam in Gas Producer Practice: Prof. W. A. Bone and R. V. Wheeler.

FRIDAY, May 10.

Royal Institution, at 9.—Recent Excavations on Forum Romanum, and the Forum Ulpium: Signor Comᵉ Giacomo Boni.

Physical Society, at 8.—Stereoscopy with long Base-line illustrated on the Screen: Dr. T. C. Porter.

Royal Astronomical Society, at 5.

Malacological Society, at 8.—The Pairing of *Limnaea peregra* with *Planorbis corneus*: W. D. Lang.—Notes on *Achatina denisoni*, Reeve, and *Achatina magnifica*, Pfr.: E. A. Smith.—Review of the New Zealand Acmæidæ, with Descriptions of New Species and Sub-species: Henry Suter.

Iron and Steel Institute, at 10.30 a.m.—Sentinel Pyrometers and their Application to the Heat Treatment of Tool Steel: H. Brearley and F. Colin Moorwood.—Induced Draught with Hot-air Economisers for Steel-Works and Blast-Furnace Boilers: A. J. Capron.—The Influence of Process of Manufacture on Some of the Properties of Steel: F. W. Harbord.—The Distribution of Sulphur in Metal Ingot Moulds: J. Henderson.—The Ageing of Mild Steel: C. E. Stromeyer.—Carbon-Tungsten Steels: T. Swinden.—The Nomenclature of Iron and Steel: Report of a Committee of the International Association for Testing Materials.

SATURDAY, May 11.

Royal Institution, at 3.—Scientific Work in the Sea-Fisheries: Prof. W. C. McIntosh, F.R.S.

CONTENTS.

THURSDAY, MAY 9, 1907.

IS THE ELECTRONIC THEORY OF MATTER LEGITIMATE?

Electrons, or the Nature and Properties of Negative Electricity. By Sir Oliver Lodge, F.R.S. Pp. xv+230. (London: George Bell and Sons, 1906.) Price 6s. net.

AT the present time there are few more absorbing topics among physicists and chemists than the electron and its relation to matter, and none on which a more complete mystification exists. A book on the subject by so illuminating and inspiring a publicist as Sir Oliver Lodge is therefore doubly acceptable at the present time.

A few words on the existing situation may be of general interest. It will be recalled that the researches in optics on the one hand, culminating in the discovery and elucidation of the Zeeman effect, and in the phenomena of the Crookes's tube on the other, resulting in the isolation of the free electron and the measurement of its constants by J. J. Thomson, made the scientific world familiar with the conclusion that the same electron or atom of negative electricity is *an* ultimate constituent of all atoms, and possesses, in virtue of the magnetic field it creates in motion, inertia which, though small, is definite and indistinguishable in ordinary circumstances from the inertia possessed by ordinary matter. There is little that would to-day be generally considered as controversial in these two conclusions. On the contrary, the researches which have led to them have received the unstinted admiration of all. But upon these conclusions are based others, concerned, not with the nature of electricity, but of matter, in the highest degree controversial and speculative, which regard the electron as the universal unit out of which all matter is essentially built up, and mass as an electromagnetic phenomenon due to a vast assemblage of constituent electrons grouped together in stable configurations constituting the atoms. This view of atomic structure was developed by J. J. Thomson in two papers (*Phil. Mag.*, December, 1903, and March, 1904). He regarded the atom as composed of a uniform sphere of positive electrification containing an electrically equivalent number of electrons revolving in regular motion about the centre, and showed that according to the numbers of the electrons periodic sequences of properties of the systems would occur strikingly similar to the periodic sequences in the properties of the atoms of the actual elements themselves.

One of the most enthusiastic supporters of the universal extension of the electronic theory to explain the properties of matter has been Sir Oliver Lodge himself, who saw in the instability, natural to a system constituted of electrons in constrained motion, due to the external radiation of energy that must be supposed to take place, a possible cause of radioactivity and of the observed disintegration of the radioactive elements. Some few months ago, however, J. J. Thomson (*Phil. Mag.*, June, 1906) published the results of an investigation into the actual number of electrons existing in an atom of matter by three independent methods, which led to the uniform and unexpected conclusion that the number of electrons is of the same order as the weight of the atom in terms of that of hydrogen as unity. Since then it may be safely said that no one has known quite what to think with regard to the electronic theory in its application to material phenomena, and the present book, from the pen of a writer to whom so often in the past the student has looked for light and leading in difficult places, will therefore be opened with curiosity and read with eagerness.

The effect of the profound changes which have come over the subject in the last few months is evident in the preface, where we read:—

"A proof that the atom of matter is essentially composed of such electrons, and that its mass, too, is of purely electromagnetic nature, is lacking; the electromagnetic theory of Matter . . . must be regarded for the present as no better than a working hypothesis. It is a hypothesis of stimulating character, and of great probability, but its truth is still an open question that is probably not going to be speedily closed."

The extract may be said to give the keynote to the treatment in the book. It is evident that the writer himself has not lost confidence in the ultimate triumph of the electron theory in its universal aspect, and although he is aware of, and does not attempt to minimise the magnitude of, the recent difficulties which have arisen, his enthusiasm is still undamped. In a chapter towards the end of the book, devoted to a consideration of some of these difficulties, he himself describes the recent paper of J. J. Thomson, to which reference has been made, as "the most serious blow yet dealt at the theory, at least in its simpler and cruder form" (p. 194); and again (p. 151), "it has tended to reduce the whole subject to a state of exaggerated uncertainty." But his final conclusion is (p. 200):—

"The most exciting part of the whole is the explanation of matter in terms of electricity, the view that electricity is, after all, the fundamental substance, and that what we have been accustomed to regard as an indivisible atom of matter is built up out of it; that all atoms—atoms of all sorts of substances—are built up of the same thing. . . . But it must be remembered that although this solution is strongly suggested it is not yet a completed proof. Much more work remains to be done before we are certain that mass is due to electric nuclei."

No excuse need be offered for dwelling on this side of the book, for the attitude of the leading exponents to the recent developments of the electronic theory of matter is topically the most interesting to the scientific reader at the moment. But attention must not on that account be diverted from what is, after all, the main subject of the book, not the nature of matter, but that of electricity. The major part is devoted to an admirable and inspiring treatment of those solid results of experiment and analysis elucidating the nature and properties of negative electricity, which have led to the establishment on a firm basis of the atomic theory of electricity. It is only the last third which is devoted to the speculative and controversial side in which the electron becomes also a material conception replacing the "*urstoff*" or "protyle" of earlier similar speculations. Some of the points touched upon in the text are treated at greater length in a series of appendices, but no index has been furnished, which is a decided omission.

Of the chapters presenting special features of interest may be mentioned chapter ix., which is largely concerned with the size of the electron and its power of penetrating matter, the effects of a collision between electron and atom, and the ratio of the distribution of the energy of collision between heat and X-rays; chapter xi., which deals with the magnetism of light, and affords a very clear exposition of the nature of the action, which "has opened up a new branch of physics, a new department, as it were, of atomic astronomy, with atoms and electrons instead of planets and satellites"; and chapter xiv., which contains a full treatment of the experimental work of Kaufmann on the high-velocity β-ray electrons expelled by radium. In chapter xv. no less than five alternative views of the constitution of the atom are considered, which emphasises, to use the author's own expression, the "painfully indefinite character" of the theory applied to matter. Exception must be taken to chapter xviii., entitled "Summary of other Consequences of the Electron Theory," which begins with a section headed "Radioactivity" (!). Now this is surely unfair to a great and independent experimental subject, because not only has radio-activity taught us something really definite and fundamental about matter as distinguished from electricity, but also it has at the same time furnished, for example, in the penetrating power of the α and β rays, the most damaging evidence against the possibility of an electronic constitution of matter.

Sir Oliver Lodge's well-known forceful and attractive style is always in its element in dealing with the conquests achieved in physical science, but the concluding passage is something of the nature of a parting shot at the reader.

"Especially must the inner ethereal meaning both of positive and negative charges be explained: whether on the notion of a right-and-left-handed self-locked intrinsic wrench-strain in a Kelvin gyrostatically-stable ether, elaborated by Larmor, or on some hitherto unimagined plan. And this will entail a quantity of exploring mathematical work of the highest order."

To explore the inner ethereal meaning of this right-and-left-hander elaborated by the author demands a brain of unquestionable gyrostatic stability.

Having dealt with the author's book as the exposition of his views of the nature of electricity and matter, and having first fully acknowledged the debt the reading public owe to Sir Oliver Lodge for the leading part he has taken in the public work of advancing and expounding the new doctrines, it may not be considered ungracious to touch a little less enthusiastically than the author does on certain aspects of the new theories themselves here so powerfully advocated.

Without in the least wishing to minimise the importance of the part played by imagination and hypothesis in experimental science, the question may fairly be asked whether these persistent efforts to "simplify" matter and reduce it to a single fundamental existence have a place in the legitimate scientific thought of the present day, or whether they are not a continually recurring phase of an apparently innate primitive mental aspiration, the origin of which is to be sought, not in the phenomena themselves, but in the predilections of the human brain. The rule that where one conception suffices it is superfluous to use more than one may be fully granted. But it is surely still something of a mental luxury to believe that these ideas of the essential unity of matter and its ultimate reducibility to a single type, which exist deep down in the most ancient mythologies, and may be said to form part of the common stock of original ways of thinking, have as yet any other than this foundation. Matter continues to be experimentally incomprehensible, and as recent work in radio-activity has shown, the possibilities of its complexity are far from exhausted by the eighty or more recognised elements. The attempts, for example Prout's hypothesis, to reduce matter to one common basis testify rather to the aspiration for that kind of explanation which to our ideas seems appropriate. It is undoubtedly satisfying to picture all matter as built up of some one unit, because an ingrained bias exists in the mind towards the simplest possible origin of phenomena. There is, however, evidence that our natural subjective impressions of what is fit and appropriate are, when they are traced to their source, derived in the first place from an insufficient study of the operations of Nature, which fuller knowledge usually dispels. It is, of course, possible that with the even fuller knowledge of the future some such doctrine as a connection between what is mentally harmonious and what is physically true may transpire, and the doctrine find a legitimate place in the theories of pure physics. But for the present the supporters of the electronic theory of matter have to show that they have not allowed their enthusiasm to betray them into an attitude of mind which belongs rather to the past than to the future of scientific thought.

FREDERICK SODDY.

THE COLONISATION OF VIRGINIA.

The Generall Historie of Virginia, New England, and the Summer Isles, together with the True Travels, Adventures and Observations, and a Sea Grammar. By Captaine John Smith. Two vols. Vol. i., pp. xxxiii+396; vol. ii., pp. xix+330. (Glasgow: James Maclehose and Sons; London: Macmillan and Co., Ltd., 1907.) Price 25s. net.

AT the time of writing (April) the warships of the Powers are gathered together in Hampton Roads to honour the tercentenary of the founding of the Commonwealth of Virginia, and the Jamestown Exposition (held at Norfolk) will soon be opened for all the world and his wife to come and see what Virginia can show them after three hundred years of existence, in spite of the grievous calamity of forty years since. What the warships of the other Powers have to do with the celebration is not quite clear; one would have thought that this would have been a domestic event to be celebrated by the navies and peoples of the United States and Great Britain alone. For there was no foreigner, barring a recalcitrant Dutchman or two, concerned in the settling of Jamestown and the creation of Virginia in the fair land of Wingandacoa, in the year of grace 1607.

For although Wingandacoa had been discovered by the emissaries of Sir Walter Raleigh, and its name changed to "Virginia" by "Her Maiesties Grace" in honour of her glorious self, in 1584, it was not until 1607 that the permanent settlement was made, and called Jamestown in honour of the "Solomon" who now presided over the destinies of the British nation. It was odd that the name of his tobacco-hating majesty should have been given to the first capital of the country which has always produced the bulk of the obnoxious weed!

With the expedition which set sail from Blackwall in December, 1606, came Master John Smith the redoubtable, who bore for his arms the three Turks' heads granted to him by Sigismundus Bathory, "by the Grace of God Duke of Transilvania, Wallachia, and Moldavia, Earle of Anchard, Salford, and Growenda," in commemoration of his great exploit in the service of that prince, when, "with his sword, before the towne of Regall, in single combat he did overcome, kill, and cut off" the heads of three Turkish champions. In memory of which exploit the three isles off the American coast called the "Turks' Heads" were also named by Master John Smith himself. Smith was a man of the most indomitable energy and determination, as his fellow-voyagers to Virginia, Mr. Edward-maria Wingfield and the rest, soon found; and it was not very long before the hero of the Turks' heads was in full command of the colony, very much for its good, and Wingfield and Smith's enemies returned to England to sow the seeds of opposition which eventually made the position of the masterful governor untenable.

Smith himself tells the story of his work in his remarkable "Generall Historie," of which Messrs. Maclehose have issued the present admirable reprint just at the right moment, when the tercentenary of the founding of Jamestown is being celebrated in Virginia. Egotistical the book is, but when he wrote it Smith was smarting under the undeserved reproach of the enemies that his energy had made for him, and his purpose was to assert to the world what he had done, and to show, what none will gainsay, that but for him the Commonwealth of Virginia would never have been securely founded. Enemies he may well have made, for he called a spade a spade, and could not suffer a fool gladly; the gentlemen of the Virginia Company at home were roundly trounced in his despatches to them for their foolish desires for non-existent gold, when all that Virginia could give them was fish, tobacco, and a little copper; and why not raise revenue and gain honest profit from fish and tobacco? says he. Rough with the natives he was said to be, but that is the way of the pioneers, and we can see from many passages in his book that Smith was really a most kindly man, and liked the "salvages." We know in our own time how accusations of roughness to "natives" are made against men of the type of Smith by people whose knowledge of foreign lands is derived from books and their own brains, and have never themselves come into personal contact with the less civilised races in their own home. Of his truly scientific quality of observation and deduction Smith's book is eloquent proof; he knew what he was talking about. But that he was tactless and undiplomatic in dealing with his own fellows, however well he may have understood the natives, is equally evident. And the man who knows, but is impatient and tactless in trying to drive others to realise his knowledge for their own good, often sees his work torn from him before he can complete it. This was the case with Smith, who never returned to Virginia after he left it, wounded and discouraged, in 1609. To New England he went, and had much to do with the constitution of the northern colony; but though during the rest of his life he never wearied in strenuous advertisement of the Virginian settlement, he did not re-visit it.

The picture of the people of Wingandacoa which Smith gives us is well known. Powhatan the "mighty emperour" and his werowances or chiefs; Pocahontas his daughter, who saved Smith's life when he was a prisoner and her father would have tortured him to death, that Pocahontas who, after Smith left, married Master Rolfe, came to England, was presented at Court, and died when leaving to re-visit her home; the marvellous incidents of Smith's imprisonment and the discoveries of himself and his men; his descriptions of all these have been known to many generations of lovers of tales of adventure, and have furnished much material to the modern writers of them. Yet to read Smith's own narrative again, with its naïf comments on men and things, its quaint spelling, and its Wegg-like "droppings into poetry," by himself and his friends, mostly very bad and merely inserted "seeing there is thus much Paper here to spare, that you should not be altogether cloyed with Prose"—is always amusing, and in the present year most interesting. So we may thank Messrs. Maclehose for their reprint, which includes, besides the timely "Generall Historie," also Smith's story of his own adventurous life in other lands than America, and his very curious "Sea-Grammar," which may well have supplied Swift with some of the material for his utterly unintelligible description of a storm in Gulliver's "Voyage to Brobdingnag"!

The book is a handsome one, and the paper and type have an air of archaism which well suits the subject. Smith's own maps are reproduced, and the famous portrait of Pocahontas, called "Matoaka alias Rebecca filia potentiss: princ: Powhatani Imp: Virginiae," or "Emperour of Ananoughkomouck, *alias* Virginia," besides the original illustrations of Smith's adventures among the "salvages."

THE LIFE-WORK OF AN EMINENT METEOROLOGIST.

Gesammelte Abhandlungen aus den Gebieten der Meteorologie und des Erdmagnetismus. Von Wilhelm von Bezold in Gemeinschaft mit A. Coym. Herausgegeben vom Verfasser. Pp. viii+448; illustrated. (Brunswick: F. Vieweg and Son, 1906.) Price 14 marks.

PROF. VON BEZOLD'S position as the late head of the Prussian Meteorological Institute suffices to make the publication of his collected works on meteorology and terrestrial magnetism an event of importance. His papers on electricity and physiological optics remain apparently to be dealt with. In preparing the present work for press, he had the assistance of Dr. Coym, formerly of the Meteorological Institute. The collection includes twenty papers; in some, slight alterations have been introduced and some notes have been added.

Only the earliest paper, written in 1864, represents von Bezold as himself an observer. It treats of the phenomena visible after sunset, especially of what von Bezold terms the "Purpurlicht." An appendix refers to recent authorities, and especially to the effect of volcanic ejecta on the richness of the phenomena.

The next three papers deal with the frequency of thunderstorms. It is explained in an appendix, pp. 83-90, that much of von Bezold's writings on this subject seemed of too local interest to reproduce. In the first paper, after dealing with statistics from a number of stations—mostly in central Europe—von Bezold decides in favour of a connection between thunderstorm and sun-spot frequency. His conclusion on p. 59, repeated in the last thunderstorm paper, p. 82, is that thunderstorm and auroral frequency follow opposite courses, thunderstorms being least frequent in years of sun-spot maximum, when auroras are most numerous. This conclusion must be regarded with some reserve.

In the next paper, dealing with sun-spot data from Bavaria and Württemberg, von Bezold considers the evidence favourable to the reality of a twenty-six-day period in thunderstorms. A footnote dated 1905 qualifies this, pointing out that it would be natural to look for the source of a twenty-six-day period in the sun, and as it is probable that the seat of greatest activity in the sun changes its position, the twenty-six-day period will naturally change its phase, and so be recognisable only in statistics covering a comparatively short period. This seems the same position as has been taken up in the case of magnetic storms by Maunder, who, however, finds a period of about 27¼ days. The reality of a period the phase of which alters in an indefinite way is rather a difficult matter to decide.

The third of the thunderstorm papers suggests an extraordinary increase in damage by lightning in Germany. In Bavaria the percentage of (insured) houses struck by lightning was fully six times as great in the decade 1893–1902 as in the decade 1833–1842. Von Bezold appears to accept the increase as proved all over Germany. Other German authorities, it may be added, have expressed some doubts as to the true significance of the insurance statistics; the phenomena may not be purely meteorological.

Papers v.–ix., pp. 91–220, form a group devoted to the thermodynamics of the atmosphere. The elementary portion of air contains moisture which may be wholly gaseous, or partly condensed in raindrops, in snow, or in hail. Also the air element resembles a compartment of a train in that its original occupants may leave it at intermediate stations, whilst new occupants may come in. Change of state in the water contents implies evolution or absorption of heat, and the five papers aim at tracing the various possible modifications and identifying them with the phenomena of cyclones, anticyclones, Föhn winds, and so on. The reader to whom German presents difficulties will find an English translation of the first three papers of the group in Prof. Cleveland Abbe's "The Mechanics of the Earth's Atmosphere"; he must, however, be on his guard against misprints. The present reprint contains some fresh notes, and shows some alterations, *e.g.* on pp. 123 and 125, dealing with cyclonic and anticyclonic phenomena. These thermodynamical papers represent a product which the typical English meteorologist will contentedly deny himself. If, however, the Cambridge mathematical meteorologist ever comes into being, he ought to read these papers as part of his preliminary education. If he reads them critically in the light of recent meteorological knowledge he will—whether he agrees wholly with the author or not—have done a good deal to qualify himself for profitable research in the dynamics of the atmosphere.

Papers x.–xv. are also in the main theoretical, but they contain information from balloon ascents as to temperature and moisture in cyclonic and anticyclonic weather at different seasons of the year. Paper xvi. gives statistics from various sources as to the mean annual values of temperature, pressure, rainfall, and cloud round parallels of the earth. To obtain zones of equal area, the author takes as parameter the *sine* of the latitude. This paper leads naturally to xvii., the first of four papers, pp. 371–448, devoted to terrestrial magnetism, in which von Bezold considers what he calls the "isanomalies" of the magnetic potential, *i.e.* the departures from the mean value round a parallel of latitude. Paper xviii. deals with what the author calls the *normal* earth's magnetism. Paper xix. treats of the foundations of the Gaussian theory as based on the vanishing of line integrals taken round areas on the earth's surface, and discusses the diurnal variation, in the light of Prof. Schuster's variation potential, and its representation by vector diagrams.

The final paper advocates the taking of magnetic observations round a parallel of latitude, which von Bezold suggests might pass through the south of England. To a magnetician familiar with the Gaussian analysis and with Schuster's work on the diurnal variation, von Bezold's contributions to the subject will appear to be rather a matter of definitions and identifications than of original ideas. To those, however, who have a difficulty in grasping the physical significance of abstruse mathematics, they may serve a useful purpose, provided it be clearly understood that anything like a complete treatment of the diurnal variation requires a careful study of the influence of the season of the year as well as the relation to sun-spot frequency. The proposal advocated by von Bezold and others to effect a line integration round a parallel of latitude ought before its adoption to receive careful consideration from the side of atmospheric electricity. It should be remembered that the earth-air currents required to invalidate the hypothesis embodied in the Gaussian potential are not transient currents varying with the hour of the day or with the weather—such currents could only modify the magnetic diurnal inequality or cause irregular disturbances—but currents of practically constant value and direction over large areas.

Since the above was written, science has had to mourn the death of the distinguished author, Prof. von Bezold, a fact already announced to the readers of NATURE (February 21, p. 397).

CHARLES CHREE.

THE COLLOIDAL THEORY OF DYEING.

The Chemistry and Physics of Dyeing. By W. P. Dreaper. Pp. viii+315; illustrated. (London: J. and A. Churchill, 1906.) Price 10s. 6d. net.

WHEN it is remembered that dyeing has become a highly scientific process, it is somewhat strange to note what a small part theoretical considerations have played in the practical development of the art, a fact no doubt largely due to the lack of definite knowledge of the chemical constitution of textile fibres. Most manuals of dyeing have been written for practical ends, and have devoted small space to the consideration of the various theories of dyeing which have been put forward, since, as before remarked, these have helped but little in the practical solution of dye-house problems. Our knowledge of the nature of fibres has, however, now reached a point when it is undoubtedly of value that the scientific dyer should make himself acquainted with this side of his subject, and recent work on the nature and properties of colloids certainly appears to throw much new light on the intricate nature of dyeing processes.

It has, of course, long been known that one and the same kind of fibre acts differently towards various dyes, and that dyestuffs may be classified into groups on the basis of this differentiation. To a considerable extent this grouping is found to correspond with fundamental similarities in the chemical constitution of the dyes, and this broad fact has lent strong support to the chemical theory of dyeing.

The older theories of dyeing could be broadly classified into two groups, those assuming a chemical reaction between fibre and dye, and those in which dyeing phenomena are explained by the physical properties of the reacting bodies. To a great extent these theories are antagonistic, and yet upholders of each are able to put forward incontrovertible facts in their support. It is, however, far from satisfactory to have to assume that similar phenomena can be explained in one case by a certain theory and in a second by an opposite theory, and the time is ripe for a wider view which shall embrace and reconcile all well-established facts concerned with dyeing processes. How far the colloidal theory of dyeing is successful in doing this may be gathered from a perusal of the book under review. Much of the experimental work mentioned lacks precision, and the various researches are somewhat detached, but the present knowledge of colloidal conditions and functions, incomplete as it is, throws much light on earlier work, and from further work in this direction a satisfactory explanation of dyeing processes may eventually emerge. In the past many difficulties, in regard to dyeing theory as in other directions, have arisen from an attempt to draw a hard and fast line between chemical and physical action, and the blending of the two may be considered as the characteristic feature of the reactions of colloids.

The book is arranged in twelve chapters, of which the first is devoted to a historical introduction, which might with advantage have been considerably extended. The properties and reactions of fibres, dyes, mordants, and assistants are dealt with in chapters ii.–v. Chapter vi. contains an excellent summary of the recent work on the properties of colloids. Chapter vii. gives facts in support of the old mechanical theory of dyeing which reached its final development in the solid solution theory of van 't Hoff and Arrhenius, which was applied to dyeing processes by O. N. Witt. Chapters viii. and ix. give a similar summary of facts supporting the chemical theory of dyeing. Then follows in chapter x. an attempt to show the application of the colloidal theory, and in this the incompleteness of the evidence becomes apparent, though as a suggestive contribution it is very interesting. A chapter on the action of light on dyeing operations and dyed fabrics appears to have little connection with the central theme of the work.

The many inaccuracies in the book lay it open to a good deal of minor criticism. For example, on p. 14 several of the formulæ are altogether inexplicable. On p. 33 it is stated that Bancroft divided dyes into *subjective* and adjective, the term used by Bancroft being *substantive*. A fair summary of the work of various investigators is usually given in the text, but it is often difficult to ascertain at what point the summary ends and the author's comments begin. There is thus some danger of injustice to one or other. Since both centigrade and Fahrenheit thermometric scales are used in the book, some confusion arises in the frequent cases where a temperature figure is given without indicating which scale it refers to. Amongst mis-spelt authors' names may be mentioned Verquin for Verguin, Pokorng for Pokorny (several times), Prager for Perger, Brand for Brandt, Boettinger for Böttiger, and Hirst for Hurst.

The general plan of the book is excellent, and the author's work, though somewhat unequal, is on the whole very satisfactory. The production of such a book would have been impossible a few years ago, and it marks a distinct advance in the linking up of one of the most ancient arts with modern scientific theory, and shows a common ground where the practical dyer, the chemist, and the physicist may meet. Its study will well repay all students of dyeing and those practically engaged in the textile trades who have been able to keep in any way abreast with recent work. WALTER M. GARDNER.

THE WAYS OF WILDFOWL.

Practical Wildfowling. A Complete Guide to the Art of the Fowler, with Descriptions of the Various Birds usually met with. By W. J. Fallon. Second edition, revised and greatly enlarged. Pp. 248; illustrated. (London: L. Upcott Gill; New York: Chas. Scribner's Sons, 1907.) Price 6*s*.

THE new edition of Mr. Fallon's useful little handbook of practical wildfowling has been brought up to date, and a considerable amount of new matter and many new illustrations have been added. Thoroughly to enjoy his sport the wildfowler must be a good field naturalist, and this little work aims, *inter alia*, at making easy the identification of those species of birds he is most likely to meet with. The enjoyment of wildfowling lies not only in killing, but in seeking to kill by pitting one's endeavours and skill against the cunning and wariness of the fowl. Unlike pheasants and partridges, they cannot be brought over the guns. Herein lies the essence of the sport, and hence the absolute necessity of understanding the life-habits and peculiarities of the various kinds of wildfowl.

With the first part of this excellent manual, which deals fully with the guns, boats, ammunition, and other outfit and accessories necessary for the pursuit, we are not immediately concerned, but pass on to the chapters on the art of wildfowling, for therein much may be learned about the habits of some of the shyest of birds. To be a successful wildfowler, a man must have an intimate knowledge of the birds' ways and behaviour under the varying conditions of time, tide, and weather. He must also be able to identify the fowl, not only when in hand, but when at a distance. His skill in handling the gun will avail him little if he cannot distinguish a jack snipe from a sandpiper, curlews from gulls, or ducks from divers, for all these and others must be attacked with a different strategy. To know birds, when at a little distance, by some peculiarity of motion, shape, or flight, is a great part of the fowler's craft, for the tactics adopted to secure one kind of duck may be quite inadequate in the case of some other species of this family. He must be familiar, too, with the food and the feeding-ground of the various ducks, geese, and shore birds in order to know where they may be found, and at what time of the day or night.

Naturalists, indeed, are indebted to the wildfowler for much that they have been able to record as to the habits of various wildfowl; and as Mr. Fallon essays, and very successfully, to instruct the tyro in all these things, his book appeals strongly to the field naturalist. In this part of the book the subject is treated under the heads of wild swans, wild geese, wild ducks, and shore birds, and the plan adopted is to describe each species of these groups likely (or even possible, for the rare kinds which *may* turn up any day are included) to be met with, and then to deal with the various methods of approaching and shooting them.

The identification of the different species is rendered more easy by the introduction of some very life-like figures, while in reading about the way to get at them we find ourselves learning a good deal about their individual peculiarities. In going through the book we come upon many good notes and original observations on the food and feeding habits of geese, ducks, and shore birds, and would instance the interesting remarks on the grain-feeding habits of the pink-footed goose. Many another out-of-the-way scrap of natural history, too, can be gleaned; for example, the curious habit of sheldrakes choosing as a nesting site the straw stacks which are placed in the fields as shelter for the cattle in some marshy districts. If we were disposed to be critical, we might suggest that the curlew sandpiper should not be described as of similar plumage to the dunlin, and that the white patch on the lower part of the back, so conspicuous when the former bird is flying, is a mark distinguishing the two species. Also that it is not up to date to say that a clutch of knot's eggs does not exist in any collection; not that this matters to the wildfowler. There have been many books written on wildfowling since the days of Hawker, but it is doubtful whether any of them give so much information in so small a compass as this little handbook. There is a good index, and we cannot withhold a word of especial praise from the delightful picture with a heron in the foreground.

O. V. APLIN.

OUR BOOK SHELF.

Hypnotism and Suggestion. By Edwin Ash. Pp. 134. (London: J. Jacobs, 1906.) Price 4*s*. net.

IN the preface the author tells the reader that the objects he had in view in writing this book were to explain the technique of experimental hypnotism and suggestive therapeutics, and at the same time to endeavour to divest the subject of the air of mystery with which it is popularly invested. In an introductory chapter he briefly alludes to certain general questions connected with hypnotism. He considers that telepathy is at present "non-proven," and, further, he does not believe in a "magnetic force" for curative purposes.

The author carefully describes the methods employed in the production of hypnosis, and the earlier and later phenomena to be observed when this condition is brought about. He discusses the various stages of hypnosis, and points out the difficulties of arranging an accurate classification. In considering the use of hypnosis for surgical anæsthesia, he recognises its limitations, and although he fully realises its value, nevertheless, from the practical standpoint, the difficulty of producing it rapidly and deeply is a serious objection in the way of bringing it into general use. Post-hypnotic influence forms the subject-matter of another chapter, and its possible relationship to criminal acts is referred to. Dr. Ash agrees with many observers that suggestions which are incompatible with the moral sense of the subject are in most cases at once rejected. Nevertheless, it must be admitted that if it is possible by means of hypnosis to suggest crime to a person whose moral sense is defective, then this is a factor which might become of vast importance if hypnotic suggestion ever became a remedy of general use.

The author gives an interesting chapter on "suggestive therapeutics," and in it he shows the power of suggestion of one mind upon another, and even in the same person the influence of the conscious mind upon the subconscious. He believes that Christian science is largely a system of auto-suggestion.

Dr. Ash strongly urges that there should be introduced into the medical curriculum a compulsory course of psychology and lectures on the principles of "suggestive therapeutics." We cordially agree with the former recommendation, for it is lamentable to find the ignorance that still exists regarding the normal mind, and some knowledge of this subject is a matter of growing importance, both from the evolutionary and dissolutionary standpoints.

For those who wish to learn some of the practical points regarding hypnosis and suggestion, Dr. Ash's book will be found most helpful, for although it is small it contains much information.

Domaine de Tervueren—Arboretum—Types de Forêts des Régions tempérées représentés dans leur Composition caractéristique. By Ch. Bommer. Pp. 211. (Brussels: Imprimerie F. and L. Terneu, 1905.)

THE site of the above arboretum was generously given by the King of the Belgians to the people. At the time of the gift His Majesty expressed the opinion that it was very useful, not to say indispensable, to create or to preserve open spaces with natural decoration near large towns, both from an æsthetic and hygienic point of view. M. Ch. Bommer was entrusted with the task of laying out the arboretum, and this he has evidently done in a scientific and practical manner. The various plots or groups have been formed to illustrate the principal types of vegetation in the temperate zone of the old and new worlds. Even the bushes and herbaceous plants characteristic of these zones have been added to complete the picture, thus very clearly illustrating the characteristics of the various species and their geographical distribution. The arboretum also forms an excellent centre for testing the acclimatisation of exotic trees. We have also in the above book a detailed account of the individual species which includes synonyms, size, habit, general characteristics, and uses of wood, &c. Numerous photographic plates are included illustrating various groups and points of general interest. Plans of the arboretum and maps showing the geographical distribution of the species are given at the end of this very useful and interesting book.

Elementary Science for Pupil Teachers. Physics Section by W. T. Clough. Chemistry Section by A. E. Dunstan. Pp. vi+183. (London: Methuen and Co., 1907.) Price 2s.

PUPIL teachers who have opportunities of doing practical work will, if they perform the experiments in this book and follow the guidance it gives, obtain sound preliminary ideas of physics and chemistry. The physics section comprises the measurement of lengths, areas, volumes, and masses, simple hydrostatics, and an introduction to the study of heat. The chemistry section covers the subjects arising from a careful study of air, water, and other common substances. The volume is on the whole attractive, but the smaller of the two types is likely to try the eyes of readers.

A First Geometry. By W. M. Baker and A. A. Bourne. Pp. viii+128+vi. (London: George Bell and Sons, 1907.) Price 1s. 6d.

WITH the exception of a dozen theorems at the end, this book is a simple course of experimental geometry designed to familiarise young pupils with fundamental geometrical conceptions by setting them to draw with mathematical instruments and to construct simple models for measuring angles and constructing plans. The lessons are interesting, and arranged in a manner that shows the authors to be well acquainted with the needs and capabilities of beginners.

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 intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Radium and Geology.

PROF. JOLY'S interesting discovery (NATURE, May 2, p. 8) that typical rocks in the Simplon Tunnel contain quantities of radium considerably in excess of the average of igneous rocks raises a question. From Mr. Strutt's investigations it appears that the average content of igneous rocks would be sufficient to account for the ordinary temperature gradient in the earth's crust were it due to radium. It seems, therefore, that, if the temperature was so caused, the gradient in the Simplon Tunnel ought to have been higher than the average, viz. 1° F. for between 50 feet and 60 feet. But, in fact, as beneath other mountains, it was considerably lower. In NATURE, October 27, 1904, it is stated that the temperature of the rocks in the advanced gallery was 108° F. where the cover was 7005 feet. This gives 1° F. for 92 feet. In the St. Gothard Tunnel it was 1° F. for 102 feet, and in the Mt. Cenis Tunnel 1° F. for 100 feet. That the gradient in the Simplon Tunnel, though low, was somewhat higher than in the other two was probably caused by the spring 23° hotter than the rock, which brought up heat from a lower level. I think I have shown in my "Physics of the Earth's Crust," chapter xvi., that these low gradients can but very slightly be attributed to the convexity of the surface.

Is not, therefore, the result of Prof. Joly's examination of the Simplon rocks rather unfavourable than otherwise to the hypothesis that the heat of the earth's crust is due to radium? O. FISHER.

Graveley, Huntingdon, May 4.

Ethnological Notes on the Aboriginal Tribes of New South Wales and Victoria.

A REVIEW of the above work appeared in NATURE of May 31, 1906 (vol. lxxiv., p. 100), to which I wish to reply briefly. The review opens by saying that my works "have either been ignored or dismissed in a footnote by experts such as Dr. Howitt and Prof. Spencer." Whilst the reviewer was quite aware of the obscure "footnote," he was quite silent regarding my reply to it, dated June 27, 1905.[1] The opinions of the two men named do not perturb me, but when such an injurious statement appears in the "thunderer" of scientific journalism, I crave fair play and the right of reply.

[1] The Queensland Geographical Journal, vol. xx., pp. 73-75.

For nearly forty years I have practised as a land surveyor in Australia, and through my professional duties I have been much in contact with the aborigines over all the eastern half of this continent. In my youth I became fascinated with the study of local ethnology, and my enthusiasm has never flagged since, so that I can claim to be no tyro in the science. Having had exceptional opportunities of studying my subject on the spot, I claim a little consideration. More than one hundred of my contributions have already been published by various scientific societies in Australia, England, France, Prussia, Austria, and the United States, so that my work has met with some appreciation. I mention these few facts about myself, not egotistically, but as *bona fides*, because Australia is so far removed from the centre of scientific civilisation that a quiet worker is apt to be overlooked unless he presents his credentials.

Now, as regards the "ignoring" referred to by the reviewer. Dr. Howitt does not mention me in his book published in 1904, but he reports, at p. 92, the names Kulpuru and Tiniwa as phratries of the Yantrawanta tribe. He omits to say, in fine he "ignores," that I reported these same phratry names in 1899,[1] and again in 1900.[2] At p. 138 he says that "Tiniwa is the same as Kararu and Kulpuru as Matteri," but he "ignores" that I reported this self-same equivalence in 1900.[3] At p. 107 he stumbled across the word Mukulu (my muggulu), which he mistook for a phratry name instead of a blood division, a thing he had apparently never heard of. At p. 211, in speaking of the Wiradjuri sociology, he says that Ippai can marry Matha as well as Kubbitha, but he "ignores" my report to the same effect in 1896, eight years before.[4]

Then again, in his account of the Dora ceremony (my Toara or Doara), at pp. 599–606, Dr. Howitt "ignores" that I described that rite in January, 1900.[5] If he did not avail himself of my work, which appeared four years earlier than his, then there is a wondrous agreement in our details.

And yet again, Dr. Howitt at p. 44 gives a sketch-map showing the habitat of certain tribes in South Australia, but he "ignores" that I published substantially the *same* map in 1900,[6] four years earlier. In comparing the two maps and the explanatory letterpress accompanying mine we observe a marvellous coincidence. Many other examples could be cited, but exigencies of space force us to pass them over for the present.

I do not particularly object to all the above instances of "ignoring," because they have the effect of confirming the accuracy of my earlier reports; my objection applies to the damaging way in which reference is made to them in NATURE.

Regarding Prof. Spencer's "footnote," I refer your readers to my reply thereto in the Queensland Geographical Journal, vol. xx., pp. 73–5. No doubt he was very much cut to find that I had forestalled him by describing the eight sections of the Wombaia (his Umbaia) tribe in 1898;[7] that I had dealt with the Binbingha sociology in 1899;[8] and that I had reported the sociology of the Chingalee in 1900,[9] with a comprehensive map showing the location of these and other tribes. The publication in 1901 of my "Ethnological Notes on the Aboriginal Tribes of the Northern Territory"[10] probably increased his irritation and disappointment.

Fault is found in the review with my statement that nothing important has been added to our knowledge of the Kamilaroi organisation since the time of Ridley and Bridgeman. I beg to repeat that Ridley showed that Ippai married Kubbitha or Ippatha, and that there were totems with female descent. He also gave many illustrations of the intermarriages of the four divisions. Bridgeman stated that certain pairs of sections had a phratry name as well. I am still of opinion that nothing new or important had since been added by anyone until I reported the Blood and Shade divisions. The reviewer mentions Dr. Howitt's book, but his work is merely confirmatory of the previous reports of Ridley and Bridgeman.

It is stated in the review that Mrs. Langloh Parker's phratry names are identical with my Blood divisions; such is not the case, because she mistook the names of the Blood divisions for the phratries. I have known the Yuāleai (Mrs. Parker's Euahlayi) tribe for many years, and have been through most of their country. When publishing a grammar and vocabulary of their language in 1902[1] I stated that their social organisation and initiation ceremonies are the same as those of the Kamilaroi, thus anticipating much of Mrs. Parker's book, which did not appear until 1905.

Much more could be added, but it is thought that enough instances have been given to show that in original research among the Australian blacks I have often been first in the field; that probably my published results have been used and "ignored" by others; and, above all, that my work will stand the most rigorous criticism.

I have explained to the editor of NATURE the cause of the delay in my replying to the review in question.

R. H. MATHEWS.

1 Journ. Roy. Soc. N.S.Wales, xxxiii., 108; Proc. Amer. Philos. Soc., Philadelphia, xxxviii., 79.
2 Proc. Amer. Philos. Soc., xxxix., 83.
3 *Op. cit.*, p. 84.
4 American Anthropologist, ix. (1896), 413; Journ. Roy. Soc. N.S. Wales, xxxi., 173–174.
5 American Anthropologist (1900), ii., New Series, 139–144.
6 Proc. Amer. Philos. Soc., xxxix., 92–93.
7 Journ. Roy. Soc. N.S.Wales, xxii., 75; Proc. Amer. Philos. Soc., xxxvii., 152.
8 Proc. Amer. Philos. Soc., xxxviii., 77.
9 American Anthropologist, ii., New Series, 495, with map.
10 Queensland Geographical Journal (1901), xvi., 69–90.

IF I have done Mr. Mathews an injustice in my notice of his book, I can only express my regret for it and offer such reparation as a statement of my present view of the matter may make.

In directing attention to the fact that Mr. Mathews is ignored by Dr. Howitt and Prof. Baldwin Spencer, I merely stated a fact; if I had seen his reply I would have mentioned it. As to the reason why he is ignored I know nothing; a closer examination of Mr. Mathews's contributions than I had at the time of writing the notice been able to make leads me to think much better of his work; his readiness to acknowledge and withdraw his errors is worthy of the highest praise; and if his work is ignored solely on the ground that it is untrustworthy, it seems to me that this readiness is a sufficient reply to his critics. If there are further reasons, it is for Mr. Mathews's fellow-workers in Australia to state what they are. I personally have never heard of any further reason, and it seems to me that we in England are entitled to have one, if one exists. I may add that in my recent work, "Kinship and Marriage in Australia," I quoted Mr. Mathews as freely as any other author; at the same time, I have expressed dissent from some of his inferences.

Mr. Mathews makes good in the foregoing remarks his claim to priority on many points. His discovery of the "blood" divisions, of which Dr. Howitt knows nothing, seems to me especially important. In order to realise exactly what the situation is, we need a complete genealogy of a tribe for several generations back, showing both phratry, class, blood, and totem names of each individual. If Mr. Mathews can provide this material we shall owe him much; failing that, I hope it may be possible for some trained anthropologist, familiar with the modern genealogical method, to investigate the matter. I may add that Mr. Mathews has invited me to verify in person all the statements in his works which he bases on his own observations; this in reply to the review which called forth the above protest is surely a guarantee of good faith. I much regret that no money is forthcoming in England for anthropological work; if the financial part of the business could be settled, I would gladly accept Mr. Mathews's offer.

Nothing was further from my mind than to hurt Mr. Mathews's feelings, and if my notice was somewhat sharp in tone, I must plead in excuse the somewhat emphatic self-assertion of the passages I quoted. I hope that any future criticisms of mine will be such as to call for no protest on Mr. Mathews's part.

NORTHCOTE W. THOMAS.

1 Journ. Roy. Soc. N.S.Wales, xxxvi., pp. 137–190.

FRENCH EXPERIMENTS ON RIVETING.[1]

A STUDY of the most elementary form of connection used by the engineer may not appear to offer anything in the way of novelty or scientific value, as a contrivance at once so old and so simple as a rivet seems at first sight not likely to afford much scope for an investigation considered as a unit apart. Indeed, the chief interest has rather been in the grouping and arrangement of rivets, and the analysis of their behaviour under stress when assembled in the various joints and connections used by engineers in boilers, bridges, and the like. In the present instance the author, keeping strictly to the simpler problem, has produced a memoir of great interest.

In the early pages the ordinary processes of hand riveting are described, and a series of measurements and photographs, after the manner of Marey, shows in an interesting way that the well-known preference of the striker for the full swing of the hammer for long-continued effort as compared with the short swing and greater number of blows is an instinctive solution of the problem of obtaining the maximum effect for the effort exerted.

Fig. 1.—Composite photograph of a smith and striker for one swing of the hammer.

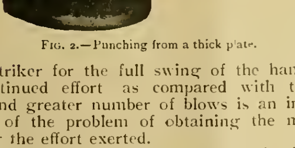

Fig. 2.—Punching from a thick plate.

The section following traces the growth of riveting machinery, and describes the characteristic effects produced when steam, air, or water is employed as the working fluid. Specimens of riveting obtained from various types of machines are noteworthy as showing that the shank of the rivet does not, as a rule, bear against the plates, and that eccentricity in the rivet head is common even in the most favourable circumstances. The essential difference between riveting by hand and that produced by a riveting machine is made clear by photographs of sections of rivets at different stages of their formation, the surfaces being prepared by polishing and etching in the usual way. The superficial effect of a blow, as compared with the squeeze of the pressure machine, is apparent in all the illustrations shown in the memoir.

The interesting question of the pressure required to produce the head of a rivet is taken up, and the various circumstances which influence this are the subject of much experimental study. These include the influence of temperature, the chilling of the metal by the die, the influence of the time in which the head is formed, and the effect of an excess of material in the shank, whereby waste material is squeezed up and forms a ring round the rivet head proper.

In addition, the diagrams drawn by the recording gear give precise information as to the work done on the rivet when the time of formation of the rivet-head is varied; they also show the effect of the cooling in drawing the plates together.

A detailed examination of the strength of the rivet gives special attention to the behaviour of the head and the way it ruptures under stress, and as a result a form of head is recommended having a radius of 0.86 the diameter of the rivet and a height of two-thirds the diameter.

The author, all through, has made great use of photographs of sections of pieces of material, but without magnification, and it seems possible that this side of the investigation would have yielded still more interesting results if it had included a detailed examination of the sections under the microscope.

As an instance of this, the accompanying figure shows the well-known form of punching produced from a thick plate, in which the characteristic sharp edge appears near the middle of the depth. Sections of such punchings would be well worth examining under the microscope, and, in fact, the possibilities of further research, with the microscope pressed into service, seem well worth consideration.

E. G. C.

[1] "Étude expérimentale du Rivetage." By Ch. Frémont. Pp. 142: 183 figures in text. (Paris: Society for the Encouragement of National Industry, Rue de Rennes, 1906.)

BIG GAME PRESERVATION.

A BLUE-BOOK containing correspondence relating to the preservation of wild animals in Africa was issued at the close of 1906, and sets forth ten years' official work in the British Empire, and in the dominions of other European nations in Africa, for the preservation of wild animals.

The Blue-book is not a satisfactory example of careful printing. It is extraordinary that before being issued, apparently from the Colonial Office, the proofs should not have been submitted to a zoologist for revision and correction. The names, in

Latin and in the vernacular, of beasts and birds are constantly disfigured by printers' errors of a childish description.

So far back as 1890 a movement began in Great Britain in favour of preserving wild life in lands under British control rather than allowing it to be exterminated by ruthless shooters. To some extent this movement was inspired from the United States. The creation of the National Park of the Yellowstone district, which was to lead to the formation of a "paradise" for the nearly extinct bison, bears, prongbuck, deer, and wolves of central North America, suggested to several sportsmen-naturalists of Great Britain similar preserves in tropical lands, especially in Africa. Of course, long antecedent to that, British naturalists had at last induced the State to legislate for the preservation of the scanty remains of the British fauna, and although our measures in this respect are still woefully inadequate, and a limited and old-fashioned class is allowed to push certain forms of sport at the expense of the wild fauna of these islands, still we have saved much; and in some districts of Great Britain birds and the smaller mammals really form constant and charming features in the landscape.

The great invasion of Africa, however, which began in earnest in 1890, directed public attention to the coincident slaughter of big game which everywhere accompanied the pioneering parties of the British. Just as Great Britain had been the greatest sinner in the slave trade, and was consequently the greatest and most enthusiastic among abolitionist nations, so her people, having gone far beyond any other nationality in the destruction of wild beasts and birds, are now foremost (though the United States is running almost neck and neck) in the world-movement for the preservation from extinction of all but the most harmful animals. We are rapidly appreciating the principle that just as "man does not live by bread alone," so we cannot be contented æsthetically with beef, mutton, poultry and pheasants, with cereals, tubers and cabbages, but that to complete the interest of our lives we must have beautiful wild things around us to admire and study; there must be a niche in our society for the rhinoceros, the lion, the tiger, and even the wolf. The hippopotamus and the walrus cannot be allowed to die out completely, still less the elephant. With improved methods of travel and rapid sea transit, we want to be able to contemplate birds of paradise, alive and well, in their New Guinea setting, and not see them in women's hats. A flock of flamingoes should be looked upon as a commercial asset of real value in Mediterranean lagoons or on West Indian beaches.

The leaders of this movement in Great Britain were mostly of the "converted-burglar" type—men like Selous, E. N. Buxton, Alfred Sharpe, and Lord Delamere—who, having had glorious sport with the rifle and killed specimens of all the great or rare beasts of Africa from north to south, had gradually transferred their interest from the mere passion of pursuing and killing to the contemplation of life-habits, to the study of the living animal. Photography—especially with the telephotographic lens was a potent agent in their reformation. Mr. E. N. Buxton especially has grown to grace, and led others with him up the pilgrims' way, through the new sport of snapshotting. An unconscious disciple of Mr. Buxton's has been Herr Schillings, whose beautiful study of wild life in East Africa ("With Flashlight and Rifle") has done much to advance the cause of game preservation in those regions. A very great share, however, in this important movement has been taken—perhaps unknown to the author himself—by Mr. J. G. Millais His book, "A Breath from the Veldt," published in 1895, was an epoch-making work. Many date their conversion to the new gospel from the days in which they first studied Mr. Millais's work. Though a sportsman of the truest type (and sport in this sense means far more than mere accurate shooting with rifle or gun), Mr. Millais realised himself, and taught those who gazed at his pictures, that it was far more profitable to our enjoyment and education to *watch living creatures alive* and study their habits with accuracy than to kill them and stuff their dead bodies.

How far the official world is in earnest about big-game preservation—in our own or any other Governments—it is difficult to say, there being so much humbug about the attitude of all Governments towards questions of art, science, and morals. Officialdom, as represented by Ministers that come and go, has taken a certain amount of tepid interest in the preservation of the African fauna. Some of the permanent officials (as distinguished from the parliamentary), like Sir Clement Hill, have displayed a praiseworthy persistency in pressing this matter on the attention of Secretaries of State, Governors of Colonies, and Commissioners of Protectorates. Sir John Kirk and the late Herr von Wissmann worked hard in the same direction. Sir Charles Eliot during his Commissionership in East Africa gave practical effect to regulations which had sometimes fallen into abeyance; the writer of this review (together with Sir Alfred Sharpe) between the years 1892 and 1901 created a number of game reserves in British Central-, British East Africa, and Uganda, the reserves ranging from an area of thirty to several thousand square miles in extent.

The policy of "game reserves" has been called much into question at different times by settlers and tourists. Settlers in regions adjoining these reserves complain that the wild game harbours the tsetse-fly, or that lions and leopards stray from the area of the reserve and become dangerous to the inhabited regions outside. Tourists, especially those who are naturalists and judicious sportsmen, complain that the "game reserve" (at any rate in Somaliland and parts of the Sudan) simply becomes a "game *preserve*" for the military officers on duty in those regions. On the other hand, if there is no special "national park," "paradise," or region set apart for the unfettered existence of wild beasts and birds, then, as Africa becomes opened up, an almost complete destruction of wild life ensues. Regulations may be framed and printed, but to attempt rigidly to enforce them is to incur constant friction, and even serious trouble, with Europeans and natives, both of whom are more or less reckless about "shooting for the pot" or destroying any creature that may threaten their crops or livestock. It has seemed to the present writer that the only real solution of this difficulty is to create and enforce game reserves—to set aside relatively large areas here and there in Africa which are not particularly well adapted for cultivation or settlement, but which may nevertheless offer features of great picturesqueness or interest, and thus become national parks where live creatures of every description are allowed to lead an unfettered life. But, naturally, in creating these game reserves the writer has not intended that their sanctity should be infringed by anyone with a gun—official or non-official. Many specially protected beasts or specially reserved areas are relieved of protection when a very distinguished or influential applicant applies for exemption from the regulations. The present writer would have the sanctity of these reserves rigidly adhered to; on the other hand, he would not attempt to enforce too drastically the preservation of game in the settled districts *outside* the reserves, though he would do everything in his power to discourage the needless killing of any beast, bird, reptile, or even insect that was not markedly harmful to the interests of man. Creatures of extraordinary beauty or interest, like the tiger, lion, moose, or elephant, should be allowed considerable latitude, and the State should compensate the cultivator or the passing tourist for annoyance because of the general interest felt by the community in the splendid development of these remarkable mammals.

The writer of this review deeply regrets that no efficient steps have been taken to create on a small scale national parks within the limits of Great Britain and Ireland for the preservation of wild life under wild conditions. He pointed out several years ago how admirably adapted for such a purpose is Achill Island, off the west coast of Ireland, a place which is fortunately still a refuge for many of the rarer and more interesting British birds.

H. H. Johnston.

THE INTERNATIONAL UNION FOR CO-OPERATION IN SOLAR RESEARCH.

A MEETING of the International Union for Co-operation in Solar Research will be held in Meudon, near Paris, during Whit-week, and a provisional programme of the proceedings has been sent to those who have accepted invitations to attend. The meeting will open on May 20, when formal business will be transacted in the morning. In the afternoon it is intended that all new proposals for joint work shall be submitted to the meeting, so that members will have an opportunity of privately discussing the desirability of adopting the proposals before a final decision is taken towards the end of the week.

The mornings of Tuesday and Wednesday, May 21 and 22, will be spent in receiving the reports of the committees appointed at the Oxford meeting in 1905. It is understood that Prof. Pérot is ready to submit his measurements of the wave-length of the red cadmium line, and that his results are in such good agreement with those previously obtained by Michelson that the meeting probably will be able to adopt finally a primary standard of wave-length. Other reports deal with the observations of sun-spot spectra and the organisation of the systematic application of the spectroheliograph to solar work. A question of interest to which several members of the union have given considerable attention consists in fixing the best methods of measuring the areas of flocculi. This matter has been under consideration at some of the American observatories, as well as at the Solar Physics Observatory at South Kensington and at the University Observatory, Oxford, so that an interesting and fruit-bearing discussion may be expected. On Tuesday evening, Dr. Janssen, the president of the congress, will give a banquet to the members at the Hôtel d'Orsay, in Paris, and on Wednesday afternoon Prof. Julius will demonstrate in the physical laboratories of the Sorbonne some of his experiments on anomalous dispersion. Arrangements have also been made to visit the Observatory of Paris in the same afternoon.

It is hoped that the scientific work of the meeting will be concluded on Thursday, May 23, and an excursion to the Château de Chantilly has been arranged for the Friday. A formal business meeting on Saturday, May 25, will bring the meeting to a close.

UNIVERSITY NEEDS AND THE DUTY OF THE STATE.

THE Chancellor and Vice-Chancellor of Oxford University have just appealed through the medium of the Press for at least 250,000*l.* to enable our oldest university to meet the demands that are made upon it by the ever-expanding requirements of modern learning. This appeal, coming so soon after a similar plea for a million and a half pounds, put forward recently by the Duke of Devonshire on behalf of the University of Cambridge, again brings into prominence the general question of the place of the university in the modern State and the duty of a Government in relation to the financial needs of institutions of higher learning.

In both cases appeals are made to the generosity of the wealthy public, and there is no suggestion that any responsibility attaches to the Government for the comparative poverty of these universities, in which Englishmen profess to feel great pride. The Oxford Chancellor and Vice-Chancellor, indeed, say of the needs of their university:—"In this country it is of no avail to look to the State for the satisfaction of those requirements; and it is to private generosity that the appeal must in consequence be made." It will be instructive to examine this attitude of mind towards one of the gravest questions confronting the nation at the beginning of the twentieth century, to analyse the appeals made in the light of recent experience, and to compare the results obtained with the experiences of university authorities in other great countries of the world.

In February last, in his letter to the public asking for a million and a half pounds for the University of Cambridge, the Duke of Devonshire reviewed the bequests, benefactions, and gifts received by the university since 1899, when the Cambridge University Association was formed at Devonshire House to promote the re-endowment of Cambridge University. From the sums received from our men of wealth the association was able to transfer to the university a total amount of 115,000*l.* In other words, during the seven years in which private generosity was being trusted to provide adequate means for the multifarious demands of a great university, an annual sum of about 16,430*l.* was forthcoming. That is to say, if private generosity could be trusted to display itself equally lavishly throughout so long a period, it would take more than ninety years to collect the million and a half pounds in which the University of Cambridge stands in pressing need to-day.

Similar particulars of a precise kind are not forthcoming in the case of Oxford, but it is, fortunately, possible to form some idea of the demands which are to be made upon private generosity to meet existing needs as enumerated by persons in authority in the university. The present appeal is for 250,000*l.*, and the letter signed by the Chancellor and Vice-Chancellor states two significant facts in connection with it. First, the ordinary university accounts for 1905 showed a balance of 5*l.* 17*s.* 6*d.*, and in 1906 there was "a further improvement, but the increased revenue is already allocated or pledged, and it is obvious that little more can be done in this way." Secondly, the constituent colleges contribute annually to university and academic purposes some 40,000*l.* An article was published in Nature on July 6, 1905 (vol. lxxii. p. 231), in which a detailed account was given of the needs of Oxford University, drawn up by the professors and heads of departments, and in the article an estimate was made of the capital outlay and the annual income required to meet the needs enumerated. The scheme outlined on that occasion was of a more ambitious character than the present, and involved an expenditure of more than half a million pounds; and for its effective execution an annual income of about 93,000*l.* was demanded. It seems clear, therefore, that in order to establish the University of Oxford on a scale commensurate with modern requirements—supplementing its existing departments and providing accommodation and equipment for the study of branches of knowledge of recent development—there must be found, in addition to a very substantial increase in the capital outlay, a further 50,000*l.* a year by way of income.

If it is supposed that the response made by our men of wealth particularly interested in Oxford will be on something like the same scale as that with which the appeal of the Cambridge University Association was met, it is not difficult to form a good working idea of the length of time which will be required to provide, from this source, sums of money enough to make it possible to place Oxford University in a position to invite comparison with the great universities of other countries.

The fact is, if we are to rely entirely upon private generosity to secure for this country the advantages of an adequate number of universities, planned, equipped, and financed on a scale liberal enough to meet modern needs, our chances of obtaining a supply of places of higher education comparable with that in Germany and the United States are small indeed. The vital importance of higher education in the international competition for imperial and industrial supremacy is conceded by all competent judges; and yet our statesmen hesitate to decide that what is so much worth having is worth paying for. In this country we cannot depend upon private effort to put matters right.

In his presidential address to the British Association in 1903, Sir Norman Lockyer reminded us that our universities and other institutions of higher instruction are as much a line of national defence as our Army and our Navy. The national responsibility, so far as the efficiency both of Navy and Army is concerned, is fully recognised by all political parties, and there is little difficulty in meeting the enormous financial demands which such efficiency in the services entails. As Sir Norman Lockyer pointed out, other countries are building universities even faster than they are building battleships; are, in fact, "considering brain-power first and sea-power afterwards." It is a saddening reflection how long it takes British statesmen to appreciate facts which have long been fully grasped by other nations. To leave to private enterprise the provision of necessary funds for the endowment of universities and research is as foolish as it would be in these days to relegate to private patriotism the duty of finding the money for the equipment of a modern army and an up-to-date navy.

What is the view of these matters taken in the United States? A recent publication[1] gives illuminating particulars as to the relative amounts provided in the United States for certain State universities, by the State on one hand and by private benefactions on the other. It is well to state here parenthetically that the bulletin deals only with State universities; there are, in addition, many other American universities—including Harvard, Yale, and others, the names of which are household words—which are not dealt with by the writer of the report. But the statistics provided supply ample information as to the share taken by the State in the encouragement of higher education in the United States. Details are available concerning forty State universities, but it will be sufficient for the purposes of comparison to refer to a quarter of them only. The amounts stated are approximate in every case. The University of South Carolina has received from Government support a total of 511,000*l.* and nothing from private sources. The University of Indiana has received from the former source 500,000*l.* and from the latter 20,000*l.* Corresponding numbers in the case of the other universities selected are:—University of Michigan, 1,281,000*l.* and 164,000*l.* respectively; University of Iowa, 705,000*l.* and 11,000*l.*; University of Wisconsin, 1,321,000*l.* and 18,000*l*; University of Illinois, 1,290,000*l.* and 5000*l.*; University of Minnesota, 1,072,000*l.* and 40,000*l.*; University of Nebraska, 761,000*l.* and 14,000*l.*; University of Columbus (Ohio State), 976,000*l.* and 56,000*l.*; University of Texas, 758,000*l.* and 30,000*l.* respectively.

Speaking generally, the reliance placed upon private benefactions for the provision of university education in the United States is small compared with what the Government is expected to do. Moreover, during the last decade there has been a steady increase in the amount received from the Government by American State Universities. The Western Universities in the United States may be taken as an example. The total annual amount received from Government sources by these ten State universities during the last decade shows a substantial increase of about 600,000*l.* The annual amount thus received by the University of Michigan has increased from 45,000*l.* to 87,700*l.*; that by the University of Missouri from 25,500*l.* to 73,000*l.*; by the University of Iowa, from 20,300*l.* to 85,900*l.*; by the University of Wisconsin from 62,600*l.* to 159,300*l.*; by the University of Kansas from 21,000*l.* to 60,400*l.*; by the University of California from 63,400*l.* to 135,600*l.*; by the University of Illinois from 28,900*l.* to 165,000*l.*; by the University of Minnesota from 40,000*l.* to 69,000*l.*; by the University of Nebraska from 14,000*l.* to 71,000*l.*; and by the University of Colorado from 17,300*l.* to 28,000*l.*

The semi-official bulletin from which the figures quoted have been taken leaves no doubt as to the results of American experience. To quote a remark which follows the figures we have cited, "the State University which has attempted to combine the policy of public service with the policy of appeals for private support has fallen between the two." Speaking of the eight institutions which represent the strong State universities of the Central West States, the bulletin remarks: these institutions "have received somewhat less than five per cent. of their total support since their foundation from private sources, and this support has come in the main to a few institutions."

University authorities in the United States may well smile when they read the opinion of the Chancellor and the Vice-Chancellor of the University of Oxford:—"In this country it is of no avail to look to the State" for the satisfaction of University requirements.

The same principle is conceded generously in Germany. An article, published in NATURE on March 12, 1903 (vol. lxvii., p. 433), showed that the ordinary total income of all the German universities, excluding Jena, was for the year 1891–2 about 939,000*l.*, of which nearly 709,000*l.* was derived from State funds.

Surely the lesson of these facts is plain to the least reflective citizen. The future struggles for supremacy among the nations of the world will be contests between minds, and muscles will be at a discount. The nations which have sacrificed present luxury in order suitably to train their young men by attendance at modern universities will reap the

[1] "Bulletin of the Carnegie Foundation for the Advancement of Teaching." No. 1. (Published by the Foundation, March, 1907.)

advantages of their forethought and prescience; and those countries which, content with ancient prestige and former prowess, have neglected their duty to higher learning and have left their universities to languish on the doles of patriotic benefactors will sink into subsidiary places, and their part for the future will be to serve the men of brains with whom they have had to contend on such unequal terms.

SCIENCE AND THE EMPIRE.

IT was a happy idea which resulted in the association of the British Empire League and the British Science Guild to pay honour to the Colonial Prime Ministers during their visit to this country. The cooperation of men of science with statesmen whose special work is to govern and develop the constituent parts of the Empire can result in nothing but increased national efficiency, and the presence of Sir Wilfrid Laurier, Mr. Deakin, Sir Joseph Ward, Sir William Lyne, Mr. F. R. Moor, and Mr. T. Bent at the banquet held on May 2 is a gratifying sign that the need for applying the methods of science to affairs of State becomes year by year more fully recognised. The banquet provided the only opportunity the Prime Ministers have had of meeting men of science and others interested in the progress of knowledge and desirous of introducing the scientific spirit into the administration of Imperial affairs.

Lord Derby occupied the chair at the banquet, and about 260 guests were present, including many men of science and distinguished representatives of the Imperial service and administration, and of law, art, and other departments of intellectual activity. Mr. Haldane, who was to have represented the united interests of the British Empire League and the British Science Guild, was, unfortunately, unable to be present; and his place was taken by the Vice-Chancellor of the University of Oxford, Mr. T. H. Warren, who, in supporting the toast of "Our Guests," proposed by Lord Derby, referred to the relation of universities to the Empire and national progress as follows:—

Why do the universities and the educational interests wish to add their greeting to those which have been pressed, I am afraid, in overwhelming and almost surfeiting measure, on those distinguished men who have crossed the ocean to visit us? I can assure them that no welcome can be more warm, but that is not enough. I think it is because we feel that to the instinctive and intuitive welcome which has manifested itself so spontaneously from every portion of English society we have some little to add. We feel that learning and science have something to say to Empire. We feel that, more and more, nowadays scientific training and thorough study of history, of the science of history and of sociology, is necessary to the proper carrying out of every great enterprise, and that Empire is one of the greatest enterprises on which man, intrepid man, has advanced. The student of history sees, or thinks he sees, a development, an evolution in the political as in the animal kingdom. The family, the clan, the city, the kingdom, the Empire, as they unravel themselves in the long series of sequences, need a corresponding advance in trained and educated intelligence. Now, we in our universities, and in the learned societies study these questions in the abstract. It is our duty and privilege in the insulated detachment, in the clear and calm life of academic tranquillity, to study these problems, and to try to find the solution of them; to study economic problems apart from the bias and prejudices of party and of commercial interest, and to study science in that spirit of disinterested devotion which, after all, I think Sir Norman Lockyer will agree with me, in the long run has the promise of this world, and, in a sense, of the other—of the world alike of truth and the world of success. But universities have now, not only an abstract, but a personal part to play. It is their privilege to bring together, and their duty to bring together, the brightest minds, at the most impressionable age, of those who will be in the future the leaders, whether in thought or in action, of the Empire. The university has had in the past a great part in bringing our leading men together in their early days and giving them common sentiment and common loyalty and knowledge of each other. May it not be so still more in the future on a wider scale and in a wider way? I hope that the universities, and the learned societies, and the educational establishments of this country feel, I believe I can say they do feel, that they have new and extended duties. Already Oxford and Cambridge, and the old universities of which I have spoken, realise that they are not only universities of a kingdom, but universities of an Empire. In future, no doubt, other universities of the Empire more and more will play their part—the universities of Montreal, of Melbourne, of Sydney, of New Zealand, and of the Cape. They, too, will have their traditions and their opportunities. There will be special opportunities of science and of learning, a special atmosphere and special surroundings in one place more than another, and I look forward to the time when students and professors will pass to and from one university to another. Meanwhile, let us make the beginnings, let us attack at once this great future which lies before us, let us take those steps which are now possible and promising. Let us use every opportunity of getting to know and to understand each other, and then I think that this great gathering of 1907 will prove not less fruitful in the scientific, and in the learned, and in the academic, than it has proved and is proving in the political and social sphere.

The toast was responded to by Sir Wilfrid Laurier, the Hon. Alfred Deakin, and Sir Joseph Ward. In the course of his remarks, Mr. Deakin said:—

Of all the meetings which we have been able to attend this has perhaps the most distinctive character. Never before in my experience have we seen blended the two sections of an Empire League of patriotism united to a body of scientific men whose immense abilities, whose sterling achievements, are the pride of the last century and the promise of this, and who are content to descend from those exalted heights, in which they unravel the mysteries of the universe, to find themselves perplexed by the truisms of politics. And if, as has been suggested, this union be typical, surely it is most fortunate, and certainly most necessary. If there is anything on this earth in human action which is casual and empirical, which is go-as-you-please and happy-go-lucky, it is the British Empire. Exactly how it came to be, precisely what it is, and what on earth it is going to be, no scientific prophet can tell. On the other hand, we have the men of science, calm and luminous, rigid and regular—I mean in their professional studies—aiming above all things at method, at principle, at organisation, the last three things we seem incapable of introducing into our Empire. And yet, though imperceptible, though unchangeable, there are manifest forces of cohesion, which even the finest instruments cannot measure, which keep this Empire as an Empire together. There are a series of rudimentary, of imperfect, of catch-as-catch-can organisations, by means of which, in some mysterious manner, this unwieldy, this gigantic and inexplicable combination, manages to survive. Surely we shall yet be found willing to sit at the feet of our scientific teachers and to endeavour, at all events at the outset, to acquire that knowledge in scientific manner, and by scientific methods, which shall enable us to appreciate, in the first place, the vast, the incalculable natural resources which are at present in our possession under the Flag—the means of utilising these instruments of material power for the benefit of our race. That appears to me to be the task of Empire, the task of scientific conquest of its physical, and shall we not be bold and say, ultimately of its political problems? The Empire rests upon the individual citizen—the individual citizen that has great capacity for service, providing you permit him to have access to these means of knowledge, to that stored-up wisdom of the ages, to these lessons and teachings which science can place in our hands. By these means we annihilate distance and draw the Empire together. By these means we enable them to conquer the wilderness and still carry with them the necessities of civilisation. By these means, in the tiniest hamlet, we plant almost first the schoolhouse to which the children go, and, when the principle of a scientific system of education is really in practice, the Empire will be marching indeed. Therefore I hail to-night, sir, the presence here of the intellectual men who are representatives of the scientific movement, and their blending with the British Empire League I take as one of the happiest auguries of our future.

NOTES.

The managers of the Royal Institution have awarded the Actonian prize of one hundred guineas to Madame Curie, as the author of the essay "Recherches sur les Substances Radioactives."

Sir William Ramsay, K.C.B., F.R.S., has been elected an honorary member of the Academy of Sciences of Christiania; and the Società italiana delle Scienze (known as the Society of the Forty) has conferred upon him the Matteucci gold medal for 1907.

The North Sea Investigation Commissioners will be entertained by the Corporation at the Guildhall on Friday, June 14, the Lord Mayor presiding. The Fishmongers' Company will give a dinner in their honour on the previous evening at Fishmongers' Hall.

The Government of Chili has appointed Count de Montessus de Ballore, of Abbeville, France, to institute a seismological service of the first rank. This action on the part of the Chilian Government is, says *Science*, a direct result of the disastrous Valparaiso earthquake of last August. The service in question will, at the beginning, include one station of the first rank and three of the second.

Prof. Ira Remsen, president of the Johns Hopkins University, has been elected president of the National Academy of Sciences, in succession to Mr. Alexander Agassiz. The vacancy thus created in the vice-presidency has been filled by the election of Dr. C. D. Walcott, secretary of the Smithsonian Institution. Sir James Dewar, F.R.S., Prof. A. R. Forsyth, F.R.S., Prof. D. Hilbert (Göttingen), and Prof. J. C. Kapteyn (Gröningen) have been elected foreign associates of the academy.

The University of Geneva will celebrate with appropriate pomp and circumstance the 350th anniversary of its foundation, which falls in 1909. We learn from the *British Medical Journal* that a committee has been appointed to arrange for the proper solemnisation of the festal rites, to which representatives of foreign universities will be invited. The "Academy," founded by John Calvin in 1559, retained that title until 1798. It was afterwards erected into a university, and reached its full development, with faculties of theology, law, physic, philosophy, and science, in 1873.

Reuter reports that the Observatory of Catania and Etna has issued the following statement:—"The activity of Mount Etna is increasing. The mouth at the base of the central crater is emitting vapour and small incandescent stones. On May 4, at 11.10 a.m., another mouth of smaller dimensions opened and threw up boiling lava. At the observatory the sound of an almost continuous eruption has been heard up to May 6. At Nicolosi a reddish vapour was seen rising from the volcano."

The professors of the National Museum of Natural History of Paris have decided to open an international subscription with the object of offering a worthy tribute to the memory of Lamarck, by erecting his statue in the Jardin des Plantes. Subscriptions may be sent to Prof. Joubin, at the National Museum of Natural History, Paris. The committee has decided to offer to all subscribers of not less than twenty francs a reproduction in heliogravure of an authentic unpublished portrait of Lamarck, which was painted for his family by Thévenin in 1801. To all subscribers of not less than 200 francs a plaster cast of the bust of Lamarck by the sculptor Fagel (to whom is entrusted the execution of the proposed monument) will be presented. The scheme has already received distinguished support, and a comprehensive committee comprising representative men of science of all nationalities has been formed. Among the list of the committee we notice the names of Sir John Evans, K.C.B., Sir Archibald Geikie, Prof. Ray Lankester, and Sir John Murray, K.C.B.

The New York Academy of Sciences will celebrate on May 23 the 200th anniversary of the birth of Linnæus. The anniversary celebrations will begin at the American Museum of Natural History with an exhibition of American animals known to Linnæus. Letters concerning the anniversary received from scientific societies will be read at the beginning of the morning session, and afterwards an address on North American geography in the time of Linnæus will be delivered by the president of the American Geographical Society. Dr. J. A. Allen has been invited to speak on Linnæus and American zoology. In the afternoon there will be an exhibition of American plants known to the Swedish naturalist, and an address on Linnæus and American botany will be given by Dr. Per Axel Rydberg. A bronze tablet in memory of Linnæus, a gift to New York from the Academy of Sciences, will be unveiled at the bridge—which is to be dedicated to Linnæus—over the Bronx River in Pelham Parkway, between the Botanical Garden and the Zoological Park. Numerous addresses will be delivered in connection with the unveiling ceremony. In the evening, at the museum, the director of the museum of the Brooklyn Institute will deliver an address on Linnæus and American natural history. The various meetings will be open to the public.

We have to acknowledge the receipt of a copy of the first part of a memoir on the caterpillars of French Lepidoptera ("Les Premiers États des Lépidoptères Français"), by Prof. C. Frionnet, of the College of Natural Science at St. Dizier. The memoir is being published in the *Mémoires* of the Society of Letters, Sciences, &c., of St. Dizier, the first part, which deals with the caterpillars of butterflies, being dated 1906. Unfortunately, there are no illustrations.

In a report on Antarctic birds collected by the *Scotia* Expedition contributed to the *Ibis* for April, Mr. Eagle Clarke has added four species—the Arctic tern, the blue petrel, the short-winged petrel, and Hutton's sooty albatross—to the nine previously recorded from within the Antarctic circle. Petrels and their relatives are attracted, it is suggested, so far south by the extraordinary abundance of food to be found immediately north of the ice-barrier, some of these visitors making their appearance in autumn after the breeding season, while others may be non-breeding birds which spend the whole summer in the South Antarctic. That the Arctic tern, after breeding in the far north, should visit the opposite pole is a most remarkable fact.

In reference to a suggestion that Fair Island, an outlying member of the Shetland group, is specially favoured by migratory birds, Mr. Eagle Clarke, in a paper published in the April number of the *Annals of Scottish Natural History*, points out that we should rather consider the island specially favourable to the observer. Despite the number of trained observers, the writer considers that "we in Britain see only an infinitesimal number of the migrants which visit our shores: far fewer than is generally supposed, and this is especially the case on the mainland." In addition to recording, for the first time, the red-rumped swallow as a visitor to the British Isles, Mr. Clarke was fortunate enough to observe a number of rare birds, several of which were previously unknown to visit the Shetlands.

AMONG rare birds recorded in Norfolk by Mr. J. H. Gurney in his ornithological report for 1906, published in the April number of the *Zoologist*, are five glossy ibises, which made their appearance on Breydon Broad on September 3. It is believed that three birds of the same species, killed shortly afterwards in Ireland, together with one shot in Sussex, represented this flock. Immediately following the ibises came a flock of thirteen red-headed pochards, which settled on Breydon, where they were soon destroyed. The movements of these birds were connected, in the author's opinion, with a wave of heat which occurred at the same time. A pelican and a couple of flamingoes were also among the summer arrivals, but the latter appear to have been birds which escaped from Woburn, and there can be little doubt that the former had likewise been in captivity. The occurrence on the coast of an example of a bulbul, *Liothrix lutea*, may apparently be accounted for by the fact that a number of these birds were turned out at Woburn.

THE Journal of the Society of Arts for December 14, 1906, contains a paper read before the council of the National Fruit-growers' Federation by Mr. C. H. Hooper, on fruit-growing and bird-protection. The paper is also in course of publication in the *Gardener's Magazine*, of which the issue for April 20 contains the first instalment. It is satisfactory to see that Mr. Hooper speaks his mind plainly, without any attempt at special pleading for species which are notoriously harmful; and while admitting that birds are, on the whole, beneficial to the agriculturist and horticulturist, advocates the relentless destruction of certain kinds and a restriction of the numbers of others. Another author has already advocated the most stringent measures for the extermination of sparrows, wood-pigeons, and stock-doves as being distinctly injurious, and pleaded in favour of permitting, or rather encouraging, the taking of the eggs of the chaffinch, greenfinch, and bullfinch. Mr. Hooper, in addition to reducing the numbers of the species just named, urges that in fruit-growing districts it may be absolutely essential to kill off a percentage of blackbirds, starlings, and even missel-thrushes, thrushes, and rooks. On the other hand, hawks, owls, and strictly insectivorous birds of all kinds should be religiously protected. A few more straightforward and outspoken addresses of this description, and there would perhaps be less nonsense talked and written about the duty of encouraging and protecting birds even where they are eating the unfortunate gardener and farmer out of house and home.

IN a paper read before the Epidemiological Society, Colonel Bruce, F.R.S., details recent researches into the epidemiology of Malta fever, showing that goats' milk is the principal source of infection. One-third of the cases of Malta fever in the Navy could be traced to residence in the Royal Naval Hospital, Malta, but since the use of goats' milk has been prohibited not a single case has occurred there.

THE making of models of microscopic objects by means of wax reconstruction plates has taken a recognised place in morphological, embryological, and pathological research. The cutting out of the plates by means of a scalpel, the usual method, has disadvantages, and Mr. Mark has devised an electric wax-cutter in which a platinum wire, electrically heated and mounted in a sewing machine, performs the work expeditiously and efficiently (Proc. Amer. Acad. of Arts and Sciences, xlii., No. 23, March).

IN the *Bio-Chemical Journal* for April (ii., No. 4) Mr. Lovatt Evans discusses the catalytic decomposition of hydrogen peroxide by the catalase of blood. His experiments suggest that the reaction velocity may be explained by the hypothesis known as the "active system" theory, first suggested by Prof. Adrian Brown and subsequently by Prof. Armstrong. Dr. Maclean describes experiments on the influence of kreatinin in modifying certain reactions of sugar in urine, and Dr. Spriggs discusses the excretion of the same substance in pseudo-hypertrophic muscular dystrophy. Messrs. Bearn and Cramer detail observations on zymoids, substances present in enzymes which have the property of combining with the substrate without the power of destroying it, and obtain evidence of their existence in pepsin, rennin, emulsin, and takadiastase. Mr. Coleman describes the effect of certain drugs and toxins on the coagulation of the blood.

A PRELIMINARY list of higher fungi collected by Mr. N. M. Glatfelter in the vicinity of St. Louis during a period of eight years is published as vol. xvi., No. 4, of the Transactions of the Academy of Science of St. Louis. Of about five hundred species enumerated, the majority are basidiomycetes. The determinations authenticated by Prof. C. A. Peck include twenty new species.

AN account of an instruction camp organised by Mr. J. A. Leach for members of the Field Naturalists' Club in Victoria appears in their journal, the *Victorian Naturalist* (March). The camp was pitched at Mornington, on the eastern shore of Port Phillip Bay. Each day was devoted to the study of one or other branch of natural history under the direction of special leaders, and lectures were arranged in the evening. The reports of the excursions made each day and the evening lectures are printed in the journal.

THE reports of the director and other Government officials connected with the Royal Botanic Gardens, Ceylon, are published as a consecutive series, beginning with No. 20, in vol. iii. of the *Circulars and Agricultural Journal*. Mr. T. Petch, in his report as Government mycologist, refers to a number of fungi infesting tea bushes; of these, a new species, *Massaria theicola*, producing a stem-disease, is under examination, also the horse-hair blight, generally attributed to *Marasmius sarmentosus*. The most serious outbreak of fungal disease was caused by a Phytophthora growing on the fruits of Para rubber trees, inducing decay and rot. The disease spread rapidly during the rains in June, and seemed likely to cut short the supply of seed, but was checked by the dry weather in July. The most dangerous insect pests mentioned by Mr. E. E. Green were the tortrix, *Capua coffearia*, and shot-hole borer, *Xyleborus fornicatus*, both pests of the tea plant; a leaf-rolling caterpillar was fortunately restricted to the Funtumia rubber trees. Mr. Green also alludes to experiments for introducing the *eri*-silkworm, *Attacus ricini*, and European bees into Ceylon.

THE importance of a closer alliance between science and industry was again strongly emphasised by Sir Alfred Jones at Liverpool on April 8, when, at his invitation, a number of prominent men of science and commerce met at a luncheon given in honour of Mr. Herbert Wright, the author of a valuable work on the rubber industry. Mr. Wright gave a brief account of the progress and methods of rubber cultivation in the British Empire, quoting, as an example of the benefits accruing from the adoption of scientific methods, the enormous advances made by the industry in the Indo-Malayan area during the past decade. Ceylon alone, in a few years' time, may be expected to produce some 5000 to 7000 tons of rubber annually, and our other possessions in the East are developing similarly.

IN the Transactions of the Royal Society of Canada (vol. xii., pp. 267–288) Dr. R. W. Ells gives some useful notes on the mineral fuel supply of Canada. He shows that in the western half of the Dominion the supplies of mineral fuel are practically inexhaustible. The analyses of these coals show that their quality is greatly superior to that of those now mined in the Pacific States of the American Union.

THE Transactions of the Institution of Engineers and Shipbuilders in Scotland (vol. l., part vi.) contain a suggestive paper by Mr. R. Royds on the most economical mean effective pressure for steam engines. He appends a bibliography of papers dealing with the steam-engine problem, all of which are based upon direct experimental evidence. These should be studied by all concerned with the generation of motive power.

THE demolition of the Great Wheel at Earl's Court, which for twelve years has formed so conspicuous a feature in the London landscape, is now completed. The work, which is described in detail in *Engineering* of April 26, has been one requiring the exercise of much ingenuity in the devising of safe methods of procedure. The wheel was a pin-jointed structure 300 feet in diameter, weighing, with the cars in position, 1000 tons, whilst the two standards on which it was mounted weighed 400 tons more. The whole structure was demolished in less than six months, which, considering that every rivet had to be sawn through, as every nut was completely set in rust, reflects great credit on all concerned.

THE address delivered by the president, Mr. T. Hurry Riches, to the Institution of Mechanical Engineers on April 25 forms a valuable work of reference on rolling stock and the machinery used in railway engineering, its value being enhanced by the seventy-six illustrations accompanying it depicting the locomotives and rolling stock of the railways of Great Britain at the present time. It is evident from these illustrations that modern requirements are gradually bringing the locomotives on the railways more and more into accord with one another when the work to be done is similar.

AN interesting set of models, showing the development of the rack-rail locomotive from Blenkinsop to Abt, has lately been placed on view in the mechanical engineering collection of the Victoria and Albert Museum. The models, which are described in detail in the *Engineer* of April 26, comprise Blenkinsop's original model of the Middleton colliery locomotive of 1812, and models, made at the museum to a scale of 1 to 16, of the Fell centre rail engine of 1867 for the line over the Mont Cenis, of Riggenbach's system of a ladder-rack midway between the running rails (1874), and of Abt's improved form of rack (1882). The three models are admirably adapted for the use of engineering students, and throw much light on a somewhat complex subject.

THE new island in the Bay of Bengal, referred to in Admiral Field's letter in NATURE of February 28, is the subject of a detailed account, by Lieut. E. J. Headlam, R.I.M., in the April number of the *Geographical Journal*. By the courtesy of the editor we are permitted to reproduce one of the illustrations, which gives a good idea of the general appearance of this mud-bank. An illustration to some notes on the San Francisco earthquake, by Jacques W. Redway, in the same number, gives a very good idea of the ploughed land along one of the faults, where this shows at the surface as a belt of shearing instead of as a simple fracture.

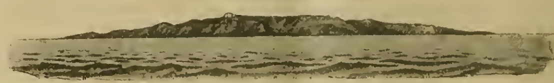

FIG. 1.—General appearance of the new Island in the Bay of Bengal from the eastward, at a distance of about half a mile.

Photo.] [*R. S. Holway.*

FIG. 2.—The San Francisco Earthquake: Ploughed land along the earthquake rift.

IN a letter to NATURE of February 14 (p. 368) Mr. Charles G. Barkla described experiments which indicated that nickel must have an atomic weight of about 61·3 instead of the value 58·7 generally accepted by chemists. This result, which is confirmed in a letter just received from Prof. B. Walter, of Hamburg, is based on the law that the secondary Röntgen rays from a chemical element have a specially high penetrative power with regard to the material from which they originate; for other elements this specific penetrative power falls off proportionately as the atomic weight of the element differs from that of the substance producing the rays. Prof. Walter points out, however, that the general properties utilised by Mr. Barkla as a basis for his considerations were in the main published by him in the year 1905 (*Annalen der Physik*, Bd. 17, p. 561; *Fortschritte auf dem Gebiete der Röntgenstrahlen*, Bd. 8, p. 297). Referring to the fact that Mr. Barkla does not accept a specific power of penetration such as Prof. Walter suggested, but holds the opinion which was generally accepted previously, that a selective absorption takes place, Prof. Walter says that this assumption is shown in his papers to lead to contradictions in the case of the *primary* Röntgen rays. In his opinion, it cannot be correct in the case of the *secondary* rays, because the phenomena in question become all the more apparent for these rays the *thinner* the absorbing laminæ be made. According to Mr. Barkla's conception, exactly the opposite should be true.

Whilst cuprous chloride and bromide have long been known, the existence of cuprous sulphate has been recognised mainly as a disturbing factor in the copper voltameter. Owing to the formation of this salt, the copper deposited on the kathode is liable to be partially redissolved $Cu+CuSO_4 \rightleftharpoons Cu_2SO_4$, causing the deposit to be too light; on the other hand, if the cupric solution has been saturated with metallic copper, the deposit is too heavy, since twice as much copper is deposited per coulomb from the cuprous as from the cupric salt. The recent experiments of Foerster and Blankenberg (*Berichte*, xxxix., 4428–4436) have added much to our knowledge of this salt. By enclosing ammonium cupric sulphate with metallic copper in sealed tubes they were able to ensure the formation of a large proportion of cuprous sulphate, and actually succeeded in isolating a double salt of the formula $Cu_2SO_4,4NH_3,H_2O$. When quite dry, the salt can be kept for some weeks in sealed tubes, but it is immediately decomposed by dilute sulphuric acid, giving rise to metallic copper and cupric sulphate. It is of interest to note that a solution containing initially 0·05 mol. $CuSO_4$, 0·05 mol. NH_3, and 0·15 mol. $(NH_4)_2SO_4$, became quite colourless when saturated with metallic copper, and when electrolysed gave a kathode deposit 55 per cent. greater than that obtained from a cupric solution in series.

A popular article upon the planet Saturn and its system, by Mr. E. V. Heward, appears in the May number of the *Fortnightly Review*.

Excellent work is being done by the Central Technical College Old Students' Association, the official organ of which, the *Central*, forms a very creditable addition to periodical engineering literature. In the current issue (vol. iv., No. 11) there are original articles on the construction of a new railway, by Mr. A. C. Cookson, and on electrical test-shop measurements, by Mr. Percy Good.

We have received from Mr. C. Baker, of High Holborn, London, an advance proof of his new quarterly catalogue of second-hand scientific apparatus. The list contains particulars of more than a thousand separate items, and is worth examination.

OUR ASTRONOMICAL COLUMN.

Comet 1907*a* (Giacobini).—No. 4173 (p. 336, April 27) of the *Astronomische Nachrichten* contains a new set of elements for comet 1907*a*, computed by Miss Lamson, in which the time of perihelion passage is given as March 17·66. A daily ephemeris, calculated by Prof. Kreutz and based on these elements, is also given, and extends to May 22. The comet is at present apparently travelling very slowly and nearly due north in the northern limits of Orion, its computed positions for May 9 and May 22 respectively being α=6h. 11m., $\delta=+14° 7'·4$ and α=6h. 14m., $\delta=+17° 5'·8$. The brightness of this object is now about one-quarter of that at the time of discovery, when it was of the eleventh magnitude.

The Temperature of the Sun.—An excellent popular description of the apparatus and methods by which MM. Millochau and Féry determined the solar temperature during 1906 is given by the former observer in *La Nature* (No. 1770, p. 338, April 27). As previously recorded in these columns (see Nature, No. 1932, p. 40, November 8, 1906), the observations were made at Meudon, Chamonix, the Grands Mulets, and the summit of Mont Blanc during July and August last. The instrument used was the pyrheliometric telescope devised by M. Féry in 1902, and described and illustrated in the paper under notice. Essentially it consists of a reflecting telescope, having a mirror of 103 mm. diameter and 80 cm. focal length, in the focus of which is placed a thermoelectric couple, which is connected with a galvanometer reading directly to about one-hundredth of a millivolt. The couple is composed of two wires, one of iron, the other of constantan, soldered together at their point of intersection, the joint being covered with a carefully blackened, very small and very light disc. A bent eye-piece, placed behind the reticule bearing the couple, enables the observer to direct the telescope to any desired portion of the solar disc. The results obtained gave a temperature of 5663°, absolute, for the centre of the solar disc, considering the sun as an ideal black body, or, as M. Guillaume terms it, an "integral radiator." Correcting this value for the probable absorption in the solar atmosphere, M. Millochau obtains 6130° absolute as the effective temperature of the sun's interior.

Photography of the Infra-red Solar Spectrum.—In No. 14 (p. 725, April 8) of the *Comptes rendus* M. Millochau records some results he has obtained in the photography of the infra-red region of the solar spectrum. The plates employed were specially prepared by plunging them for about ten minutes into distilled water to which several drops of acetic acid had been added, then into a saturated alcoholic solution of malachite green, and finally washing and drying them. They were then rendered much more sensitive by exposing them for 30 seconds at a distance of 75 cm. to a 4 candle-power electric lamp, according to the method suggested by Major-General Waterhouse in 1875.

With plates thus prepared the solar spectrum was photographed, in the region 0·750 μ to 0·950 μ, on such a scale that one Angström unit=0·1 mm., the photographs showing that the structure of the A band in the solar spectrum is identical with that of the B band. Another photograph showed the Z band resolved into lines.

A plane-grating spectrograph of 3 cm. aperture and 60 cm. focal length was employed, and with this apparatus the A band, under good conditions, could be photographed in ten, and the extreme region in thirty, minutes.

The Orbit of α Draconis.—The following elements have been found for the orbit of α Draconis from spectrograms secured at the Dominion Observatory, Ottawa, by Mr. J. S. Plaskett:—period=51·42 days, ϵ=0·322, ω=20°·3, m_0=294°, T=1906 July 11d. 4h., velocity of system=−18·4 km. per sec.

In No. 2, vol. i. (March–April) of the Journal of the R.A.S. Canada, where the above is published, Mr. Plaskett also gives a very interesting description of the methods employed in adapting a Brashear universal spectroscope to the requirements of line-of-sight spectrography.

RUSSIAN GEOGRAPHICAL WORKS.

THE labours of the great Prjevalsky have been continued by his lieutenants and others who participated in his explorations of Central Asia, and we have already mentioned the achievements of Mr. P. K. Kosloff. Mr. V. I. Roborovsky conducted an expedition, under the auspices of the Imperial Russian Geographical Society, largely along previous lines, during 1893–5, and the records are published in three volumes, viz.:—(1) the report of the head of the expedition; (2) that of his assistant, Mr. P. K. Kosloff; and (3) embodying the scientific results. We have received the three parts of the first volume, (*a*) from Tian-Shan to Nan-Shan; (*b*) Nan-Shan and Amne-Matshin; and (*c*) from Amne-Matshin to Zaisan. Elaborate preparations were made, and the best procurable instruments were placed at the disposal of the expedition. It is interesting to note that Messrs. Vladimir and Eugene Prjevalsky, brothers of the pioneer, cooperated with Mr. Roborovsky and furnished some instruments used on former occasions. A halt was made at the tomb of Prjevalsky, on the shore of the lake Issik-kul, near Prjevalsk, where a requiem was held. It was found that camels, valuable for arid desert transport, suffer severely in cold and damp regions, whereas yaks are most at ease in mountain travelling.

The sands of Kum-tag cover a legendary city of vice, destroyed beneath a shower of sand, one righteous man escaping, as in the case of the cities of the plain. At Sa-tshzhoy the expedition met with M. Splingaerd, a Belgian in the Chinese service, whose knowledge of the Chinese and their life is probably unique after many years' residence. Gold is found in the mountains near the Sa-tshzhoy oasis, of which unscrupulous advantage is taken by officials and citizens to the detriment of the revenue. The Shan-rdi lama, visited by the party, previously thought that Russians and English were the same people. Mongols and Tanguts call every European a Russian. The Tanguts, who seem to live by cattle-lifting, are dreaded by the Chinese and Mongols, and more than once attempted to raid the expedition. A chapter is devoted to the social and marriage customs of the Tanguts, with whom polyandry is rife and the expression "illegitimate" has no meaning. The Mongols showed Mr. Roborovsky a large portrait of Genghis khan, whose re-appearance is expected before long. Marriage among the lamas is prohibited in most Buddhist countries, but is regarded lightly at Tsaidam, where many lamas settle. The city of Luktshun and the Chantu people form the subject of a long chapter. A preparation of stags' horns is a feature of Chinese medicine. Wild stags are said to feed on a mythical herb which no man can find, giving them special strength and vigour. The horns are cut, dried, and smeared, then taken as a tonic by men who feel their powers decay. "Three days' weeping" is a strange remedy for scorpion bite, suggested by a Sart named Abdurahman. Sickness of men and beasts seriously hindered progress, and sympathy will be felt for the courageous leader, whose breakdown led to an earlier return from exploration and delay in publication of these volumes. Elegant phototypes of scenery add to their interest, together with meteorological and botanical observations.

In the first issue of the Transactions of the Imperial Russian Geographical Society for 1906 appears a lengthy and interesting illustrated article by the botanist Mr. V. I. Lipsky, author of "The Flora of Central Asia," on his journeys in Russian Turkestan (Tian-Shan) in 1903. Travelling was difficult, and many hardships had to be surmounted, including locusts and piercing cold. Part of the journey was "by Dunganin," *i.e.* the Dunganins are a tribe of Chinese Mussulmans who have settled in Russian territory, and gain a living by horse transport of goods and passengers. Though progress is slow, it is not unpleasant, and these people bear a high reputation for honesty. The Aksai country resembles the better-known Pamir region. Mr. Lipsky records the fact as remarkable that in the mountain lake Tshatir-kul, at a very high level, he found specimens of *Zostera marina*. This article concludes with some notes on the Kirghiz, in whom the author found strong Little Russian characteristics, both in customs and songs. Kirghiz women enjoy greater freedom than the rest of their Mussulman sisters, and attract involuntary attention when walking unveiled in the streets of Tashkend. In the same issue Mr. O. A. Shkapsky describes two journeys to the mountains of the Tashkend district. After inspection of the mountain pastures, where cattle are reared for the Ferghana and Tashkend markets, he attaches great economic importance to their more detailed survey, both as regards the food of the cattle and the customs of the breeders. Mr. Y. Edelstein contributes notes on the glaciers of the ridge of Peter the Great, where he marked indications for the guidance of future observers. There is also a translation of Prince P. Kropotkin's memoir of M. Reclus, and a memoir of Baron F. von Richthofen by Mr. K. Bogdanovitch. About twenty-five pages are occupied by a bibliography of Russian geographical literature, indicating a prolific output.

Fig. 1.—Murman Biological Station of the St. Petersburg Society of Naturalists.

Mr. Y. S. Edelstein made a geological excursion in the autumn of 1903 in the south-eastern districts of Mukden (Shentszin) province, including the Sin-tzin-tin, Feng-huang-chen, and Liao-yang districts, and has published a detailed account of his investigation of a semicircular route from Mukden to Liao-yang. He collected specimens of rocks and soil, but the outbreak of war prevented him from bringing these home. In consequence, Mr. Edelstein could only offer general deductions and a map of the broad features of the immediate areas through which his route lay. His justification for the publication of details more meagre than he could have wished is the increased interest attaching to Manchuria, and the fact that the Mukden province has been unvisited by geologists since Richthofen. In the early chapters of his work he traces his progress step by step, and sums up general conclusions in the final chapter. Mr. Edelstein thinks that serious gold-mining enterprise would be amply rewarded, but hitherto the Chinese have neither suspected the presence of gold in pyrites nor understood how to extract it. Without entering into particulars, he observes that there is a great future for this industry in Liao-dun. While there are no large coal areas like that of the Don basin, there is ample for local needs, while silver and lead veins were worked when this region was under Corean sway. Marble, copper, and asbestos are also reported, and the Chinese obtain sulphur from pyrites. Considering that the expedition was accomplished within one month, there is reason to believe that a wide field of profitable research and future mining operations has been revealed by Mr. Edelstein's skilled labours.

No. 18 of the reports of the Zoological and Zootomical Cabinets of St. Petersburg University forms a very interesting report by Mr. K. M. Derjugin on the Murman Biological Station, a centre of activity for six years in the Kola gulf and peninsula. Previously, the station was on the Solovetsk Islands, and the band of naturalists came into contact, not free from misunderstanding, with the authorities of the famous monastery. The station consists of a main building with laboratories, library, museum, and aquarium; living quarters; houses for attendants; shed and dock, with ice-house; engine-house and workshop; pavilion above a granite basin; and small harbour, with fresh- and salt-water channels. The *Orca*, a small sailing vessel of Norwegian type, is used for cruising and exploration. The fauna resembles that of Spitsbergen, especially on its western side. The journey from Archangel, we learn, presents great interest and variety for the naturalist. In his enumeration of species of plankton, Mr. A. K. Linko remarks that a vast amount of material in the northern seas has not yet been studied, and promises future reports. The work contains tables of observations, records of temperature, plans and sketches, and a library catalogue.

Mr. V. V. Markovitch has described a botanical excursion from Ossetia to Colchis, including the sources of the rivers Ardon and Rion. His first chapter opens

Fig. 2.—Wood growing horizontally out of permanent snow mounds.

with an account of the great mountain range at different seasons, and of the gaudy sun-tints. The people of Ossetia, whose characteristics are respectively modified by proximity to Georgians or Kabardians, are generally grouped under the heads of Irontsi, Tualtsi, Digortsi, and Tagaurtsi, the central point being Alagir. As it was known that this region possessed silver-lead ore, and the Tsar Nicholas I. desired that the Russians should depend upon their own resources for lead in time of war instead of upon imports, this mining centre was established under the direction of the engineer Ivanitzky. This energetic official also started a nursery and fruit garden, the success of which has been so marked that the term "Alagirsky" denotes the highest type of fruit throughout the Caucasus. Passing along the Ossetian military road, traces of every geological period may be observed, including Palæozoic slates, but fossils are rare. Alagir itself is on the site of a huge glacier from the main crest of the Caucasus. Long experience convinced Mr. Markovitch that there is no marked difference between the northern and southern slopes of the Caucasus, but a gradual transition, and having received material support from the highest botanical authorities he was encouraged to study transitional forms. The most convenient time of year for exploration of the Ossetian mountains appears to be the end of July and the beginning of August, though botanists would need to go a little earlier. Throughout Ossetia sacred trees are found, into which pilgrims throw offerings of money and other gifts. This pagan survival is adapted to Christian saints' days, especially to the festival of the popular St. George, celebrated in November. A main conclusion of Mr. Markovitch's survey is that the differences between people living side by side on a limited area are greater than those in the flora, while in Russia the contrary is the case. Ossetians and Imeritians, who live together, are entirely distinct, while there is much similarity in neighbouring peoples along European frontiers. Contrary to former suppositions, the flora of the Colchis region varies very slightly from that of the northern Caucasus.

THE TEMPERATURE OF THE NORTH SEA.[1]

In a Blue book just published dealing with hydrographical work done in connection with the International Investigation of the North Sea, I have included a paper on some methods and results of hydrographical investigation, or, as it might perhaps have been more correctly termed, on some methods of representing hydrographical results.

We have from the work of our own vessel, the *Goldseeker*, quarterly observations at numerous stations in the northern part of the North Sea, and also monthly or six-weekly observations at some twenty other stations off the east coast of Scotland as far to the eastward as 1° east. At these stations, some fifty in all, we have observations at all depths, both as to temperature and to salinity. In addition to this work of our own, we receive from a large number of passenger captains frequent observations as to temperature and a smaller number of samples for the determination of salinity, taken at the

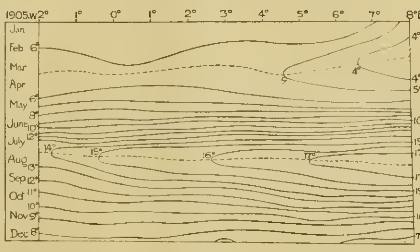

Fig. 1.

surface along many important routes crossing the North Sea. In the present paper temperature-phenomena alone are dealt with, and the results are based mainly upon our own work with but little attempt as yet to include or correlate the work of our foreign colleagues.

From a large number of observations such as we receive, from our own vessel and from the captains of liners—observations made at varying dates, and, in the case of the voluntary observations, at shifting points along particular lines—it is necessary in the first place to obtain, by interpolation, approximate data for given dates and localities. These data may then be diagrammatically represented in various ways.

Fig. 1 is a diagram of surface temperatures on the route from Leith to Hamburg, from January to December, 1905. It is constructed on a method devised some sixty years ago by Lalanne. The coordinates are time and distance along the given line, and over these coordinates are superposed contour lines, or "isopleths," representing temperature. It will be seen that from this diagram we can read at a glance many things; we see, for instance, that in early summer and late autumn there is little or no difference of temperature all the way, while, on the other hand, about March the sea gets gradually colder and about August gradually hotter as we travel eastward towards the

[1] Abstracted from the Second Report (Northern Area) on Fishery and Hydrographical Investigations in the North Sea and Adjacent Waters, 1904-1905 [Cd. 3358]. (1907.)

German coast. We easily see the extent of difference in seasonal range of temperature, which near our own coast runs from less than 6° C. to more than 13° C., at 2° east

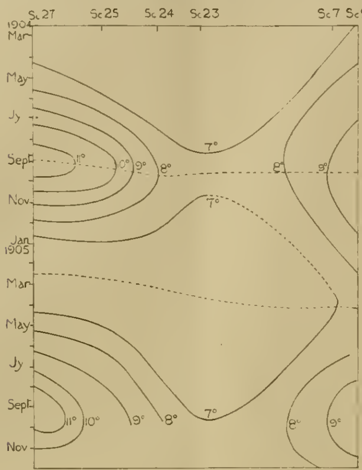

FIG. 2.

from less than 6° C. to more than 15° C., and off the German coast from less than 4° C. to more than 17° C. We notice next how comparatively slow are the changes of temperature when near the minimum in winter and the maximum in summer, and how rapid in spring and autumn when near the middle of the rise and fall, and we also perceive that the fall takes place somewhat slower than the rise, for the isopleths are less crowded in autumn than in spring. Lastly, we may discern that lines joining the cusps of the closed curves, in other words, the lines of minimum and maximum, tend to run somewhat obliquely across the chart, and that the maximum at least is definitely later as we approach the Continental coasts. Similar charts for various other routes show essentially the same phenomenon, and those drawn from the Scottish coast in the direction of Norway tend to show the influence of land at both ends of the route, the range of temperature being least in the middle.

Similar diagrams may be drawn for any given depth, and Fig. 2 is so drawn for a depth of 100 metres on a line from Buchan Deep, near Aberdeen, to the Viking Bank between Shetland and Norway. In this diagram we see that as we leave the coast the temperature-isopleths diminish rapidly in number, until in the neighbourhood of our station xxiii. (about 59° 40′ N., 0° 40′ E.) the seasonal change is only from something less to something more than 7°; but as we go further north we come again to a region of larger temperature variations, where the maximum is considerably higher and the minimum not quite so low. We notice also a retardation of dates, the maximum not being attained until well on in September.

Another series of diagrams, of a kind that has been more frequently employed, and notably by Dr. H. R. Mill in his work on the Clyde sea area, shows temperature plotted by means of isopleths over coordinates representing time and depth. While the former diagrams showed temperature changes along a line of stations during successive months, but for one depth only, these diagrams show the changes at all depths during successive months, but at one point of space only.

These and other methods of representing sea temperatures by means of diagrams may be supplemented by the use of empirical formulæ. The rise and fall of surface temperature at a given point is a very simple wave that can be suitably expressed as a sine-curve. In the periodic temperature-function

$$f(\theta) = A_0 + A_1 \sin(\theta + e_1) + A_2 \sin(2\theta + e_2),$$

&c., θ is an angle increasing in proportion to the time, A_0, A_1, A_2 are constants expressed in degrees centigrade, and e is a phase angle of which each degree signifies approximately one day in advance or arrear of our starting point, namely (since we are dealing with monthly means), January 15. If we submit an annual series of temperature observations to harmonic analysis, we find that the first sine-factor differs but little from the actual curve, while the third and following factors are entirely negligible. If we deal with mean temperatures at a given point over several years, we find the simple sine-formulæ still more closely applicable. Thus, for the surface temperatures at Abertay, taking the mean of ten years, 1893–1903, we obtain the formula $f(\theta) = 8{\cdot}43 - 4{\cdot}32 \sin(\theta + 60°)$, and find that results calculated from this formula for the middle points of the successive months differ in no case by so much as half a degree centigrade, and by a mean difference of only one-fifth of a degree centigrade, from the means of the observed temperatures for the said months. If we were to apply the next factor of our harmonic formula $[+0{\cdot}29 \sin(2\theta + 49°)]$ we should obtain calculated results showing a maximum discrepancy from observation of about a quarter of a degree, and a mean discrepancy of one-tenth of a degree.

After repeated trials of this kind we come to the conclusion that the sine-formula is a safe representation of the annual wave of temperature change. That it is a highly convenient one is obvious, for, in the first place, it gives us at a glance the three essential factors of the phenomenon, the mean temperature (A_0), the range or half-range of temperature (A_1), and the phase (e_1), which last we may briefly describe as the mean retardation of maximum and minimum. Furthermore, it enables us to compare these three factors very easily for a series of adjacent stations or for successive years. Thus if we work out our formula for points a degree of longitude apart on the route from Leith to Hamburg we obtain a table of which the following is a part:—

Table of Harmonic Constants for Surface Temperatures. Leith to Hamburg.

Long.	1904 A_0	1904 A_1	1904 e_1	1905 A_0	1905 A_1	1905 e_1
W. 2	8·90	4·18	51	8·86	3·07	56
1	9·20	4·18	50	9·24	3·09	56
0	9·48	4·39	51	9·55	4·24	56
E. 1	9·45	4·49	52	9·62	4·50	59
2	9·45	4·88	51	9·62	4·70	61
3	9·50	5·47	52	9·62	5·10	62
4	9·70	5·70	49	9·76	5·45	61
5	9·81	5·60	48	9·98	5·73	58

This orderly succession of constants may then anew be transferred to diagrams, as in Fig. 3. Similar data may

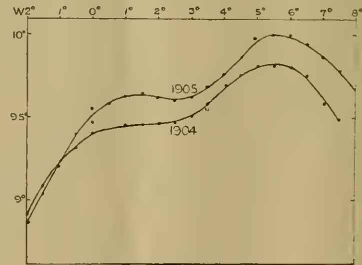

FIG. 3.

also be transferred to charts, of which a series is printed in the report.

Lastly, if it be granted that a sine-curve approximately represents the actual succession of temperatures, we may modify our diagram of the annual wave by substituting for it a circle (Fig. 4), on which time and temperature may be read together. The centre of the circle is at a height above the base-line proportionate to the mean temperature, the radius is proportionate to the half-range, and when we shall have marked upon the circle a date-

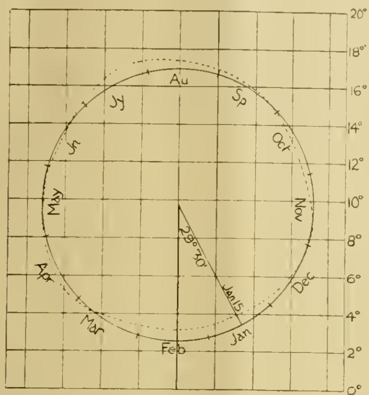

Fig. 4.

mark having reference to the phase, the temperature at a given date will be proportional to the perpendicular that falls on the base from a corresponding point of the circle. By superposing a number of such circles, or, better still perhaps, by combining them at proportionate distances in a solid model, we may represent all the various changes from point to point.

D'Arcy W. Thompson.

MAYA HIEROGLYPHS.[1]

By way of encouraging the study of ancient documents having reference to the early history of the Mayas, the museum committee on Central American research purpose publishing translations of the more important papers that have appeared in connection with the deciphering of the Maya hieroglyphs. The most recent issue of this series is a translation of Dr. Förstemann's commentary on the Maya MS. in the Royal Library of Dresden, generally known as the Dresden Codex. The figures of the original manuscript may be known to students from the admirable reproductions due to Lord Kingsborough (London, 1831), and for the proper appreciation of the value of Förstemann's commentary, these plates or some other facsimile should be consulted. Without such assistance Dr. Förstemann admits that his description is of little value, and even with this aid, the book will scarcely be intelligible without some previous knowledge.

It is very much to be regretted that the committee has not seen its way to give some indication of the process by which the figures have been conjecturally deciphered, and to enable us to assign the degree of trustworthiness that can be placed on the suggested readings. This information is the more necessary, because research on Maya hieroglyphs is confined to a few experts, and the explanations that are now accepted cannot be regarded as final. We may confidently assert that these MSS. to some extent represent encyclopædias of astronomical or astrological lore, but, at the same time, it must be admitted that they include subjects of very diverse origin, the meaning of which is still obscure.

[1] Papers of the Peabody Museum of American Archæology and Ethnology, Harvard University Commentary on the Maya Manuscript in the Royal Public Library of Dresden. by Dr. Ernst Förstemann. Translated by Miss Selma Wesselhoeft and Miss A. M. Parker. (Cambridge, Mass.: Published by the Museum, 1906.)

The key of the whole is the Tonalamatl. This is a period of time, determined by the combination of the numerals 1–13, with twenty different signs indicating as many days, consequently giving rise to a period of $20 \times 13 = 260$ days. The number 20 was the base of the ancient Mexican numerical system, and it was natural that for the measurement of time a count of twenty days should form the first unit of a higher order. The 13 is not so easily explained. Apparently it may be compared with a period analogous to our week. Such a period was but little suited for chronological purposes, since it was neither directly based on astronomical observation nor was it the expression of any uniform recurring motion in time. Yet, by its divisions and references to natural objects, such a calendric system was destined to become a useful artifice in the hands of the priestly caste for supporting forecasts and giving force to divination. Consequently, the chronological importance of the MS. merges into the astrological, and we find mixed up with the pictures figures representing gods, one of whom is delineated no less than 141 times, and several others who recur with greater or less frequency. It seems not impossible, therefore, that hidden under these symbols we have the essential part of the religious conception of the Maya peoples in a tolerably complete form; but, unfortunately, any connection between the figure of the god and the principle it represents remains vague and undetermined. The accounts of the Spanish authors regarding the mythology of the Mayas correspond very slightly with these figures of gods, and since all other conjectures respecting their significance are very dubious, the deities can only be safely and temporarily defined by alphabetical designations. Dr. Paul Schellas suggested this method of distinguishing, without describing, any particular deity, and this plan has been wisely followed by Dr. Förstemann in his commentary.

We may now ask whether the planets have been identified with greater certainty? The first reference to a planet is made in connection with "an inverted figure of a person in a squatting attitude, the head surrounded by stars, and a sign on the back, which may be a suggestion of the Sun glyph. In this figure I see the planet Mercury, and I believe that the planet's retrogression (which lasts 17–18 days) or disappearance into the light of the Sun during this week is the subject of this passage." The evidence, to those unused in the exercise of a vivid imagination in such matters, does not seem overpoweringly strong. The retrograde motion of Mercury, though variable in length, has a longer duration than seventeen to eighteen days. There is the suggestion of forced agreement here, but if we are to understand the time during which the planet remained invisible between the evening and the morning appearance, the construction is not impossible. But if it were the intention of the scribe to record such phenomena, it is difficult to understand why such symbols do not occur with some approach to regularity.

The references seem to be a little less obscure in the case of Venus. The author exhibits a series of numbers the law of formation of which, unfortunately, is not given in this treatise, which indicate that the Mayas were aware of the approximate equality of five synodic periods of Venus to eight solar years. Assuming the length of the solar year as 365 days, and the synodic period of Venus 584 days, 2920 days include both periods. This number occurs repeatedly. The author takes a further step, which also seems warranted. In a manner comparable with that by which the cycle of 7980 Julian years is determined, he proposes to bring in the Tonalamatl of 260 days by connecting it with the number 37,960 days. This number occurs in various combinations, and is equal to 146×260 (Tonalamatl), 104×365 (solar year), 65×584 (Venus, synodical period). This combination is sufficiently remarkable, and still more noticeable is the recurrence of higher numbers running into millions, in which it seems possible to trace this factor. But a very rigorous examination of the manner in which these numbers are formed is necessary before it can be concluded that they bear but one interpretation. It must also be remembered that the synodic period of Mars, taken at 780 days, is equal to precisely three Tonalamatls.

But if the instances of allusion to planetary periods are remarkable, the omissions are not less so. The explanation that Dr. Förstemann offers for the absence of reference to Jupiter or Saturn in these hieroglyphs is that their synodic periods are too nearly equal to the solar year. This can scarcely be regarded as a satisfactory explanation. But still more curious is the small attention paid to the moon. It is true that the writer traces a reference to the synodic period of $29\frac{2}{3}$ days, but the effort strikes one as rather forced, and the reference is by no means so prominent as in the case of Venus. There is, too, no mention of eclipses. In one passage Dr. Förstemann finds an allusion to clouds, and one need be very cautious how he disagrees with the opinion of so distinguished an expert. But it seems scarcely likely that such ordinary phenomena as clouds should be referred to, in what is evidently the production of considerable labour, intended for a permanent record. This omission is the more strange if we accept Dr. Seler's view that the Maya documents declare an advance on the Mexican pictorial writings, and possess greater accuracy, indicating more elaborate computation. For in a Mexican MS., Codex Vaticanus, No. 3773, we have a distinct reference to the sun being devoured by a jaguar, and causing or explaining a solar eclipse (Kingsborough, iv., 22).

The commentary offers many other instances in which ingenuity and resource are exhibited in deciphering or in assigning meanings to these pictures, but here we can oo no more than express our admiration of the patience and skill, which have solved so many enigmas and offered so many interesting suggestions.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The Robert Boyle lecture for 1907 will be delivered by Prof. Karl Pearson, on "The Scope and Importance to the State of National Eugenics," on Friday, May 17, at 9 p.m., in Balliol Hall.

The Herbert Spencer lecture for 1907 will be given by Mr. Francis Galton, on "Probability, the Foundation of Eugenics," in the Sheldonian Theatre on Wednesday, June 5, at 2.30 p.m.

Mr. C. G. Douglas, formerly Demy of Magdalen College, has been elected to an official fellowship in natural science at St. John's College.

Cambridge.—During their visits to England, it is proposed to confer the degrees of Doctor of Law upon the King of Siam and Prince Fushimi.

At a congregation to be held in June, the degree of Doctor of Science, *honoris causa*, will be conferred upon Sir Clements R. Markham, Colonel Sir T. H. Holdich, and Sir T. R. Fraser, professor of materia medica and of clinical medicine in the University of Edinburgh.

Prof. Hughes has been nominated to represent the University at the celebration of the centenary of the Geological Society of London in September.

Mr. A. D. Imms, Christ's College, has been appointed professor of biology at Allahabad University.

Prof. Nuttall will deliver his inaugural lecture in the anatomical lecture theatre on Wednesday, May 22, at 4.30 p.m.

An exhibition of 50*l.* a year tenable for two years is offered by the governing body of Emmanuel College to an advanced student commencing residence at the college in October. Application should be sent to the Master of Emmanuel not later than October 1.

The professorship of agriculture is vacant by the resignation of Prof. Middleton. The title of the professorship will in future be "The Drapers Professorship of Agriculture." The election of a professor will take place on Saturday, June 1, at the University Offices, St. Andrew's Street. Candidates for the chair are requested to communicate with the Vice-Chancellor of the University on or before Thursday, May 23.

The Mercers' Company lectures on "The Internal Media of the Body and their Relation to the Tissues" will be given in the physiological department of University College (University of London) by Prof. E. H. Starling, F.R.S., on Fridays at 5 p.m., commencing Friday, May 10. These lectures are open to all students of the London medical schools, and to medical men on presentation of their cards.

In the course of some remarks at the annual dinner of the Institution of Mining and Metallurgy on May 3, Mr. R. McKenna, M.P., President of the Board of Education, referred to the new Imperial College of Science and Technology, and said he hopes that a year hence it will be in a state of flourishing existence. He announced that this week it will be his duty to petition the King for a charter for the new college. The Bessemer memorial fund now amounts to 13,000*l.* or 14,000*l.*, and it is hoped that the amount will rapidly be increased to 30,000*l.* or 40,000*l.* The very best equipment the world can produce is needed for the Royal School of Mines, which even without such facilities has created a world-wide reputation for itself.

In the House of Commons on Monday, Mr. Murray Macdonald asked the Prime Minister whether, in view of the recent and prospective increased expenditure upon the improvement and development of State-aided education, of the importance of connecting it more closely with the universities, and of the fact that more than twenty-six years had elapsed since the last public inquiry into the universities and colleges of Oxford and Cambridge was held, he would appoint a commission to examine into the desirability of amending the existing enactments with regard to the finances, emoluments, and government of these universities. In reply to the question, Sir H. Campbell-Bannerman said:—I am disposed to agree with my hon. friend that the conditions of the universities are ripe for a thorough and comprehensive inquiry, but I am not disposed to add, at the present moment, to the number of Royal Commissions already existing.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 28.—"On the Dispersion in Artificial Double Refraction." By Dr. L. N. G. **Filon.** Communicated by Prof. F. T. Trouton, F.R.S.

It is well known that glass compressed unequally in different directions behaves like a temporary crystal. If T_1, T_2 be the principal stresses in the wave-front, τ the thickness of glass traversed, then the relative retardation of the two oppositely polarised rays is $R=C(T_1-T_2)\tau$. C may be called the "stress-optical coefficient" of the glass.

The experiments described were undertaken in order to find out how C for borosilicate glasses varied with the colour of the light used and with the composition of the glass.

Polarised light was passed through a combination of glasses under flexure optically equivalent to a slab under uniform stress. It was then analysed by a Nicol and spectroscope. The spectrum was crossed by a dark band whenever R = integer multiple of λ. The measurement of λ then gave R and C.

It is found that, on the whole, the dependence of the stress-optical coefficient on the colour is very well expressed by the empirical formula

$$\left(\frac{C}{C_0}-1\right)\left(\frac{\lambda}{\lambda_0}-1\right)=1,$$

C_0, λ_0 being constants. This gives a hyperbolic law.

In certain glasses, however, systematic deviations from this law exist. These deviations are local in character, and their study suggests a strong analogy with the effect of absorption bands on the dispersion in single refraction.

With regard to the effect of chemical composition, it appears that an increase in the percentage of B_2O_3 increases C_0; an increased percentage of K_2O probably decreases C_0. λ_0, on the other hand, seems roughly independent of the composition, so that, for the glasses examined, the curves of C plotted to λ differ only in their scale; the dispersion increases with the stress-optical coefficient.

Chemical Society, April 18.—Sir William Ramsay, K.C.B., F.R.S., president, in the chair.—The magnetic rotation of hexatriene, $CH_2 : CH.CH : CH.CH : CH_2$, and its relationship to benzene and other aromatic compounds, also its refractive power: Sir W. H. **Perkin.** Hexatriene was found to have the rotation 12·196, which, when reduced by 0·982, the constant due to the effect of ring formation, gives 11·214 for benzene as against 11·284 actually found for benzene. This indicates that benzene contains three contiguous unsaturated groupings (Kekulé's formula), and that these have substantially the same values as in open chain compounds.—Aromatic azoimides, part i., *p*-hydroxyphenylazoimide: M. O. **Forster** and H. E. **Fierz.** The properties of *p*-hydroxyphenylazoimide were described and compared with those of camphorylazoimide.—Measurements of the velocities of saponification of the *l*-menthyl and *l*-bornyl esters of the stereoisomeric mandelic acids: A. **McKenzie** and H. B. **Thompson.** *l*-Bornyl *d*-mandelate is saponified more quickly than *l*-bornyl *l*-mandelate. The bornyl esters are more quickly saponified than the menthyl esters.—The constituents of the essential oil of American pennyroyal. Occurrence of a dextro-menthone: M. **Barrowcliff.** The oil has been found to consist of (1) an undetermined phenol; (2) *l*-pinene; (3) *l*-limonene; (4) dipentene; (5) *l*-methyl-3-*cyclo*hexanone; (6) pulegone; (7) *l*-menthone; (8) *d-iso*menthone; (9) a sesquiterpene alcohol; (10) esters of formic, acetic, octoic, decylic, and salicylic acids, and the ester of a dibasic acid of the probable formula $C_8H_{14}O_4$, together with formic, butyric, octoic, and decylic acids in the free state.—Studies in the camphane series, part xxiii., oximes of camphorylsemicarbazide and camphorylazoimide: M. O. **Forster** and H. E. **Fierz.**—The action of ethyl oxalate on thioacetanilide and its homologues: S. **Ruhemann.**—The action of tribromopropane on the sodium derivative of ethyl acetoacetate: T. E. **Gardner** and W. H. **Perkin,** jun.—Indican. Preliminary notice: A. G. **Perkin** and W. P. **Bloxam.** A process is described for the isolation of the glucoside from Indigofera leaves, and it is shown that the indican from *I. sumatrana* is identical with that from *I. arrecta*.—Cupric nitrite: P. C. **Rây.**—The action of hydrogen peroxide on potassium cyanide: O. **Masson.** The products of the action are potassium cyanate and potassium and ammonium carbonates.—The reaction between calcium carbonate and chlorine water: A. **Richardson.**—The density of hydrogen chloride: R. W. **Gray.** The highest value obtained for the weight of a litre of the gas at 0° and 760 mm. in London was 1·64091 grams, and the lowest 1·64026 grams. The mean value, corrected to lat. 45°, is 1·6397 grams, which is practically identical with the value 1·6398 grams found by Prof. Guye.—Di-iodocamphor: J. E. **Marsh** and R. de J. F. **Struthers.**—Acyl-ψ-derivatives of iminothiocarbamic acid and their isomerides: A. E. **Dixon** and J. **Taylor.**

Institution of Mining and Metallurgy, April 18.—Prof. W. Gowland, president, in the chair.—A visit to the goldfields of Orenburg, Russia: F. H. **Hatch.** Notes of a journey recently made through the district, with a brief review of its physical characteristics, the occurrence of gold in alluvials and quartz, and the systems of mining adopted.—The McMurtry-Rogers process for desulphurising copper ores and matte: communicated by T. C. **Cloud.** A description of this process as carried on at the Wallaroo Works. It consists in calcining sulphide ores containing a large proportion of silica or siliceous material in converters fitted with blast-pipes and air-holes, thereby allowing a strong current of air to pass through the charge; an important part of the process is the preliminary "swamping" of the ore and the materials to be treated with water.—The ironstone of Cleveland: A. E. **Pratt.** A brief account of the Cleveland ironstone beds, which produce 40 per cent. of the iron ore raised in this country. The author described the geology, mining, and calcination methods pursued at leading mines, with practical notes on the working of the Cleveland kiln.—Laboratory crucible and muffle furnaces: G. T. **Holloway.** An illustrated description, accompanied by a complete specification, of furnaces erected in the author's own laboratory.

PARIS.

Academy of Sciences, April 29.—M. A. Chauveau in the chair.—A suspended collimator giving the position of the zenith: G. **Lippmann.** A vertical collimator carrying a very fine hole in its focal plane is suspended by a very flexible spring in such a manner that it is perfectly free to oscillate in a vertical plane. The suspending spring is formed of steel ribbon, 1/20th of a millimetre thick, 1 cm. wide, and 20 cm. long. The system is damped by a set of plates dipping in oil, and ceases to oscillate in two minutes. The apparatus is not sensitive to slight earth tremors, and the luminous image returns to exactly the same spot even after violent shocks.—The representations of an integral by a sum of ten or twelve squares: G. **Humbert.**—The direct hydrogenation of allyl compounds: Paul **Sabatier.** The vapour of allyl alcohol in a current of hydrogen carried over reduced nickel maintained at a temperature of between 130° C. and 170° C. gives nearly pure propyl alcohol, the only impurity being a trace of propionic aldehyde. Reduced copper at 180° C. produces the same reaction, but both the yield and the quality of the product are inferior.—Observation of the eclipse of the sun of January 14, 1907, at the Observatory of Phu-Lien, Tonkin: G. **Le Cadet.** An account of visual observations, actinometric measurements, and barometric changes during the partial eclipse.—The distances of the satellites of Uranus and of Jupiter: Émile **Belot.**—The analytical nature of the solutions of certain partial differential equations of the second order: Charles **Goldziher.**—The development of hyperelliptic functions in trigonometrical series: Z. **Krygowski.**—The surfaces developed by a circular helix: E. **Barré.**—The most general representation of the equation of nomographical order 3 by a conical nomogram: Maurice **d'Ocagne.**—The sharp edge integrator: M. **Jacob.** This form of planimeter is capable of dealing with important questions arising from the equations of Abel and Riccati, and presents especial interest from the point of view of artillery.—The action of a horizontal aërial current upon a vertical vortex: Bernard **Brunhes.**—The direct determination of the absolute value of the electric charge of a monovalent electrolytic ion: H. **Pellat.** It has been shown by Townsend that the electric charge carried by a gaseous ion is the same as the charge carried by a monovalent ion during electrolysis; J. J. Thomson has determined the first of these two quantities, thus giving the second indirectly. In the present note a method is given for measuring the charge carried by a monovalent electrolytic ion without assuming any of the properties of gaseous ions. The numerical results are of the same order as those furnished by the Thomson-Townsend method.—The dielectric constant of ice and of water in the neighbourhood of 0° C.: F. **Beaulard.** It is found that the dielectric constant of ice is of the same order of magnitude as the square of the refractive index; the constant for water near 0° C. is about double that of ice.—An apparatus for measuring the rate of consumption of petrol in motors: M. **Krebs.** An acknowledgment of priority for a similar apparatus invented by M. Parenty.—The acoustic efficiency of the telephone: Henri **Abraham.** Leaving cases of resonance out of account, the best telephone does not transmit more than one-thousandth part of the energy which it receives to the line.—A new microscope and its applications to stereoscopic photomicrography: A. **Quidor** and A. **Nachet.**—The limit of inflammability of mixtures of ether vapour and air: O. **Boudouard** and H. **Le Chatelier.** Referring to a paper on this subject published recently by J. Meunier, the authors point out that they anticipated these results ten years ago.—Researches on the compressibility and vapour pressure of mixtures of methyl ether and sulphur dioxide; the formation of a compound between these two bodies: E. **Briner** and E. **Cardoso.** Data are given proving the existence under strong compression of a compound having the composition $(CH_3)_2O,SO_2$. The critical temperature and pressure of this compound were measured.—The temperature of formation of the carbides of strontium and barium: Morel **Kahn.** The reduction of baryta and strontia by carbon can be realised at a temperature near that of the fusion of platinum, with formation of the corresponding carbides.—The preparation and properties of a new variety of chromium: Binet **du Jassonneix.** At a high temperature copper dissolves about 1·6 per cent. of chromium, and this separates out during cooling in the form of a spongy mass. The chromium can be isolated by dissolving away the copper in nitric acid.—The limit to the proportion of silicon which can be taken up by copper: Em. **Vigouroux.** In the presence of lead, bismuth, or antimony, silicon in excess reacts with the copper only to form a copper silicide, the maximum percentage of silicon taken up being about 10 per cent.—The higher oxides of rubidium: E. **Rengade.** By the regulated action of oxygen upon rubidium, evidence is obtained of the formation of a black oxide intermediate between the dioxide and the peroxide, and of a composition approximating to Rb_2O_3.—The isomeric dioximidosuccinic acids: A. **Wahl.**—The dibromides of the allyl phenolic ethers; the formation of cyclopropanols: MM. **Tiffenau** and **Daufresne.**—The bitterness of milk: MM. **Trillat** and **Sauton.** The bitterness of milk, as of cheese, is produced whenever contamination occurs with any organism capable of producing both aldehydes and ammonia, or by several species of organisms, some of which are capable of producing ammonia, others aldehydes.—The presence of sympathetic ganglia situated below the spinal ganglia; microsympathetic and hypo-spinal ganglia: G. **Marinesco** and J. **Minea.**—The nephro-poïetical activity of the fœtal kidney: P. **Carnot** and A. **Lelièvre.**—The mode of action of sodium salicylate on the uric excretion: Pierre **Fauvel.** Salicylate of soda does not increase the amount of uric acid or xantho-uric products, but only exerts a modifying action on the secretion.—The discovery of a human jawbone in a Quaternary breccia: A. **Favraud.**—The relations between glacial erosion and fluvial erosion: Jean **Brunhes.**—The movements of sands along the coastline: M. **Thoulet.**

DIARY OF SOCIETIES.

THURSDAY, MAY 9.

ROYAL SOCIETY, at 4.30. The Anatomy of the Julianiaceæ considered from the Systematic Point of View: Dr. F. E. Fritsch.—The Ascent of Water in Trees, Second Paper: Prof A. J. Ewart.—Increase in the Complement-Content of Fresh Blood-Serum: Dr. J. Henderson Smith.—On the Periodic Variations of the Nile Flood: E. B H. Wade.

ROYAL INSTITUTION, at 3.—Spectroscopic Phenomena in Stars, (1) Chemistry: H. F. Newall, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Telephonic Transmission Measurements: B S. Cohen and G. M. Shepherd.

IRON AND STEEL INSTITUTE, at 10.30 A.M.—Presidential Address.—Electrically Driven Reversing Roller-Mills: D Selby-Bigge.—(1) Steel Making from High Silicon Phosphoric Pig Iron by the Basic Bessemer Process: (2) Steel Making from Pig Iron containing Chromium, Nickel, and Cobalt: A W. Richards.—The Use of Steam in Gas Producer Practice: Prof. W. A. Bone and R. V. Wheeler.

MATHEMATICAL SOCIETY, at 5.30.—Rational Expression of the Invariants of a Quintic by Means of Three: Dr. H. F. Baker.—Secular Stability: Prof. H. Lamb.—A Lemma connected with Fourier's Series: F. J. W. Whipple.

FRIDAY, MAY 10.

ROYAL INSTITUTION, at 9.—Recent Excavations on Forum Romanum, and the Forum Ulpium: Signor Comᵉ Giacomo Boni.

PHYSICAL SOCIETY, at 8.—Stereoscopy with long Base-line illustrated on the Screen: Dr. T. C. Porter

ROYAL ASTRONOMICAL SOCIETY, at 5.—On the Presence of Tin in Stellar Atmospheres: J. Lunt.—Tables to Accompany Mr. Innes's Paper on Computation of Secular Perturbations: F. Robbins —Note on Certain Photo-visual Objectives: W. J. S. Lockyer.—On the Variable Stars *RV* and *RX Andromedae*: A. Stanley Williams.—Note on Le Verrier's Tables of Saturn: A. M. W. Downing.—Note on the Range in Brightness at Maximum of Long-period Variables: H. H. Turner.—An apparent Influence of the Earth on the Numbers and Areas of Sun-spots in the Cycle 1889–1901: Mrs. A. S. D. Maunder.—Some Notes on the Classification of Long-period Variables: H. H. Turner.—*Promised Papers*: Distribution of Prominences in Latitude in the Year 1906: John Evershed.—Description of the 30-inch Reflector recently erected at the Helwan Observatory, Egypt: J. H. Reynolds.—Note on the Spectrum of α Orionis: H. F. Newall.—Observations of Jupiter's Sixth and Seventh Satellites from Photographs taken with the 30-inch Reflector in 1906–7: Royal Observatory, Greenwich.—Recent Work at the Kodaikánal Observatory: Prof. Michie Smith.

MALACOLOGICAL SOCIETY, at 8.—The Pairing of *Limnaea peregra* with *Planorbis corneus*: W. D. Lang.—Notes on *Achatina denisoni*, Reeve, and *Achatina magnifica*, Pfr.: E. A. Smith —Review of the New Zealand Acmæidæ, with Descriptions of New Species and Sub-species: Henry Suter.

IRON AND STEEL INSTITUTE, at 10.30 A.M.—Sentinel Pyrometers and their Application to the Heat Treatment of Tool Steel: H. Brearley and F. Colin Moorwood.—Induced Draught with Hot-air Economisers for Steel-Works and Blast-Furnace Boilers: A J. Capron —The Influence of Process of Manufacture on Some of the Properties of Steel: F. W. Harbord.—The Distribution of Sulphur in Metal-Ingot Moulds: J. Henderson.—The Ageing of Mild Steel: C. E. Stromeyer.—Carbon-Tungsten Steels: T. Swinden.—The Nomenclature of Iron and Steel: Report of a Committee of the International Association for Testing Materials.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Consideration of the Patents and Designs Bill, 1907.

SATURDAY, MAY 11.

ROYAL INSTITUTION, at 3.—Scientific Work in the Sea-Fisheries: Prof. W. C. McIntosh, F.R.S.

MONDAY, MAY 13.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—An Expedition from the Niger to the Nile: Lieut. Boyd Alexander.

VICTORIA INSTITUTE, at 4.30.—Recent Discoveries in Palestine and Syria: Dr. Ernest W. G. Masterman.

TUESDAY, MAY 14.

ROYAL STATISTICAL SOCIETY, at 5.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—Exhibition of Australian Specimens and Photographs recently received from Dr. Ramsay Smith, of Adelaide: Prof. D. J. Cunningham, F R.S.—Dolls: N. W. Thomas.

WEDNESDAY, MAY 15.

SOCIETY OF ARTS, at 8.—Trypanosomiasis or Sleeping Sickness: Dr. H. W. G. Macleod.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Standard Rain Gauge, with Notes on Other Forms: Dr. Hugh Robert Mill.—On a Method and Apparatus for Measuring Fog Densities: J. W. Lovibond.—Note on a Balloon Struck by Lightning, April 11, 1907: Colonel J. E. Capper.—Account of a Remarkable Excavation made by Lightning in Peat-earth on August 2 or 3, 1906: J. Nevin and A. S. Herschel, F.R.S.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Diffraction Rings due to a Circular Aperture: Prof. A. W. Porter and P. F. Everitt.—An Improved Vertical Illuminator: E. M Nelson.

GEOLOGICAL SOCIETY, at 8.—The Origin of certain Cañon-like Valleys Associated with Lake-like Areas of Depression: F. W. Harmer.

THURSDAY, MAY 16.

ROYAL INSTITUTION, at 3.—Spectroscopic Phenomena in Stars, (2) Motion: H. F. Newall, F R.S.

CHEMICAL SOCIETY, at 8.30.—The Relation Between the Crystalline form and the Chemical Constitution of Simple Inorganic Substances: W. Barlow and W. J. Pope.—Experimental Investigation into the Process of Dyeing: J. Hübner.—Some Derivatives of *p*-Pyranol allied to certain Derivatives of Brazilein and Hæmatein, Preliminary Communication: W. H. Perkin, jun., and R. Robinson.—Mixed Semi-ortho-Oxalic Compounds: G. D. Lander.—The Mechanism of Bromination of Acylamino-compounds, Preliminary Notice: J. B. Cohen.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Present State of Direct Current Design as Influenced by Interpoles: F. Handley Page and Fielder J. Hiss.

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THURSDAY, MAY 16, 1907.

DEVELOPMENT OF THE HUMAN EMBRYO.

Handatlas der Entwicklungsgeschichte des Menschen. By Prof. Julius Kollmann. Part i. Pp. viii+340 figures, many of them printed in several colours, with a brief explanatory text. (Jena: Gustav Fischer, 1907.) Price 13 marks.

THOSE who wish to see at a glance a truthful and graphic representation of our present knowledge concerning the conception and development of the human body will find it in this hand-atlas by Prof. Kollmann. Here is a museum rather than a book, a museum in which specimens illustrating nearly all stages of development have been judiciously collected from the best sources—many of them from the shelves of the author's own museum—and represented by all the skill of modern pictorial art, a brief description being given of each specimen to supply the place of a catalogue. Altogether, this work will contain 800 figures illustrating stages in the development of the human body.

Five-and-twenty years ago our knowledge of the human embryo, if not a complete blank, was almost a complete series of blanks. When the late Prof. His published his great monograph on the early human embryo in 1882, he was able to find accounts of only ten specimens belonging to the first month of development, these accounts being, for the greater part, imperfect descriptions of the external appearances of poorly preserved embryos. The rapid progress which has made the production of this hand-atlas possible was the result of the application of a new method by which the minute and exceedingly delicate embryo could be cut, fixed, sectionised, and accurately reconstructed on a magnified scale. The reconstructional method gave embryologists an easy means of mutual exchange; by a reconstructed model it became possible to show accurately in five minutes what had been acquired by five months of labour. The method of reconstruction by wax plates is usually ascribed to Prof. Born, but the late Prof. G. B. Howes claimed the invention for Mr. E. T. Newton, who applied it to the reconstruction of the brain of insects before 1878. This laborious method has never appealed to the English anatomist; hence we find that not one of the forty-four specimens which Prof. Kollmann uses to illustrate the stages of development in the first and second months was prepared in England; the reconstructed models of which illustrations are given were made in the laboratories of Germany, Switzerland, and America. Yet the method by which progress has been attained was first used in England; nor were human embryologists lacking in England in the early days, for when Prof. His began his great work he counted that of the late Prof. Allen Thomson amongst the best. How far we have lost preeminence in this subject may be seen from the fact that in the 340 illustrations used in the first part of this atlas, only one is the work of a British anatomist, and that is a diagram published a good many years ago by Sir William Turner, of Edinburgh.

It has always been the habit to utilise our knowledge of the developmental history of the domestic animals to fill in the blanks in the history of human development. That is now unnecessary except for the first week; Leopold's ovum represents the earliest stage of human development, and it is probably in the seventh or eighth day of growth. The fertilisation and segmentation of the human ovum have not yet been seen, but it is highly improbable that they will present any peculiar features. To supply this blank, Prof. Kollmann reproduces the excellent illustrations of the fertilisation of the mouse's ovum given by Sobotta, and those of the segmentation of the ovum of the dog and bat depicted by Bonnet and van Beneden. The author also realises the great value of comparative embryology as a key to the more obscure processes of human development, and draws freely on the work of van Wijhe, Flemming, van der Stricht, Hertwig, Froriep, Stöhr, and Schauinsland. Abnormalities of development are also illustrated.

There was a general expectation that a complete knowledge of the phases of embryonic development would give a key to the origin and past history of man. That expectation has not been fulfilled. If to some extent developmental phases do recapitulate certain generalised stages of evolution, yet so blurred are they, so much are they modified by the conditions of fœtal growth, that they give us no certain knowledge. In the excellent series of models which the author uses to illustrate the transformations at the end of the first month and beginning of the second one can see the gill arches and cleft appear and then disappear, the tail bud out and then become suppressed. But even in these early stages it is to be seen that the brain is planned on a large scale; Prof. Kollmann reproduces side by side a human embryo in the second month of development with that of an ape (*Macacus cynomolgus*) in a corresponding phase; superficially they look wonderfully alike, especially as regards their limbs, but the human head, if the same in type, already shows a distinct difference in form and proportion. It is too soon to say how far embryology may yet throw light on the relationship of man to other Primates. We know practically nothing of the embryology of the anthropoids which are most closely related to man. Thanks to the labours of Selenka, which are freely used by Prof. Kollmann, we know a good deal of the early history of one anthropoid, the gibbon, and in it the process by which the ovum becomes embedded in the uterus is identical to that in man and differs from that of the common ape. That was to be expected from what is known of their anatomy. It is possible, too, that the investigations which are being made in America by Mall, Bardeen, and Lewis on the later stages of the development of the human embryo—the formation of the bones and muscles of the limb and trunk—may give definite bearings as to man's relationship to other Primates. All the present evidence for the solution of such problems has been brought together and made available for those who are interested in this subject by Prof. Kollmann. The price of the hand-atlas is so low that one marvels how the venture can be made to pay.

THE PROBLEM OF CRYSTALLISATION.

An Introduction to Chemical Crystallography. By P. Groth. Authorised translation by Dr. Hugh Marshall, F.R.S. Pp. xii+123. (London: Gurney and Jackson, 1906.) Price 4s. net.

IN providing for English-speaking readers a translation of Prof. Groth's "Einleitung in die chemische Krystallographie," Dr. Marshall has performed a task of great utility, the value of which is no doubt enhanced to many in this country by the references to abstracts and papers in the Journal of the Chemical Society added by him. In preparing the translation he has kept closely to the original, but not so slavishly as to mar the literary style.

The question as to the precise nature of the constitution of unorganised matter, including as it does the problem of the phenomenon of crystallisation and the relation between the chemical composition and the crystal structure, has since the time of Lucretius, and even earlier, been the subject of no little speculative thought, much of which has necessarily been abortive because the knowledge derived from experiment was not sufficiently far advanced to act as a check on the correctness of the various theories propounded. The past century has, however, seen a vast increase in the store of facts relating to the characters of mineral substances, and chemists have, particularly in recent years, recognised the importance of determining with precision the crystallographical properties of the salts prepared by them in the laboratory. For many years past Prof. Groth has been engaged in the preparation of a complete digest of the physical properties of all crystallised substances. The first of the four volumes in which that work will appear was reviewed in NATURE of April 4 (vol. lxxv., p. 529). To that colossal work this small volume forms an introduction.

In a remarkably brief compass, and with all his customary lucidity of exposition, Prof. Groth has summarised the state of our knowledge at the time of writing. After a short discussion of the possible varieties of crystal structure, he proceeds to consider the main subject in its various aspects. Polymorphism deals with the various modifications displayed by the same substance, such as, to take the best-known instance, sulphur, and the nature of the transition between them. The next chapter is concerned with morphotropy, or the comparison of the crystal structures of chemically allied substances, such as, for instance, the aromatic compounds. Isomorphism is a particular case of morphotropy, in which the change in composition leaves the structure almost unaltered. The last chapter treats of molecular compounds, which, however, cannot be differentiated from isomorphous mixtures.

So vigorous is the growth of this subject that, even though various alterations have been embodied in the translation which were necessitated by the publication of investigations during the short interval that elapsed between the dates of appearance of the original and the translation, further revision is demanded by still more recent material. Of primary importance is the simple yet fundamental theory of close-packing put forward by Mr. Barlow and Prof. Pope in a paper read before the Chemical Society in November last.

We may commend this introduction to all who are interested in this important subject, and especially to chemists in this country, to whom we hope it may reveal the advantages of a study of crystallography, a branch of science of which they are said to be neglectful.

PHYSICS FROM MANY POINTS OF VIEW.

(1) *First Year's Course in Practical Physics.* By James Sinclair. Pp. viii+124; illustrated. (London: George Bell and Sons, 1906.) Price 1s. 6d.

(2) *Theoretical and Practical Mechanics and Physics.* By A. H. Mackenzie. Pp. xvi+112; illustrated. (London: Macmillan and Co., Ltd.; New York: The Macmillan Co., 1906.) Price 1s.

(3) *Junior Experimental Science.* By W. M. Hooton. Pp. viii+260; illustrated. (Cambridge: University Tutorial Press, Ltd., 1906.) Price 2s. 6d.

(4) *Text-book of Mechanics.* By Louis A. Martin, jun. Vol. i. Pp. xii+142; with diagrams. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 5s. 6d. net.

(5) *The Tutorial Physics.* Vol. v. Properties of Matter. By C. J. L. Wagstaff. Pp. iv+251; illustrated. (Cambridge: University Tutorial Press, Ltd., 1906.) Price 3s. 6d.

(6) *Practical Physics.* By W. R. Bower and J. Satterly. Pp. xi+399; illustrated. (Cambridge: University Tutorial Press, Ltd., 1906.) Price 4s. 6d.

(7) *The School Magnetism and Electricity; a Treatise for Use in Secondary Schools and Technical Colleges: based on Potential and Potential-gradient.* By Dr. R. H. Jude. Pp. vi+403; illustrated. (Cambridge: University Tutorial Press, Ltd., 1906.) Price 3s. 6d.

(8) *Mechanics Problems for Engineering Students.* By Frank B. Sanborn. Second edition, revised and enlarged. Pp. viii+194; illustrated. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 6s. 6d. net.

(9) *A First Course in Physics.* By Dr. R. A. Millikan and Dr. H. G. Gale. Pp. viii+488; with illustrations. (Boston, New York, Chicago, and London: Ginn and Co., n.d.) Price 5s. 6d.

ANYONE who thinks that the existing supply of text-books in mechanics and physics is quite sufficient is neglecting to make an adequate estimate of the extremely varied conditions under which teachers and pupils work. There was never a time when so much teaching was being done as now. Elementary school, high school, public school, technical school and college, each is developing on different lines, with the result that each feels the need of a text-book written specially to suit its work. Besides these, there is the cramming school, the main object of which is to get a man "through" an examination; this also has its special aims and needs, and seeks to satisfy them. Those of us who are ceasing to be young fared very differently in our day from the modern student. A few leading text-books we had from which to select; after reading these we were encouraged at once to study the more simple of original papers and treatises. In this way we were led early to view science in the making, and ever since we have valued the independent spirit which this mode of training infused into us. Granting the increased facilities for absorption (it is amazing what some of our junior students "know"), it yet remains to be seen whether the present mode of boiling down science into a sort of intellectual pemmican will turn out better scientific men. Meanwhile, the flow of text-books continues, each written to meet some want. The above are some that we have received.

(1) In this first course in practical physics an attempt is made to provide for pupils in day schools, evening schools, and pupil teachers' classes a course which is not too difficult for young students, but which contains all that is really essential. The description of the experiments is not surrounded by any theory, the author's opinion being that this should be given by the teacher—at any rate in the first year. The course is a very simple one, consisting of exercises in the measurement of length, area, volume, mass, relative density, pressure of air, and of a few experiments in heat. The instructions given seem to be very clear in the main, and the order of experiment is quite logical.

(2) The text-book by Mr. Mackenzie is intended for artisans in evening schools. These belong to a class of student which has not been sufficiently catered for up to the present. A volume like this is an effort to provide something suitable for preparing them to benefit more fully from the instruction given them in the principles underlying their trades.

The course laid down is wholly experimental.

"Although instructions on the carrying out of experiments are given in detail, the students are not told as a rule what they are expected to see or what conclusions they should draw."

No previous experience of laboratory work is expected. The range covered is the same as in No. 1. We recommend this volume as a very suitable introduction to the rudiments of the subject.

(3) "This book has been written in order to supply a want," viz. a work containing approximately all that is required by the syllabuses in experimental science set for the Oxford and Cambridge junior local and Central Welsh Board junior examinations. It is primarily meant to help the teacher by providing the material required for revision. The subject-matter includes hydrostatics, mechanics, heat, and chemistry. Each experiment is prefaced by a short theoretical account which will add value to the book, and each chapter ends with a set of questions. There is not much room for originality in such a volume—the conditions laid down in producing it tend to preclude originality. The descriptions, so far as they go, appear to be clear, and provided a student actually does the described experiments are probably sufficient. We regret to see the phrase "whole pressure" alluded to in a modern text-book; still more do we regret to see it defined as the total force tending to deform a body.

(4) Mr. Martin's "Text-book of Mechanics" deals only with statics; the kinematics and kinetics are to follow in a second volume. For such an elementary book sufficient care is not always exercised in connection with fundamental illustrations. The necessity of a strong push to displace appreciably a large ball of iron hung up by a string indicates its great *weight*, and not its great mass. The difficulty of displacing it *quickly* depends on its mass. It is not usually true to say that "two bodies of equal mass moving with equal and opposite velocities will on impact (collision) come to rest." Even two equal lead balls will not behave in this way. Force is defined in the introduction as rate of change of momentum; no attempt is made to connect this definition with the use of the word force in the body of the book. Putting aside, however, this incompleteness of logical treatment, the volume may be considered a useful summary of elementary rules regulating the equilibrium of bodies. The last third of the book consists of chapters on graphical statics with applications to stresses in members of framed structures. These chapters will be found to be useful in teaching technical students, for whom they are primarily intended. There is no calculus employed, although it will be used extensively in the companion volume, which is nearly ready for the press.

(5) "Properties of Matter," by Mr. Wagstaff, is a somewhat more ambitious work, since it is intended to include all that is usually required for a pass degree; it therefore deserves a stricter examination. We must point out that Borda's metre has long been obsolete; the same remark applies to Borda's kilogram. The work of the Bureau International seems to be little known to writers of text-books. The author deserves credit for attempting to introduce vitality into his subject by outlining various attempts to "explain" matter. However, is not Osborne Reynolds's interesting granular theory now discredited? Also, is there not some doubt about the possibility of explaining all mass as being electromagnetic? We think that the selection of problems has been very well made, and the treatment is very clear. A proof is given of most of the theorems stated, and this is usually sufficient for those who intend to proceed only to a pass degree. Suggestions, of course, might be offered in many ways. The experiment on a stretching wire is most easily made with a wire of copper. With a thin wire the whole course of the extension up to the breaking point can be obtained with small loads, and the amount of permanent extension is much more considerable than with steel. We think that some idea of the nature and character of rolling friction should be included. Were this done, an explanation could also be given of the incompleteness of the working out of the problem of the disc rolling down an inclined plane. The solution given (the usual one, by the way) involves perpetual motion of the disc when once started on a horizontal plane, for its acceleration would be zero. The fact is that if the friction be represented by a single force it cannot be represented

at the same time as acting at the point of contact between the disc and the surface.

(6) In the "Practical Physics" of Messrs. Bower and Satterly we have a course intended for matriculated students. No previous knowledge of experimental physics is assumed, however, and hence the handbook is a complete elementary manual of the subject. Great pains have evidently been taken to secure efficiency, and the result is a text-book which merits great praise. Both the writers have had considerable experience in practical work, and, moreover, have the ability to impart the results of this experience to others. The volume is profusely illustrated with sketches, which will prove of great use to teachers who are obliged to make their own apparatus. Most of the experiments are intended to be performed in a properly equipped laboratory; certain of them are designed to be performed at home. The latter have been arranged so as to keep the cost of performance low, but at the same time merely trifling experiments have been avoided. These experiments form part of the complete course, and are meant to be done in a laboratory, if not at home.

(7) In spite of the considerable merit of the preceding manuals, we turn from them to Dr. Jude's elementary treatise and peruse it with some sense of exhilaration. It is only a school book, containing "all of the subject that is required for the London University Matriculation," though not written to the syllabus of any examination; but from first to last there is an originality of treatment which makes it interesting reading even to one who is *blasé* in the reading of text-books. Our only doubt is whether it is not too thorough for such examinations as that named; a wise teacher will know, however, how to benefit by it himself, and at the same time to temper it to the more junior boys without sacrificing the thoroughness. According to its subtitle, it is based on "potential and potential-gradient," notions which even university students sometimes find it hard to grasp. The fallacy of the old theory of "free and bound" charges is exposed, and this exposure is made much more effective than is customary. It is shown that when a conductor is under electric induction, the amount of electricity which runs out of the conductor on earthing is not in general equal to that which resided beyond the neutral line before the earth connection was made. In the case of a sphere under the action of a point-charge placed at a distance of four times the radius from the centre, the so-called "bound" charge is less than one-fifth of the induced charge when the sphere is earthed. A matriculation pupil will not understand the mathematical quotations in respect to this point, but these quotations will serve to keep many a teacher on the right path. This example indicates the thoroughness characteristic of the volume. The diagrams are numerous, and, in general, are good, but it is certainly with regret, and also with some surprise, that we see certain familiar lines-of-force diagrams doing duty once more. A moment's reflection should persuade anyone that a diaper pattern between two north poles (p. 206) hardly does justice to the lines as pourtrayed by iron-filings, imperfect though these are. Still less does it do justice to the true lines of force between two such poles. The figure for two opposite poles (Fig. 94) should also be replaced by a much more satisfactory one. We do not wish to conclude the notice of the book by an adverse criticism, however slight. It has given us great pleasure to read through it, and we hope that this pleasure will be felt by very many more.

(8) The collection of mechanics problems made by Mr. Sanborn is a second edition of a book prepared for engineering students. The aim has been to present many practical problems, together with brief definitions and solutions of typical problems, to help the student to follow George Stephenson's advice to his son Robert: Learn for yourself, think for yourself, make yourself master of principles. It is illustrated with process-work cuts in the new manner, presumably with the object of adding interest to a mere collection of problems. Whenever these cuts illustrate a definite point, their inclusion acquires a real value. In some cases the moral is somewhat hazy. The frontispiece of an engine belching black smoke on an up-grade on the Pennsylvania Railroad at Tyrone seems somewhat superfluous, especially as the camera, having seized the wrong perspective, has given the lines a down-grade rather than an up-grade appearance. In other cases, where, for example, it is a dipper dredge which is depicted in full working order, the picture is necessary to the proper understanding of the problem on the opposite page. There is a novelty about the choice of problems which we very much appreciate. The utility of the book would be enhanced if more of these problems were worked out in detail. With regard to provision of answers, a middle ground has been taken in giving them to about half the questions. The answer to a problem is not the principal thing from the standpoint of education, though it of course becomes very important when it forms the basis of a monetary transfer. The one feature of the book which we fail completely to understand is the order in which the questions are arranged—work, force, motion. Is it possible that it is intended that the exercises should be performed backwards?

(9) "A First Course of Physics," by Drs. Millikan and Gale, "has grown out of the actual needs of the elementary work in Physics in the University of Chicago, particularly in the University High School." The aim has been to give "a simple and immediate presentation in language which the student already understands, of the hows and whys of the physical world in which he lives." It must not be understood from this quotation that we have here merely a compilation for the amateur reader; the volume is a genuine text-book for schools. We think that in the choice of matter and in its treatment the authors have been successful. Not the least valuable feature is the large number of excellent portraits of physicists, old and new, from Aristotle to Galileo, Maxwell, and J. J. Thomson; these will help to stimulate the budding genius. In the section on image formation the method of wave-curvature has been adopted. We agree that in the elementary treatment of images there is advantage in this method; at the same time,

we do not see in what respect the representation of waves by their wave-fronts is associated with less fiction than what the authors refer to as "the time-honoured fiction of rays." Whether the wave is represented by its front or its normal is a question merely of convenience or lucidity. The fiction which affects both equally consists in regarding the wave as a simple spherical one, and when the question is the higher one of the deviation from sphericity, we think the advantage lies all on the side of the method of rays. We conclude by wishing this volume all success; it deserves to be widely read.

THE PRINCE OF ENTOMOLOGY.

Les Débuts d'un Savant Naturaliste. Le Prince de l'Entomologie. Pierre-André Latreille à Brive de 1762 à 1798. By Louis de Nussac. Pp. vii+264. (Paris: G. Steinheil, 1907.) Price 5 francs.

THE subject of this memoir was the natural son of Baron d'Espagnac, and some doubt exists as to the exact date and place of his birth; his biographers, however, are agreed in giving the former as 1762, and Brive, in the department of Corrèze, as the place where he first saw the light of day. He was educated at Brive and at Paris, took orders in 1781, and eight years later became a fully ordained priest. The Revolution altered the ecclesiastical future of Latreille, for in 1793 he was arrested on the charge of neglecting to take the oath of allegiance to the new Government, was thrown into prison, and sentenced to exile in Cayenne in company with other recalcitrant priests.

Latreille was saved from this fate by the influence of friends and by a fortunate accident, the story of which is of considerable interest. On the wall of his cell, which he shared with an invalid prisoner, Latreille, who was already an expert entomologist, found a specimen of a beetle that he recognised as new to science; the surgeon attending the invalid observed Latreille's excitement, and on discovering the cause of it asked if he might give the specimen to a scientific friend, M. Bory. Next day the surgeon brought back word that M. Bory was unable to identify the new beetle, and Latreille, perceiving that he was dealing with a brother entomologist, sent him the message:—"Vous lui direz que je suis l'Abbé Latreille, qui va aller mourir à la Guyane avant d'avoir publié son 'Examen des Genres de Fabricius.'" Steps were immediately taken to free the captive, and he was literally snatched from the ship bearing the exiles to Cayenne; the ship subsequently foundered off the French coast, and all hands were lost. Latreille, in his classic work on insects and crustaceans, describes the insect that was the means of his salvation as *Necrobia ruficollis*, and details the circumstances of its discovery; in his "Genera crustaceorum et insectorum" he apostrophises it as "Insectum mihi carissimum," and a representation of it is carved on the bust of the great entomologist in the museum at Brive with the inscription "Necrobia ruficollis Latreillii salus anno MDCCXCIII.

After these adventures Latreille returned to Brive, and tranquilly resumed his entomological studies. The end of the eighteenth century in France was marked by the immense stimulus given to the scientific study of agriculture; societies for the encouragement and advancement of agriculture sprang up everywhere, and met with official sanction and help. Experiments on the cultivation of all sorts of crops were carried out, new agricultural machines were invented and tested, efforts were made to combat insect pests, and the methods of other countries were studied. In fact, France more than a century ago had arrived at a stage in agricultural progress which the modern Englishman may well envy. To-day an industrious peasantry, firmly rooted to the soil, is the prop and mainstay of France, and who can doubt that their existence is largely due to the work of those early agricultural societies, called into being themselves by the revulsion of feeling against a tyrannical and effete landed aristocracy? The cry of "Back to the Land" is only heard in those countries where the needs of agriculture are regarded by legislators with languid indifference.

In a milieu of eager and scientific inquiry a man like Latreille was bound to make his mark; he was appointed professor of natural history at Brive, and in 1798 was elected a member of the Institut National des Sciences et des Arts of France. During these years he was in active correspondence with Fabricius, to whom he owes his title of *Princeps Entomologiae*, with Olivier, Bosc d'Antic, and other entomologists of the day, and he was personally known to the Paris zoologists, the great Cuvier, Duméril, Daubenton, and Lacépède. Several of his letters are quoted by M. de Nussac, and these alone show, even if we had not his published works to convince us, that Latreille possessed the true Frenchman's power of generalisation and ability to seize on characters of prime importance for systems of classification. In 1796 Latreille published at Brive his first great work, "Précis des Caractères génériques des Insectes," which earned for him the plaudits of the entomological world of the day; it was followed by "Essai sur l'Histoire des Fourmis de la France," and shortly afterwards Latreille migrated to Paris to take up a post in the Natural History Museum. There his biographer leaves him, but promises a second volume on his subsequent career; M. de Nussac will find it difficult to write a more interesting volume than his first.

R. S.

OUR BOOK SHELF.

The Steam Turbine as Applied to Marine Purposes. By Prof. J. H. Biles. Pp. vii+126. (London: Charles Griffin and Co., Ltd., 1906.) Price 6s. net.

PROF. BILES delivered the Keith lectures before the Royal Scottish Society of Arts in Edinburgh during the spring of 1906, and as only a condensed summary of the lectures was published by the society in its monthly journal, while many requests were made to the lecturer for complete copies of the lectures, he decided to publish them in book form.

Before dealing with the special form of turbine most suitable for marine purposes, the author gives a condensed and useful account of the development of the turbine from the time of Hero to the present day. In the second chapter the main features in the design of marine turbines are discussed, and then a detailed account is given of the method of blading the turbine drum and casing. In a convenient table at the end of this chapter the author gives in detail the sizes of the blades and their spacing for the H.P., L.P., and astern turbines of an ocean liner. The next chapter is well illustrated, and the reproductions of photographs, taken at various stages in the process of building a large set of marine turbines, will do much to make the non-technical reader familiar with the more important details in turbine construction. The thermodynamic principles which govern the design of turbines are then briefly touched upon, and their application illustrated by the calculations, necessary in determining blade dimensions for a channel steamer, being fully worked out. The success of the marine turbine is so entirely dependent on the efficiency of the propeller to which it is connected that it was most desirable that Prof. Biles should in these lectures discuss fully the theory and design of the screw propeller as employed in turbine vessels; the important and complete series of experiments carried out at the United States Navy Tank at Washington are admirably summarised; the results are illustrated by graphs, and their application to the design of a propeller which has to work under any given set of conditions is clearly explained.

The book concludes with a summary of all the trustworthy information at present available as to the comparative economy of turbine and reciprocating marine engines, and it is worth pointing out that, judging from the performances of certain cross-channel steamers, the considerable economy of the turbine-engined steamer which is shown during the preliminary trials is apparently not maintained in active service, though the author has every confidence that this loss in economy, which he considers is due to cavitation, will eventually be overcome.

T. H. B.

A First Year's Course in Geometry and Physics. By Ernest Young. Parts i. and ii. Pp. viii+101. (London: George Bell and Sons, 1907.) Price 1s. 6d.

THIS satisfactory first year's course of work in geometry and physics recognises fully the desirability of making the introductory lessons in mathematics and science as practical as possible. The author is an experienced schoolmaster who understands the need of setting young pupils to do things for themselves if they are really to understand the subjects under consideration. Though there is little that is novel in the methods adopted, the book provides an abundance of well graduated exercises suitable for boys of twelve to thirteen years old.

New Geometry Papers. By Rupert Deakin. Pp. 103. (London: Macmillan and Co., Ltd., 1907.) Price 1s.

THE recent changes in teaching geometry have rendered Mr. Deakin's "Rider Papers on Euclid" of little use in most schools, and the present book is intended to serve a similar purpose under the new conditions. The papers are graduated and arranged in order of difficulty, while hints are provided on the method of solving riders. The collection should prove useful as a supplement to the school text-book of geometry.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Name of the Cave Horse.

IN the paper on the derivation of the horse in the April number of the *Quarterly Review*, to which reference was recently made in NATURE, Prof. J. C. Ewart expresses the opinion that the wild Mongolian horse, commonly known as Przewalski's horse, is identical with the horse depicted by the prehistoric inhabitants of La Madelaine Cave, in the Dordogne. The same view is even more emphatically expressed by Dr. E. L. Trouessart in the Bulletin of the Paris Museum (1906, p. 453). No mention is made by either writer of any change in nomenclature involved in this identification.

In the Phil. Trans. for 1906 Sir R. Owen described the prehistoric horse of the cavern of Bruniquel (Tarn et Garonne) as *Equus spelaeus*; and although he estimated the height of the animal at 13½ hands, it is practically certain that it was really much less, as he was not aware of the relatively large size of the molars in the Mongolian horse.

Now it can scarcely be doubted that the small prehistoric horse of the Bruniquel cave is identical with the one depicted by the prehistoric hunters of La Madelaine, and as there is equally little doubt that both are merely races of *Equus caballus*, the name of the La Madelaine horse is *Equus caballus spelaeus*.

Hence, if Messrs. Ewart and Trouessart are right, it is also the title of the wild Mongolian horse, the name *Equus przewalskii* dating only from 1881. It is true that there is a possibility that a name given by Hamilton Smith to a horse supposed to be from Tatary may antedate both *spelaeus* and *przewalskii*, while *Equus fossilis*, dating from 1836 or 1846, may possibly be identical with *spelaeus*. Nothing certain can, however, be affirmed with regard to either of these points.

The name *E. c. spelaeus* for the La Madelaine horse certainly cannot be ignored, but it seems inadvisable that it should be made to supersede *E. c. przewalskii*, especially when the wide separation in time and space between the types of the two is taken into consideration. A way out of the difficulty may be found in a refusal to admit Messrs. Ewart and Trouessart's absolute identification of the fossil with the living form, and to regard them as distinct, although closely related, races, when they will stand respectively as *Equus caballus spelaeus* and *Equus caballus przewalskii*.

I may add that I cannot agree with Prof. Ewart in regarding the skull of Przewalski's horse as conforming to the type in which the face is bent down on the cranial axis. On the contrary, it is more or less of the straight type, in common with the prehistoric horses of Europe. The bent type seems to me characteristic of domesticated breeds, especially thoroughbreds and Arabs, and as it also occurs in the fossil Indian *Equus sivalensis*, my suggestion that Arabs and thoroughbreds are descended from that species, while the ordinary "cold-blooded" European horses trace their origin to the "Przewalski," is strongly confirmed. In a short time I hope to put skulls of the two types on exhibition in the Natural History Museum, so that visitors can judge for themselves on the point at issue.

R. LYDEKKER.

The Enigma of Life.

IN the review of my book "The Evolution of Life" in NATURE of May 2 (p. 1), "J. A. T." admits his inability to "point out precisely where my experiments are fallacious," and says he does "not know what to answer unless it be that the sterilisation was inadequate, or that the preparations were contaminated before the photographs were taken." But the adequacy of the sterilisation, in accordance with all existing knowledge, is fully shown in the book: and, as for the last suggestion, it seems really absurd when "J. A. T." was told that the organisms removed from the tube were received on a sterilised slip, covered with a sterilised cover-glass, and were there photographed almost as soon as they were found.

That he should not be convinced, however, by my "final decisive experiments" is only what might be expected when he says, in excuse for not himself repeating my simple experiments, "we regard archebiosis as so great a miracle that we do not expect to see it repeated," thus implying a disbelief even in its occurrence in the past. I certainly could not hope to convince anyone, by my experiments, who disbelieves in the natural origin of living matter on this earth when its crust became sufficiently cool to permit of such an occurrence.

Then, "harking back to heterogenesis," "J. A. T." refers to my belief in the origin of Otostoma from the Hydatina egg, and it is what he says on this subject that tempts me, in the main, to write this letter.

He says I was good enough to show him "the mummy of an Otostoma reposing within the egg-case of Hydatina. *There can be no doubt about it.*" These latter words, which I have italicised, are of some significance in reference to previous doubts expressed by many persons; but in the former statement Prof. J. Arthur Thomson (for your reviewer evidently affects no concealment of his identity) has certainly said too little. I showed him, not one specimen of Otostoma only, but about fifty specimens of this rare ciliate, either within egg-cases of Hydatina or lying among them. As he says, he thought it a result of parasitism, notwithstanding all the evidence against this view; and he left me with the expressed intention of investigating the subject himself. He now says that he, and also Dr. John Rennie, "watched many ova of Hydatina. But neither the expected nor the unexpected happened." From which I deem it quite possible, judging from the great rarity of Otostoma, that neither of them may even have seen one of these ciliates among the Hydatina eggs which they were watching. Yet I have taken some hundreds of Otostomata from my experimental pots. One may be permitted to smile at the puerile suggestion that, because Dr. John Rennie saw two infusorians moving within a split Hydatina egg-case, that kind of thing, which may be commonly enough seen, can at all explain my repeated observations with details and photographs concerning the origin of Otostoma from the egg of the rotifer. Yet it is with such a suggestion that "J. A. T." dismisses the subject.

Still, his attitude in regard to this question is much the same as it is concerning archebiosis, seeing that he has previously said concerning it (NATURE, February 25, 1904):—"There are some things that one must see for oneself, and even then one would not believe them." I, however, have seen this transformation, marvellous as it is, on so many occasions that I find no possible room for doubt as to the reality of its occurrence. Parasitism, I maintain, is out of the question, because no minute germs of ciliates are known; because of the extreme rarity of this particular great ciliate; and, above all, because it is the whole substance of the egg which becomes transformed within the unruptured egg-case, and because no movement can be seen until *the whole mass* begins slowly to revolve and speedily issues as a great embryo ciliate—which in its free state attains a bulk two or three times as great. Full evidence in support of this is to be found in my work "The Nature and Origin of Living Matter," chapter xiii., and in the Proceedings of the Royal Society, vol. lxxvi., B, pp. 385–392. H. CHARLTON BASTIAN.

Radium and Geology.

IN his letter in NATURE of May 9 (p. 31) the Rev. O. Fisher raises a point of wide interest, but one which admits at the present moment of little more than the suggestion of fresh hypotheses and the destructive criticism of old ones.

Sediments rich in radium involve *prima facie* parent rocks capable of supplying the necessary uranium. Failing this explanation, we must, I think, assume that the uranium is derived from an extra-terrestrial source. Neither hypothesis is at the present moment capable of proof. Much will turn upon (among other things) our final estimates of the quantities to be accounted for.

With the concluding portion of Mr. Fisher's letter I regret I am not able to concur. Many predictions, based on the best knowledge available, were made of the temperatures which would probably be encountered in boring the Simplon Tunnel. Geologists and engineers both arrived at results much below those which were afterwards observed. That of Heim was 38°–39°. That of Stockalpen (formerly head engineer of the north boring, St. Gothard) was 38°, &c. The highest predicted temperature—then criticised as quite excessive—was that of the "Ingenieur-Geolog" Stapff, which was 47° C., but the actual temperature reached was 55° C. (see papers by Ed. Sulzer-Zeigler and by Prof. H. Schardt in the *Verhandlungen der schweizerischen naturforschenden Gesellschaft*, July–August, 1904). This will give a considerably higher gradient than that reckoned by Mr. Fisher, more especially as the highest temperatures were by no means coincident with the greatest overlying mass.

Nor do I think the facts will admit of explanation by hot springs coming from below. Prof. H. Schardt, perhaps the highest authority on the subject, in a contribution to the journal cited above, states that the region of highest temperature was characterised by abnormal dryness of the rocks, and to this fact (the *absence* of circulating water) and the horizontality of the strata he ascribes the specially elevated temperature.

Mr. Fox, in the article in NATURE of October 27, 1904 (vol. lxx., p. 628), to which Mr. Fisher refers, states that the ordinary gradient of 1° F. in 70 feet is insufficient to account for the great heat, and suggests a volcanic source.

Trinity College, Dublin, May 13. J. JOLY.

The Relationship of Lemurs and Apes.

IN NATURE of May 2 Dr. Elliot Smith has referred to a memoir presented by me to the Zoological Society on "Recently Discovered Sub-fossil Primates" from Madagascar. On the evidence supplied by the brain-casts of three of these fossils, Dr. Elliot Smith takes exception to my conclusion that certain of these extinct Prosimiæ are in many respects intermediate between the extant Malagasy lemurs and the true monkeys.

I have nowhere in my memoir maintained, as Dr. Elliot Smith seems to imply, that, *so far as their brain-conformation is concerned*, these recently discovered sub-fossil lemurs form a distinct link between the existing genera and monkeys. On the contrary, I have emphasised the fact, insisted on by Dr. Elliot Smith himself, that many of them show evidence of marked retrogressive changes in their brain-structure; and I have pointed out that, just because of this *retrogressive specialisation*, it is the condition of the brain which, of all characters, is least likely to afford satisfactory evidence of close affinity between the Malagasy lemurs and the Old and New World monkeys. I will not anticipate the suggestions which I make in my memoir as to the possible causes which have brought about this curiously degenerate condition of the brain of these Malagasy lemurs, nor is it possible here to give in detail the facts and arguments on which I base my conclusion that, *in spite of this brain degeneracy*, these recently discovered fossils do, in fact, afford strong evidence that they, in common with their extant allies, are descended from ape-like ancestors. A detailed study of these fossils and a comparison with their nearest living relatives, on the one hand, and with various genera of Old and New World monkeys on the other, has convinced me that most of the so-called *lemuroid* characters of the extant Malagasy lemurs have been secondarily acquired, and that, taken as a group, the characters which differentiate the Malagasy lemurs, recent and extinct, from the monkeys are so few and (with the possible exception of brain-structure) so unimportant as not to justify their retention in a separate suborder.

A satisfactory discussion of the subject seems, however, hardly possible until the publication of the two memoirs by Dr. Elliot Smith and myself describing in detail the fossils themselves. H. F. STANDING.

South Kensington, May 9.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.

THE draft of the Charter for the incorporation and government of the Imperial College of Science and Technology to be established at South Kensington has now been laid on the table of the House of Commons. It provides for the appointment of a governing body which, when complete, will consist of forty members, each member holding office for a period of four years. The governing body will be constituted in accordance with the recommendations of the Departmental Committee which reported in January, 1906. When complete, it will consist of forty members, of whom six will be appointed by the Crown, four by the President of the Board of Education, five each by the University of London, the London County Council, and the City and Guilds of London Institute, two by the Royal Commissioners for the 1851 Exhibition, one by the Royal Society, four by the professorial staff of the college, and eight by various technical societies, viz. one each by the Institutions of Civil Engineers, Mechanical Engineers, and Electrical Engineers, the Iron and Steel Institute, the Institution of Naval Architects, the Society of Chemical Industry, the Institution of Mining Engineers, and the Institution of Mining and Metallurgy. The President of the Board of Education will summon the first meeting of the governing body, which will be deemed to be constituted on the occasion of that meeting. The governing body will meet at least four times a year, and will publish a report of its proceedings annually. It will be permitted to delegate powers to an executive committee and to other committees, provision being made for the possible inclusion on any of these committees, except the executive committee, of non-members of the governing body. The governing body will in this way be able to secure the advice of independent experts, including persons with practical experience of industrial requirements. Advisory boards may also be appointed with the same object in view.

The purposes of the Imperial College will be to give the highest specialised instruction and to provide the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry, and to do all or any of such things as the governing body consider conducive or incidental thereto, having regard to the provision for those purposes which already exists elsewhere. For these purposes the governing body will carry on the work of the Royal College of Science and the Royal School of Mines (at present under the direct control of the Board of Education), and may establish colleges or other institutions or departments of instruction. Any institution or department so established, and, subject to the fulfilment of certain conditions, the Central Technical College of the City and Guilds of London Institute, will become integral parts of the Imperial College. The special conditions attaching to the affiliation of the Central Technical College have for their object to secure for the college a certain measure of independence. The college, which will in future be known as the City and Guilds College, will be managed—subject to such powers of general supervision, direction, and control as are reserved for the governing body of the Imperial College—by a committee of management appointed for the purpose by the City and Guilds of London Institute, to which committee the governing body of the Imperial College will add five additional members; and the Institute will continue to exercise its privilege of awarding the diplomas of Associate and Fellow. As already announced by Mr. McKenna, the Royal School of Mines will retain its name, and the governing body of the Imperial College will award the diploma of "Associate of the Royal School of Mines" to any student who completes the prescribed courses to the satisfaction of the governing body. Subject to agreement with the authorities of any college or other institution, the governing body may by resolution recognise that college or institution or any department thereof as being in association with the Imperial College, but no such resolution will be valid or operative until allowed by His Majesty in Council. Power will be reserved to His Majesty in Council to amend or add to the provisions of the Charter, and in particular to declare and define more precisely the purposes and scope of the Imperial College in relation to matters appertaining to the biological sciences, and to make such provision in reference thereto as may appear expedient.

As regards the connection between the Imperial College and the University of London—a matter which has been fully discussed during the past year—it is proposed that, pending the settlement of the question of the incorporation of the Imperial College with the University, the college shall be established, in the first instance, as a "school" of the University. It is expected that an inquiry by Royal Commission, which has been suggested by Mr. McKenna, will be necessary before this question of incorporation can be decided. In the meantime, the governing body of the college will be directed to enter into communication with the University with regard to the coordination of the work of the college with the work of the University and its other schools, and for the purpose of carrying out or facilitating such coordination the governing body may enter into such arrangements either by way of transferring or exchanging departments of instruction or otherwise, and upon such terms as may be agreed upon between the governing body and the University.

The resources which are at present available for the purposes of the Imperial College are considerable. In the first place, there are the buildings and equipment of the Royal College of Science, including the new chemical and physical laboratories, which have cost nearly 300,000*l.* The Royal Commissioners of the 1851 Exhibition have resolved to appropriate certain portions of their estate at South Kensington for the purposes of the college. The late Mr. Alfred Beit bequeathed 50,000*l.* and 5,000 preferred shares of 2*l.* 10*s.* each in De Beers Consolidated Mines (total value about 135,000*l.*) to be applied for the purposes of the "College for Technology (including Mining and Metallurgy) in connection with the University of London." Lord Rosebery, in a letter to *The Times*, published on June 29, 1903, announced that Messrs. Wernher, Beit and Co. had offered to place a sum of money in the hands of trustees to be applied as a contribution towards the cost of building and equipping an institution at South Kensington for advanced technology, and that further offers of the same kind had been made by other public-spirited London citizens. The Bessemer memorial fund, which will probably amount to not less than 20,000*l.*, will be devoted in whole or part to the Royal School of Mines. As regards income, the Treasury has consented to place in the Estimates a grant of 20,000*l.* per annum in respect of the cost of the staff and of laboratory expenses of the Royal College of Science and the Royal School of Mines. The London County Council, which in the past has not contributed generously in aid of higher technological work, may be expected to avail itself gladly of the opportunity of developing such work in London which the establishment of the Imperial College will afford, especially in view of the fact that the Council is now under a legal obligation to consider the educational needs of its area, and may supply or aid the supply of higher education. The Council on

July 21, 1903, considered Lord Rosebery's letter, to which reference has already been made, and placed on record its opinion that, when certain conditions had been complied with, the Council would be well advised to contribute out of the money annually placed at its disposal under the Local Taxation (Customs and Excise) Act of 1890 a sum not exceeding 20,000*l.* per annum towards such part of the work described in Lord Rosebery's letter as fell within the statutory definition of technical education. Although the conditions are now entirely changed, there is no reason to suppose that the annual contribution of the Council to the college will be less than that suggested four years ago. The Board of Education will pay the fees for its selected scholars, and the fees payable by other students will amount to a considerable sum. It is expected that the resources of the Central Technical College will also be available. The total expenditure on this college for buildings, fittings, &c., has exceeded 130,000*l.*, and the current expenses of the college (about 15,000*l.* per annum) are met by the fees of students and a subvention from the City and Guilds of London Institute. The total value of the land, buildings, equipment, and capital available for the Imperial College (including the Central Technical College) will certainly exceed one million pounds.

The assets in the way of teaching staff and students also deserve mention. The teaching staff of the colleges includes such well-known men of science as Profs. Tilden, Callendar, Perry, Watts, Gowland, Cox, Ayrton, Armstrong, Dalby, and Henrici. At the Royal College of Science and the Royal School of Mines the total number of students is about 300; a high standard for entry is not at present demanded, and the proportion of students preparing for university degrees is comparatively small; but a large number of able students are entered at the college under the Board of Education system of national scholarships for science students. At the Central Technical College the number of regular students is about 375; the test for admission is approximately equivalent to London Matriculation, and a fairly large number of students are reading for London degrees as internal students of the University.

THE BUTTERFLIES OF INDIA.[1]

THE second volume of Colonel Bingham's important work on the butterflies of India includes the Papilionidæ and Pieridæ, and five out of the seven subfamilies into which the author divides the Lycænidæ "provisionally . . . on the structural characters of the imago or perfect insect." These subfamilies are Gerydinæ, Lycæninæ, Curetinæ, Liphyrinæ, Poritinæ, Theiclinæ, and Arhopalinæ, of which the last two stand over until the next volume. The tables and descriptions are very carefully drawn up, and the illustrations, both coloured and uncoloured, the latter often representing venation, legs, and other important structural characters, are worthy of high praise. Some of the text-figures of large species are reduced. The transformations, broods, habits, flight, scent, stridulation, &c., of various butterflies are also fully discussed, especially the curious relationships between Lycænidæ and their larvæ and ants and aphides. We notice, however, that references to the transformations of common European species have generally been omitted; we are not certain whether this is done to save space (for it might have been thought hardly necessary to repeat information to be found in every European book on butterflies) or because Indian records of the transformations of these particular species happen to be wanting.

[1] "The Fauna of British India, including Ceylon and Burma." Published under the Authority of the Secretary of State for India in Council. Edited by Lieut.-Colonel C. T. Bingham. Butterflies, vol. ii. By Lieut.-Colonel C. T. Bingham. Pp. viii+480; plates xi–xx. (London: Taylor and Francis, 1907.)

Notwithstanding the care with which the book is written, we notice an occasional oversight; for instance, the range of the genus Colias is incompletely given, as it is found in Lapland, South Africa, and other localities which would seem to be excluded by the wording of the paragraph. Perhaps the newest and most interesting observation in the book is that recorded by Colonel H. J. W. Barrow, R.A.M.C., who observed a Lycænide (*Allotinus horsfieldi*) "milking" an aphis in the same manner as if the butterfly had been an ant (p. 287, Fig. 73). The description of the tentacles of the larvæ of *Curetis bulis* (p. 445) is also quite original and very curious, as is also the long account of the carnivorous larva of the very anomalous *Liphyra*

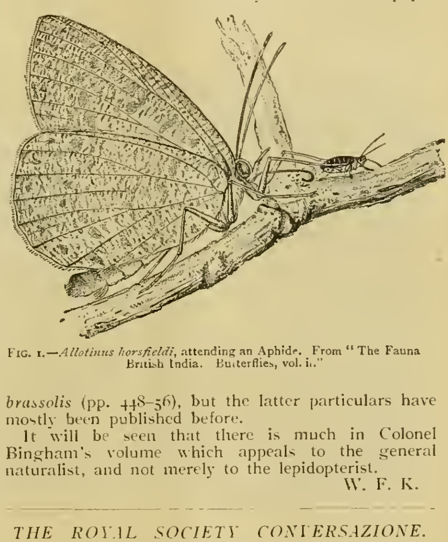


FIG. 1.—*Allotinus horsfieldi*, attending an Aphide. From "The Fauna British India. Butterflies, vol. ii."

brassolis (pp. 448–56), but the latter particulars have mostly been published before.

It will be seen that there is much in Colonel Bingham's volume which appeals to the general naturalist, and not merely to the lepidopterist.

W. F. K.

THE ROYAL SOCIETY CONVERSAZIONE.

THERE were numerous interesting exhibits at the Royal Society conversazione on May 8. The guests were received by the president, Lord Rayleigh, and included representatives of many departments of intellectual activity.

During the evening, demonstrations were given in the meeting-room of the Society by Mr. Louis Brennan, C.B., Dr. C. G. Seligmann, and Dr. Hele Shaw, F.R.S. Mr. Brennan explained the principle and action of his mono-railway by means of a working model. On his system each vehicle is provided with automatic stability mechanism which endows it with the power of maintaining its equilibrium upon a single rail laid upon the ground, either while standing still or travelling at any rate of speed, notwithstanding that the centre of gravity of the vehicle is above the rail, and that wind pressure, centrifugal force, or the movement of passengers or displacement of load may tend to upset it. This mechanism consists of two gyroscopes, revolving in opposite directions, and their precession, by being accelerated, produces a restoring couple at right angles to the rail. The same principle is applicable to motor-cars, flying-machines, and other structures.

Dr. C. G. Seligmann gave a kinematograph exhibition of native dances taken during the course of the Daniels ethnographical expedition to British New Guinea. The demonstration by Dr. Hele Shaw was on the subject of aërial gliding. During the last few years a large number of experiments have been made in connection with aëroplanes and machines for soaring and gliding. Dr. Shaw gave a brief account of the work of Lilienthal, the Wright Brothers, and others, and summarised the present state of our knowledge on the subject.

Two exhibits of particular interest were apparatus of pure iridium and rhodium and of fused silica by Messrs. Johnson, Matthey and Co., Ltd. This firm has succeeded in producing iridium and rhodium of such extreme purity as to render these hitherto practically unworkable metals so malleable as to enable their being used for the manufacture of such apparatus as basins, tubes, and flasks. These metals, having a very high melting point, and being almost unattacked by acids, should prove of great value in chemical research. The scientific work of which the process of manufacturing apparatus of fused silica is the outcome was carried out by two English men of science about ten years ago; unfortunately, as so often happens in these cases, its commercial importance was first recognised in Germany, and its production on an industrial scale commenced, little or nothing of a similar nature being attempted at home. Messrs. Johnson, Matthey and Co. have now taken up the original process, and by suitable modifications to meet industrial requirements are enabled to place this material upon the market at a price which can no longer be considered prohibitive. The apparatus is manufactured from the purest silica obtainable. At a high temperature this substance melts, and yields a viscid liquid which can by suitable means be fashioned into apparatus having all the appearance of ordinary glass, as is shown in the accompanying illustration. The apparatus possesses many properties which are likely to render it of great service both to science and to industry; *e.g.*, it can be made white hot and plunged into water, or otherwise rapidly cooled, without any danger of cracking; it is quite unattacked by water or acids, while ordinary glass under similar conditions is appreciably dissolved.

Transparent Silica Apparatus.

In the subjoined summary of the official catalogue of the exhibits, those on related subjects have, so far as possible, been grouped together.

Mr. H. R. A. Mallock, F.R.S.: Instrument for recording by photography rapid changes of pressure in the air, such, for example, as are caused by the wave produced by an explosion.—*The Director of the Meteorological Office:* Model of the neighbourhood of the winter quarters of the National Antarctic ship *Discovery*, 1902–4.—*Dr. W. J. S. Lockyer:* Cloud studies. The pictures exhibited represent some of the first results secured in attempting to photograph cloud forms during the past year. After some trials it was found that by the use of yellow screens (×10 for summer and ×5 for winter) and an ortho-process plate, sufficient contrast was obtained without undue length of exposure. No difficulty was experienced in photographing either heavy "cumulus" cloud or very elevated "cirrus."—*Solar Physics Observatory, South Kensington:* (1) Stellar spectrograms. (*a*) Bellatrix. (*b*) Rigel, (*c*) Sirius, (*d*) ε Ursæ Majoris, (*e*) Capella. (2) Spectroheliograms. Two series showing the development of the large spot of March (5–17), 1907. (3) Recent photographs of British stone circles, &c., in Cornwall.—*Commander Chetwynd, R.N.:* Improved liquid compass. In the compass exhibited the diameter of the card is considerably smaller than that of the bowl, the proportion being three-quarters, so that the edge of the card is substantially outside the influence of that ring of damping fluid which, on altering the ship's course (or whilst turning the compass bowl), adheres to and is drawn round by the inner surface of the bowl. The edge of the card being so far from the inner surface of the bowl on which the lubber's line is usually marked, a special lubber's mark or pointer is introduced projecting horizontally from the bowl on a level with the card. The extremity of this pointer, filed to a fine point and being in close proximity to the edge of the card, obviates all possibility of error of parallax in reading the course, without in any way causing a disturbance of the card.—*Mr. H. Cunynghame, C.B.:* A detached gravity escapement. The object of this escapement is to cause the impulse on the pendulum to be given by means of a light arm which falls by the action of gravity, and is hence independent of the force of the train, and to provide that the release of the train that winds up the arm is not derived from a blow by the pendulum, but of the arm itself.

Prof. W. E. Dalby: Working models, illustrating the balancing of a two-cylinder gas engine and a locomotive.—*Prof. A. G. Ashcroft:* Lecture table testing machine.—*Colonel R. E. Crompton, R.E.:* Crompton's measuring machine, combining accuracy with rapidity in working. With this measuring machine, which has been designed for observing length differences due to the heat treatment of specimens of steel, measurements of objects from 1 inch to 6 inches long, not differing among themselves more than a quarter of an inch, can be made and entered on the test sheet at the rate of one per minute. The accuracy obtainable is greater than 1 in 200,000.—*Mr. S. G. Brown:*

Relay working of long submarine telegraph cables. The apparatus consists of (1) an automatic transmitter, the movements of which are governed by means of a perforated tape, and originate the signals sent into an imitation cable; (2) a relay, receiving the signals at the other end of the line, and actuating an automatic perforator by which a duplicate of the originating type is reproduced at the relay station for re-transmission on another cable.—*Sir James Dewar, F.R.S.:* The Crookes radiometer—motion arrested in very high vacua, &c. (1) Experiments showing the cessation of radiometer action in very high vacua, made by charcoal cooled in liquid hydrogen or liquid air, even when the instrument is subjected to the concentrated radiation of an electric lamp. (2) Radiometer filled with helium at atmospheric pressure, which is inactive to a charcoal liquid-air vacuum, but becomes active in a charcoal liquid-hydrogen vacuum.—*Mr. W. Duddell, F.R.S.:* Persistent electric oscillations. The oscillations are produced by the method of the "musical arc." In this method a direct-current arc is shunted with a circuit consisting of a condenser and a self-induction in series. The frequency of the oscillations can be varied by altering either the capacity or the self-induction in the shunt circuit. The oscillograph records exhibited show the variations in the potential difference and current when the oscillations are produced. To obtain powerful oscillations at very high frequencies, the arc may be placed in hydrogen gas as employed by Paulsen. In the apparatus shown the arc burns in coal gas, and *no magnetic field* is used to blow out the arc. Experiments in magnetic induction, tuning, and discharge *in vacuo* are easily demonstrated with persistent high-frequency oscillations. The persistent oscillations are of special use for energising the transmitter in wireless telegraphy, as they permit better syntony or tuning to be obtained.—*Mr. W. A. Douglas Rudge:* The action of radium and other salts on gelatin culture medium. Radium, barium, strontium, and lead salts, when placed in contact with gelatin culture medium, give rise to a kind of cellular growth, which is due to the formation of an insoluble precipitate with the sulphuric acid usually present. Radium salt added to the medium from which the sulphuric acid has been removed causes no growth, but the addition of a soluble sulphate produces a growth at once. Analyses of the growths obtained with radium salts show that they are composed of barium sulphate.

Messrs. R. and J. Beck, Ltd.: (1) New diffraction wave-length spectroscope. This instrument comprises a Thorpe replica diffraction grating with a collimator and slit. The observing telescope swings on an axis which passes through the grating, parallel with the lines. The motion is by means of a micrometer screw which reads the sine of angle of rotation direct, thus giving on its divided milled head the wave-length in A.U. (2) The "isostigmar" photographic lens on optical testing bench.—*Mr. A. Kershaw:* A new visual method of measuring the speeds of photographic shutters.—*Mr. Ulrich Behn:* (1) The flame tube. A simple apparatus capable of indicating very small changes of air-pressure. It consists of a short metal tube with wide outlets, at which, after the tube is connected with the gas main, the gas is lighted. It shows, if one end is raised a few millimetres, the decrease of atmospheric pressure with height by the changes in size of the flames. The tube is capable of various applications. (2) Demonstration of the theory of microscopic images. (3) An indirect method of measuring the temperature of liquid-air baths. (4) A short glycerine barometer. This consists of an air thermometer of the old Italian type, the bulb of which is kept at zero by means of ice in a Dewar vessel.—*Dr. J. T. Bottomley, F.R.S., and Mr. F. A. King:* Experiments with vacuum gold-leaf electroscopes on the mechanical temperature effects in rarefied gases. The apparatus consists of a "radium clock" and various types of vacuum electroscopes. The vacuum electroscopes are set up to show the effects of radiations from sources of heat and light upon gold leaves hanging within highly exhausted enclosures. The gold leaves of the vacuum electroscope diverge when illumination of any kind falls upon them, and stand permanently apart when placed in bright daylight. By suitably manipulating such sources as a spirit flame, candle, or Nernst lamp near the electroscope, forces, which vary in direction and magnitude from point to point within the enclosure, are generated, and cause the leaves to be twisted into curious shapes. The gold leaves will remain in this contorted condition for a considerable time after the exciting cause has been removed.—*Dr. J. R. Milne:* A special camera for the purpose of automatically recording the readings of the scale of any instrument.—*Messrs. Pilkington and Gibbs, Ltd.:* A heliochronometer which gives Greenwich mean time by a simple direct solar observation. It comprises devices for adjustment in latitude, longitude, level, and azimuth, and is self-correcting for the equation of time.

The Cambridge Scientific Instrument Co.: (1) Prof. Féry's self-contained radiation pyrometer. The pyrometer utilises the heating effect of the "total radiation" from a hot body, focussed as an image of that body by means of a concave mirror. It differs from the already known Féry radiation pyrometer in being entirely self-contained, the image falling upon a minute bi-metallic flat spiral (Breguet spiral). This becomes partially uncoiled as its temperature rises, and a light pointer attached moves over a dial divided to give direct (centigrade) temperature readings. (2) Universal portable electrometer, designed by Mr. C. T. R. Wilson, F.R.S. A gold-leaf instrument with very small capacity and fused quartz insulation, suitable for work on atmospheric electricity, radio-activity, &c., and self-contained, with means for standardising the readings, which are very steady even in a fairly high wind.—*Mr. Joseph Goold:* Vibration experiments with steel plates and six bars tuned accurately to 400, 500, 504, 600, 700, and 800 vibrations per second.—*Dr. Otto Schlick, and Messrs. Swan, Hunter, and Wigham Richardson, Ltd.:* Working models illustrating the action of the Schlick gyroscope in steadying ships at sea (see NATURE, April 11, p. 561).—*Dr. Robert Knox and Mr. G. Pearce:* Skiagraphy of the human subject; examples illustrating the advantages of reduction in exposure. The instruments employed to produce skiagraphs, with exposures varying from one to seven seconds, consist of a powerful induction coil yielding a greatly intensified secondary current, worked in conjunction with an electrolytic interrupter directly from high-tension electric light mains. The core of the coil consists of transformer plates. The primary is of a much larger wire than usual, and has more turns. The secondary is smaller than usual. The X-ray tube is provided with a heavy anode to withstand the current. In series with the X-ray tube, a rectifier is placed to render the current unidirectional.

The Thermal Syndicate, Ltd., Wallsend-on-Tyne: Pure fused silica ware. The articles consist of pure silica, and are manufactured by an electric furnace process at a temperature of about 2000° C. The material is highly refractory, and possesses a very low coefficient of expansion (about 1/17th of that of glass), and in consequence it is able to resist sudden and extreme changes of temperature without cracking. It is unaffected by practically all acids, is an excellent electric insulator, and retains its insulating properties even at high temperatures. The specimens show that it is possible to produce a brilliant lustre on the surface of the material.—*Dr. F. D. Chattaway, F.R.S.:* Copper mirrors deposited upon glass from aqueous solution. In the mirrors exhibited, the copper had been deposited upon the glass by reducing cupric oxide by an aqueous solution of phenylhydrazine in presence of potassium hydroxide, which accelerates the action to a remarkable extent. The mirrors are equal in brilliancy and uniformity of surface to silver mirrors, and on account of the colour of the copper are much more beautiful.—*Hon. C. A. Parsons, F.R.S.:* Photographs of microscopic diamonds obtained from pure iron heated in a carbon crucible in an electric furnace and rapidly cooled. Scale, 150 diameters.—*Prof. J. Perry, F.R.S.:* British Association Album, meeting in South Africa, 1905. Two copies of an album prepared by Mr. Eustace Calland from photographs selected from those taken by members of the British Association.

Marine Biological Association of the United Kingdom: Marine algæ and their reproduction. A small representative collection of sea-weeds from the Plymouth district exhibited to illustrate their different habits of growth and reproduction.—*Prof. E. Ray Lankester, F.R.S.:* (1) Metamorphosis of the eel. Series of specimens showing the transformation from the marine larva or Leptocephalus of the common eel into the fresh-water "elver" and young eel. Also a series showing the metamorphosis of the conger eel. (2) Specimens of Cephalodiscus. Specimens of *Cephalodiscus nigrescens* and *Cephalodiscus hodgsoni* obtained by the *Discovery* in the Antarctic Ocean, and *Cephalodiscus gilchristi* obtained by Dr. Gilchrist in the Cape Seas. Also the original Cephalodiscus (*Cephalodiscus dodecalophus*) obtained by the *Challenger* in the Straits of Magellan in 1876, for comparison with the above newly discovered species. (3) Coloured cast of the tile-fish. The tile-fish was first discovered in 1879 in about 100 fathoms in the North Atlantic, and was expected to become a regular marketable fish. In 1882 a vast destruction of the tile-fish took place, owing, it is supposed, to a chilling of the part of the sea which it inhabited, and millions of the dead fish were found floating on the surface of the ocean. It was feared that the fish had become extinct, but since 1892 specimens have been caught in fair numbers. This cast was prepared and coloured by the authorities of the National Museum at Washington. (4) Specimen of the okapi. The specimen is an immature male, obtained by Major Powell Cotton in the Ituri Forest, Congo State. The bony horns have not yet penetrated the skin as they do in adult animals. Special interest attaches to this individual, in that Major Powell Cotton was able to examine the recently killed body and determine the sex. The specimen has been presented by Major Powell Cotton to the Natural History Museum, which already possesses the complete skeleton of the same individual.

Dr. F. A. Dixey: Seasonal dimorphism in butterflies. It has recently been established, partly by observation, but mainly by the experiments of Mr. G. A. K. Marshall, that in many tropical and subtropical species of butterflies which produce two or more broods in the course of the year, the broods differ in appearance according to the season at which they emerge. In several of these cases the difference is so extreme that the seasonal phases of the same insect have received different specific names, and have even been considered to be widely separated from each other in the systematic series. In some instances it has been found possible to transform one seasonal phase into the other by artificial means. Similar phenomena have long been recognised in certain European Lepidoptera (butterflies and moths), but it is only lately that experimental proof has been obtained in the case of tropical forms such as those exhibited.—*Prof. E. B. Poulton, F.R.S.:* The female forms of the African *Papilio dardanus*, the most remarkable example of mimicry hitherto discovered. Mr. Roland Trimen, F.R.S., first showed (in 1870) that these diverse forms were the females of a single species with a non-mimetic male. His evidence was not confirmed by the final test of breeding until 1902, when Mr. G. F. Leigh, of Durban, bred a single family containing males and two of the female forms. After other partial successes Mr. Leigh succeeded, in the autumn of 1906, in breeding the single family exhibited. It was bred from a female of the second form, and contains fourteen males, and examples of all the female forms known in South-East Africa: eight of the first, three of the second, and three of the third.—*Colonel Bingham:* Pupa of *Binsitta barrowi*, Bingham, with photograph of moth and pupa, and a coloured drawing of the head of a tree-snake (*Lycodon aulicus*, Linn.). *Binsitta barrowi*, Bingh., is a rare moth belonging to the family Tineidæ, lately discovered by Colonel Waller-Barrow at Maymyo, a hill station near Mandalay, Upper Burma. Colonel Barrow found the moth just issuing from the chrysalis, and noticed at once the curious resemblance of the latter to the head of a snake. When the chrysalis is looked at from in front, the likeness to the head of *Lycadon aulicus*, Linn., a bird-eating snake, is at once perceived.—*Mr. Fred Enock:* Ovivorous parasitic Hymenoptera (Mymaridæ).—*Prof. Charles Stewart, F.R.S.:* Selected specimens from the Museum of the Royal College of Surgeons, England.—*Mr. H. St. J. Donisthorpe:* The inhabitants of British ants' nests.—*Mr. W. Woodland:* Microscopic preparations illustrating the development of the plate-and-anchor spicules from the soft tissues of *Synapta inhaerens* and *S. digitata*.—*Mr. H. B. Fantham:* Microscopic preparations of *Spirochaeta* (*Trypanosoma*) *balbianii* from the crystalline style and intestine of the oyster.—*Prof. A. Dendy:* (1) The "pineal eye" in the New Zealand lamprey (Geotria) and in the tuatara (Sphenodon). (2) Reissner's fibre in the brain and spinal cord of Geotria.—*Mr. R. I. Pocock:* Example of the skins of English domestic cats. English domestic cats, whatever their colour may be, and whether they belong to "Manx," "Persian," or "ordinary" breeds, are shown by their pattern of stripes to be referable to two distinct kinds, known as the "striped" and "blotched" tabbies. The striped tabby appears to be the scarcely modified descendant of the European and North African wild cats. The origin of the blotched tabby is unknown.

Mr. R. H. Biffen: Hybrids of wheat and barley.—*Prof. W. B. Bottomley:* Fixation of nitrogen by leguminous and other plants.—*The Director, Royal Botanic Gardens, Kew:* (1) *Welwitschia mirabilis*, Hook. f. (Gnetaceæ), south-west tropical Africa. (2) *Acanthosicyos horrida*, Welw. (Cucurbitaceæ), western tropical Africa. (3) Labrador lichens. A striking feature of the Labrador lichens is their similarity to those of northern Europe. *Platysma nivale*, *Cetraria islandica*, *Bryopogon jubatum*, and species of Stereocaulon so abundant in Norway and Sweden, flourish equally well in Labrador, whilst, just as in Lapland, *Cladonia rangiferina*, the "reindeer moss," covers vast areas. (4) Figures of remarkable new or rare plants (exhibited by Mr. W. Botting Hemsley, F.R.S.). (5) Figures of African terrestrial Utriculariæ (exhibited by Dr. Otto Stapf).

Prof. John Milne, F.R.S.: Records of recent large earthquakes. (1) Jamaica earthquake; (2) San Francisco earthquake; (3) the so-called Valparaiso seismogram (see NATURE, February 21, p. 403).—*Rev. R. Ashington Bullen:* Cable broken by the Jamaica earthquake of January 14, 1907. The cable had remained intact for twenty years. It rested on a muddy bottom in a depth of 700 fathoms, about seventeen miles south of Kingston. The probability is that here it crossed the line of a geological fault.—*The Director of the Imperial Institute:* (1) Igneous and metamorphic rocks of northern Nigeria. Typical specimens collected during the course of the mineral survey of northern Nigeria now in progress in connection with the Imperial Institute. (2) Tinstone from Bauchi, northern Nigeria, and tin smelted from it. (3) New or exceptional minerals from Ceylon. (4) New vegetable products of hitherto unknown composition.—*Mr. C. Carus-Wilson:* (1) Crystallised granite. A remarkably fine mass of Cornish granite in which the mineral constituents had crystallised out around the walls of a large cavity. (2) Musical flint nodule from the chalk near Faversham. The specimen is 21 inches long, and emits a loud metallic ring when struck at the thin end.

Mr. F. J. Lewis: The succession of plant remains in British peat mosses. All the Scottish and north of England peat mosses show a definite succession of plant remains. Detailed investigations have been carried on in twenty-four districts, from Westmorland to the Shetland Islands, and the geographical distribution of the successive strata ascertained. The evidence so far shows that two distinct arctic beds and two distinct forest beds occur in the peat, and these features are so regular and spread over so wide an area that the alternation must be due to climatic changes during early post-Glacial times.—*Mr. H. F. Standing:* Recently discovered sub-fossil Primates from Madagascar. The chief interest of these relates to the light which they throw on the origin of the extant Malagasy lemurs. They show these latter to be descended from ape-like ancestors, and that many of their so-called "lemuroid" characters have been secondarily acquired. Some of the recently discovered species are of gigantic size, showing evidence of various retrogressive changes, notably in the frontal region of the brain. One of these gigantic extinct Prosimiæ (Palæopropithecus) was probably aquatic. Its brain indicates certain affinities with the aye-aye, that curious aberrant rodent-like "lemur" from the Malagasy forests.—*The Director, British Museum (Natural History):* Mandible of Tetrabelodon from the Loup Fork formation (Lower Pliocene), Nebraska, U.S.A. This specimen shows that the primitive mastodons, with a long chin and lower tusks, reached North America before their final extinction.

(Exhibited by the Keeper of Geology.)—*Prof. H. G. Seeley, F.R.S.:* Skull of a South African saurischian (*Erythrosuchus africanus*). The remains were collected by Dr. R. Kannemeyer in 1897. They were displaced, and in unusual confusion. The matrix has been entirely removed by Mr. Richard Hall, of the British Museum, but portions are missing, so that the skull has not been reconstructed as yet. The whole skeleton indicates a new division of this order of animals.

Mr. W. Dale: A cordoned bucket or cist of bronze, "Halstatt" type, early Iron age of Europe, late Bronze age of Britain, *circa* 700 B.C., found at Weybridge, Surrey, April, 1907, at a depth of 10 feet, in sinking a shaft for the pier of a bridge close to the river at the new motor track. The bucket is of north Italian manufacture, and is similar to specimens found at Halstatt and in other parts of Europe as far as Hanover, but never before in Britain. It has quite recently been proved that some brooches, in museums and private hands, found in England, must have come from north Italy in the early Iron age of Europe. On the strength of this, it has been asserted that there was commerce between Europe and Britain as early as 700 B.C., and the theory is confirmed in a remarkable way by the discovery of this bucket. The British Museum Catalogue figures a Halstatt bucket (Fig. 30, "Guide to Early Iron Age") exactly similar. The workmanship of the handles is the same as that of the ancient torques.—*Mr. Rowland G. Hazard:* Arrow heads and spear points from North America, Egypt, and Japan.—*Sir Benjamin Stone, M.P.:* History pictures of Egypt. These views are a selection from the series of photographs taken by Sir Benjamin Stone during the recent winter season. The series of about 800 views shows the aspect of Egypt and the Soudan at the present time.

NOTES.

WE regret to learn that Dr. Alexander Buchan, F.R.S., the distinguished meteorologist, died on Monday, May 13, at seventy-eight years of age.

AT the Chemical Society on Thursday, June 13, Prof. J. B. Farmer, F.R.S., will deliver a discourse entitled "Some Borderline Problems in Botany."

M. LE CHATELIER has been elected a member of the Paris Academy of Scences in succession to the late Prof. Moissan.

THERE will be a reception at the Linnean Society on June 7 in celebration of the 200th anniversary of the birth of Linnæus. The principal exhibits will be of objects associated with or belonging to Linnæus, such as letters, manuscripts, and objects of natural history.

PROF. E. RAY LANKESTER has left for the Continent with the view of studying the specimens of the okapi in the museum of the Congo Free State at Tervueren, near Brussels, and in other collections.

DR. J. HALM, assistant at the Royal Observatory, Edinburgh, has been appointed first assistant at the Cape Observatory, in succession to Mr. S. S. Hough, F.R.S., who was recently promoted to succeed Sir David Gill as H.M. Astronomer at the Cape.

THE fifteenth "James Forrest" lecture of the Institution of Civil Engineers will be delivered by Dr. Francis Elgar, F.R.S., on the evening of Tuesday, June 18, his subject being "Unsolved Problems in the Design and Propulsion of Ships." The fourth engineering conference will be held on June 19–21, commencing each day at 10 a.m., and the annual conversazione on the evening of June 20 at the Royal Albert Hall.

WE are informed that Prof. H. F. Osborn has returned to New York from Egypt, where he accompanied and superintended an expedition to search for remains of the fossil vertebrates of the Fayum for the museum he represents. He took with him a staff of trained collectors, who have been left in Egypt for some time longer to continue the work of collecting. As the result of such expert collecting, a number of remains of the smaller mammals have, we believe, been obtained, which should prove of great interest.

AN interesting undertaking is that of a party now at Seattle on the way to study seismic and volcanic conditions in the Aleutian Islands. One of the fifty-nine volcanoes in these islands was reported active last March. The expedition is headed by Prof. T. A. Jaggar, of the Massachusetts Institute of Technology, and includes Prof. H. V. Gommere, of the University of California, and Dr. Van Dyke, of San Francisco.

ON May 11 the Lowell Astronomical Expedition to the Andes sailed from New York. Its main object will be the observation of Mars in July. The site for the observations will be selected next month, probably either in the high Andes of Peru or in the desert regions of northern Chili. The work is in charge of Prof. David Todd, director of the Amherst College Observatory, Mass., who will be accompanied by Mrs. Todd. Mr. E. C. Slipher, also of Amherst, will be responsible for the photographic side of the expedition, and Mr. Albert G. Ilse, of the firm of Alvan Clark and Sons, of Cambridge, Mass., will be chief mechanician and instrument maker. The appointments of the *personnel* of the expedition have been made by Prof. Percival Lowell, who is himself working at present at Flagstaff, Arizona.

THE Cardiff public telescope and observatory are proving a decided success. During the last few weeks, in response to an appeal from Mr. Albert Taylor, a large number of teachers in the locality have applied for permission to use the instrument. The attendance of the general public also has been such as quite to warrant the corporation in the expense to which it went in connection with the observatory.

ON Thursday next, May 23, Sir James Dewar will commence a course of three lectures at the Royal Institution on "Chemical Progress—Work of Berthelot, Mendeléeff, and Moissan." The Friday evening discourse on May 24 will be delivered by Prof. J. A. Fleming, on "Recent Contributions to Electric Wave Telegraphy," and on May 31 by Mr. A. H. Savage Landor, on "Recent Journey Across Africa."

THE Gypsy Lore Society, which was first formed in 1888, and has lain dormant since 1892, is to be revived under the presidency of Mr. David MacRitchie. On July 1 next it is proposed to issue the first number of a new series of the society's quarterly journal, the publication of which ceased with the termination of the activities of the association in 1892. The society aims at enrolling every amateur of gypsy philology, folk-lore, and ethnology, and every student of Sanskrit and Indian languages. The society will be conducted on a purely honorary basis—neither writers nor officers being paid. Interested persons should communicate with the hon. sec., Mr. R. A. Scott Macfie, 6 Hope Place, Liverpool.

THE annual report of the Ray Society, read at the annual general meeting on May 9, stated (*inter alia*) that part iii. of the "British Annelids," by Prof. W. C. McIntosh, F.R.S., is now in the press, and will be issued for the present year, and that there is a sufficient number of monographs waiting their turn for two volumes per annum to be issued for several successive years if the funds of the society will permit. The officers and council for the ensuing year were elected, Lord Avebury being re-elected president; Dr. F. DuCane Godman, F.R.S., treasurer; and Mr. John Hopkinson, secretary. The new members of the council elected were Sir Charles Eliot, K.C.M.G., and Mr. C. D. Soar.

Mr. G. R. Dunell, whose death on Sunday last, at fifty-nine years of age, we regret to have to record, was the author of many articles and reports on engineering subjects in the columns of Nature. For the past twenty-five years or so, Mr. Dunell's life was devoted almost entirely to literary work connected with engineering and industry; and his wide knowledge and lucid style gave his articles a distinctive character unusual in technical description. Formerly he was a frequent contributor of articles to the *Times*, but in recent years most of his work was done for *Engineering*. His last contribution to our columns appeared on April 11, and dealt with the gyroscopic apparatus for steadying ships described at the recent meeting of the Institution of Naval Architects. Mr. Dunell was a familiar figure in the engineering world, and his death will be sincerely deplored by all who knew him.

The Catania Observatory states that at 7.40 p.m. on May 10 Stromboli burst into violent eruption, throwing masses of stone, ashes, and lava towards the eastern portion of the island, which is inhabited, and causing fires in several vineyards. The eruption was preceded by loud rumblings. Mount Etna is also in a state of activity. Large columns of thick vapour have issued from the cone of the volcano and spread over the surrounding country. On the evening of May 10 slight earthquake shocks were reported at Belpasso, Nicolosi, and Viagrande.

A special meeting of the proprietors of the London Institution, Finsbury Circus, was held on May 8 to consider a proposed scheme of re-building, having for its objects "such an increase of revenue as would enable the committee to carry out the objects of the charter on a wider basis than at present, and at the same time to give improved accommodation to the proprietors." The scheme provides for the removal of the present lecture theatre and smoking room, thus rendering vacant 10,612 superficial feet of land, to be let on a building lease for eighty or ninety years. The alterations would include a new theatre, a storage room for 200,000 volumes, refreshment and other rooms, and the dividing of the present reference library into a reading room, small lecture room, and a committee room. The cost is estimated to be about 15,600*l*. Strong criticism of the scheme led to the adjournment of the meeting for four weeks.

The ninetieth annual meeting of the Société Helvétique des Sciences Naturelles will be held at Fribourg on July 28–31. The first day will be devoted to preliminary matters and to a social gathering of visitors. The inaugural address will be delivered on July 29 by Prof. Musy, and afterwards Prof. Mühlberg will lecture on the subject of the supposed condition of Switzerland and neighbouring regions during the five Ice ages, interglacial periods, and the return of the last glaciation. Dr. John Briquet and Prof. Zchokke will speak on the post-Glacial immigration respectively of flora and fauna into Switzerland. The subject of the utility of an international atlas of erosion will be discussed by Prof. E. Chaix, and a lecture will be delivered by Prof. Jean Brunhes on glacial action. The following day will be devoted to sectional meetings, and a joint meeting of the geological, botanical, and zoological sections. The centenary of Agassiz will be celebrated on the concluding day, when discourses will be delivered by Profs. de Girard and Th. Studer. The Swiss Geological, Botanical, Zoological, and Chemical Societies, and the Physical Society of Zurich, will hold their annual meetings at Fribourg on the same days.

The twelfth annual congress of the South-Eastern Union of Scientific Societies will be held at Woolwich on June 12–15 under the presidency of Prof. Silvanus P. Thompson, F.R.S. The following papers will be read:—Goethe as a naturalist, Dr. Treutler; geology of Woolwich and district, W. Whitaker, F.R.S.; an experiment in cooperative field-work in botany, Prof. Oliver; the antiquity of *E. caballus* in Europe, with special reference to remains found in Kent, W. H. Griffin; xerophytes, Mrs. W. Plomer Young; concretionary types, forces, and evolution, G. Abbott; the storage and use of rain-water for domestic purposes, G. F. Chambers; how to make our local societies more efficient, H. Norman Gray; and local archæology, W. T. Vincent. Excursions, weather permitting, are planned to Well Hall, Eltham Palace, and Avery Park; Charlton Camp and Pits and Greenwich Park; the Royal Arsenal, R.A. Institution and Rotunda; Lessness Abbey, and Crayford Pits. There will be a reception by the Mayor (Alderman Squires, J.P.) and a congress museum. These meetings, &c., are open to members and associates of the South-Eastern Union. Mr. B. C. Polkinghorne, Woolwich Polytechnic, is the local secretary, and the hon. general secretary is the Rev. R. Ashington Bullen, Englemoor, Woking, from either of whom programmes and tickets can be obtained.

Madreporian corals from the coast of French Somaliland form the subject of a paper by Mr. T. W. Vaughan published as No. 1526 of the Proceedings of the U.S. Nat. Museum (pp. 249–266). As the collection was obtained just outside the mouth of the Red Sea, it is of special interest for comparison with the coral-fauna of that sea on the one hand, and of the East African coast on the other.

"Convergence" in animals is illustrated in an article contributed by Dr. O. Rabes, of Magdeburg, to the April number of *Himmel und Erde*. An interesting figure of a rorqual-embryo with teeth is reproduced from a paper by Dr. W. Kükenthal. Among the other illustrations, exception may be taken to one which revives the myth of the flying frog, and to a second in which the Ganges dolphin is represented with a relatively huge eye.

A revision of the genus Spilanthes, prepared by Mr. A. H. Moore, is printed as vol. xlii., No. 20, of the Proceedings of the American Academy of Arts and Sciences. The genus belonging to the order Compositæ is chiefly distributed over the American continent, but also occurs in the tropical regions of the old world. The author identifies about forty species, of which twelve are new to science.

According to a paper by Mr. J. Henderson, of which the first portion appears in vol. iv., No. 2, of the University of Colorado Studies, the land and fresh-water molluscs of Colorado have been greatly neglected by naturalists. Although the land-snails are for the most part small, water-snails and pond-mussels abound in almost every stream and piece of water, even at high elevations.

A paper by Dr. S. A. Forbes on the local distribution of certain Illinois fishes, forming article eight of vol. vii. of the Bulletin of the Illinois State Laboratory of Natural History at Urbana, is noteworthy on account of the seven exquisitely coloured plates of so-called "darters" (Etheostominæ) with which it is illustrated. In article nine of the same serial Dr. Forbes discusses from a similar point of view (that is to say, the relations of interaction between organisms and their animate and inanimate surroundings) the results of an ornithological traverse of Illinois in autumn. The predominance of European (we fail to see why they should be specially referred to as English) sparrows in certain districts and situations is very noteworthy.

The series of "ichnites" in the geological department of the British Museum (Natural History) has just been enriched by the addition of two large slabs of Triassic sandstone from Storeton, Cheshire, displaying labyrinthodont and reptilian foot-prints. Some remarkably well-preserved casts of the foot-prints of "Chirotherium," together with other much smaller ones referred to the reptile Rhynchosaurus, and likewise others of an unknown reptile, are displayed. Both slabs are the gift of the owners of the Storeton quarries. Important additions have likewise been made to the series of exhibits illustrating the development of eels and the nature of the food of well-known food-fishes. In one jar are displayed a number of specimens from the Gulf of Messina, presented by Prof. Grassi, showing various stages in the development of the larvæ of the conger-eel and their final evolution into young congers, while alongside are shown a mass of elvers recently taken in the Severn, and a few young eels from the Thames. The fishes of which the food is illustrated are the plaice, the turbot, and the sole, the exhibits being specially instructive on account of the remarkable difference existing between the nutriment of the turbot on the one hand and that of the plaice and sole on the other. The turbot, for instance, seems to subsist entirely on other fishes, including immature clupeoids and flat-fish and sand-lance. Excepting that young sand-lance are eaten by the first and very small dabs by the second, plaice and soles, on the contrary, subsist on an invertebrate diet, including lug-worms, echinoderms, crustaceans, and tellinas and other small bivalves.

Considerable interest attaches to a paper, by Mr F. W. True, just issued as No. 1694 of the quarto series of Publications of the Smithsonian Institution, on an imperfect cetacean skull obtained in 1847 from the Eocene Marl of the Ashley River, near Charlestown, South Carolina. In the same year appeared a brief account of it, with plates, by Mr. M. Tuomey, who referred it to Zeuglodon, and two years later it was named *Z. pygmaeus* by Prof. J. Müller, of Berlin. Soon afterwards the specimen came under the notice of Prof. L. Agassiz, who caused a lithographed plate to be prepared, with the lettering *Phocodon holmesi*, Agass. For some reason this plate was never issued, and in 1895 Prof. E. D. Cope referred the specimen to a new genus, under the name of *Agorophius pygmaeus*. Despite the fact that the specimen, when figured in the plate made for Agassiz, had a single Squalodon-like tooth remaining in the maxilla, a suggestion was made that the species might be an ancestral form of rorqual. Were this confirmed, it would have been a matter of much importance, and Mr. True has therefore been well advised in publishing the original plate. In his opinion, Agorophius is a squalodont, although differing in cranial characters from Squalodon itself. The European so-called *Squalodon ehrlichii* of Van Beneden has, however, a broad rostrum recalling the Carolina genus, and it may be that this imperfectly known form is a connecting link between Squalodon proper and Agorophius.

Several matters referred to in the report for 1905 of Mr. M. Kelway-Bamber, a Government chemist at the Royal Botanic Gardens, Ceylon, published as vol. iii., No. 24, of the Circulars and Agricultural Journal, are of scientific as well as practical interest. The problem of establishing a connection between the mineral ingredients of the tea plant and the quality and strength of the tea is under investigation, with a prospect of obtaining definite results. From a study of the methods of preparing Oolong tea in Formosa, it is concluded that the quality and characteristics are due to an aroma produced by faint oxidation in drying and a slight scorching during roasting of the leaf, as well as to the mild decomposition caused by a fungus, and it is suggested that the fungus acting on the legumin in the leaf produces flavouring bodies similar to the action of moulds in cheese. The report also contains hints on the distillation of camphor and citronella oil.

An article in the *West Indian Bulletin*, vol. vii., No. 4, deals with the manufacture of citrate of lime, as an article for export to take the place of concentrated lime juice. The project was brought to the notice of planters in the West Indies by Dr. F. Watts, who has published information on the production of citrate of lime in Sicily, and given public demonstrations on the process of manufacture. The commercial outcome is seen in the shipments first made from Dominica in 1906, and also from Montserrat. In the same number Mr. W. R. Buttenshaw compiles some facts on the distribution of plants from the various botanic stations in the West Indies to indicate the valuable service rendered in this connection. Incidentally he refers to the popular practice of observing Arbor Day, and mentions that palms, principally the cabbage palm, *Oreodoxa oleracea*, and the royal palm, *Oreodoxa regia*, are commonly chosen for planting, often, too, the mahogany or the white wood, *Bucida Buceras*.

The principal article in the last issue (No. 4) of the Kew Bulletin, contributed by Mr. J. S. Gamble, treats of the gutta-percha trees in the Malay Peninsula. After reviewing the species belonging to eight genera of the Sapotaceæ found in Malaya, the author concludes that the only important tree is *Palaquium Gutta*, known as "Taban Merah," with its variety oblongifolium, "Taban Sutra"; three other species, *Palaquium Oxleyanum, Palaquium obovatum*, and *Payena Leerii*, afford a second-rate gutta, and cultivation is being restricted to these four species. The lists of new plants from the herbarium comprise a decade of orchids, mostly from Asia, determined by Mr. A. N. Rolfe, and exotic fungi from India and elsewhere, identified by Mr. G. Massee. Supplementing the information given in the first two numbers of the Bulletin for this year, Mr. T. A. Sprague confirms the distinction between Dubouzetia and Tricuspidaria, and offers a revision of the former genus.

The second part of the nineteenth volume of the Proceedings of the Royal Society of Victoria contains some interesting papers on the biology and geology of Australia. It begins with the eighth of Mr. Frederick Chapman's valuable "Additions to the Palæontology of Victoria"; in this number he describes some interesting new Silurian ophiurids. He also describes a new Cypridina from Hobson's Bay. Mr. J. A. Leach directs attention to the value of surface tension in the formation of canyons, a factor hitherto neglected. There is also a contribution to the flora of Australia, describing new or little-known plants, by Prof. A. J. Ewart, who holds the double appointment of the new chair of botany at Melbourne University and botanist to the Government of Victoria.

In the Records of the Geological Survey of India (vol. xxxiv., part iv.) Mr. R. R. Simpson describes the Jaipur and Nazira coalfields, Upper Assam. The measures are of Middle Tertiary age, and the coals closely resemble in appearance those from the Makum area, but they are somewhat inferior in quality. They burn readily, with considerable flame and great heat. The amount of workable coal exceeds 20 million tons in the Jaipur field and 35 million tons in the Nazira field. The Dikhu River area is the most suitable for the establishment of a colliery. The accompanying view on the Dikhu River, with the Bor Jan landslip in the background, shows the nature of the ground, which is covered by virgin forest with a dense thorny undergrowth presenting the maximum of difficulty to penetration. The difficulties of transport could probably be overcome by means of an aërial wire-rope tramway. Mr. Simpson also has a note on the Makum coalfield between the Tirap and Namdang streams. Other papers in the same issue are on the Kabat anticline near Seiktein, Upper Burma; on the asymmetry of the Yenangyat-Singu anticline, Upper Burma; and on the northern part of the Gwegyo anticline, Upper Burma, by Mr. E. H. Pascoe; and on *Breynia multituberculata*, an undescribed species from the Nari of Baluchistan and Sind, by Mr. E. Vredenburg.

Photo. [*R. R. Simpson.*

View on Dikhu River; the Bor Jan landslip in the background.

Dr. Eredia, assistant in the Meteorological Office at Rome, has undertaken a laborious and useful work in discussing the frequency of wind direction in various parts of Italy from the observations contained in the Annals of that office. Part i. refers to the winds of Piedmont, and deals with monthly and seasonal values for various stations. Speaking very generally, winds from the south-west quadrant predominate in winter, while in summer they are south-westerly in Upper, and north-easterly and south-easterly in Lower Piedmont; in spring and autumn no very marked predominance is exhibited.

In the Bulletin of the Moscow Imperial Society of Naturalists, Nos. 1 and 2, 1906, Dr. E. Leyst completes his valuable series of statistical investigations of optical phenomena. The results deduced from observations at seventy stations, and including in the aggregate 1308 years, show that the phenomena have a yearly and secular range, and that solar coronæ are observed about five times less frequently than lunar coronæ; the maximum of the yearly range occurs in spring, and the minimum about July. The coronæ are seen more frequently inland than near the sea coast.

At the request of the seventh International Geographical Congress, the Danish Meteorological Institute has for some years past published in its year-book of nautical meteorology valuable details, accompanied by monthly maps (April–August), of the state of the ice, compiled from logs of ships and other sources. The summary for 1906 shows that, as the winter 1905–6 was comparatively mild over Spitsbergen, Barents Sea, and the Kara Sea, and severe over Greenland and parts of Arctic America, the conditions of the ice were consequently favourable in the former region and unfavourable in the latter; in Barents Sea the conditions were especially favourable, while in the Greenland Sea the ice-belt was broader, and off Labrador drift-ice was more frequent, than usual. All things considered, it is expected that the conditions in 1907 will be rather favourable along the coasts of Greenland, and less so around Labrador and Newfoundland. The most important events of the year in the Arctic regions were the accomplishment of the North-West Passage by Captain Amundsen and the attainment of latitude 87° 6′ N. by Commander Peary.

The revised edition of the Institution of Electrical Engineers Wiring Rules, which has been recently issued, contains a good many alterations and a great deal of rearrangement. The rules apply only for voltages up to 250 volts, the Board of Trade rules being appended and used for the higher pressures. The standard for copper conductors is now that of the Electrical Standards Committee instead of Mathiessen's standard, as in the past. Insulation tests are also modified in that the "bending" test has been omitted, though an increase in the length of time for which the pressure test is applied takes its place. This is a distinct advance, as the danger of mechanical rupture was always present when bending cables of any size, and was in very many cases an unnecessary strain on the cable. Bare conductors also are allowed under special conditions. Switches of more than 5 amperes at 125 volts when placed in cases are to have their cases lined with asbestos. Dynamos and motors are now placed under separate headings, but transformers are no longer kept separate, being under a combined heading with resistances and choking coils. At the end of the rules the Electrical Standards Committee's standard for the resistance and weights of copper conductors is defined as follows:—"A wire one metre long and weighing one gramme having a resistance of 0·1539 E.S.C. standard ohms at 60° F." In addition to the Board of Trade rules for voltages from 250 volts to 650 volts, the Home Office

Regulations for Mining Work are also attached. The revised rules are certainly an improvement on the previous edition, and the rearrangement and enlargement under the different headings tend to simplify them greatly.

The May issue of the *Westminster Review* contains an appreciative unsigned article on the life and work of the late Prof. Marcellin Berthelot. This biographical notice, in addition to its references to Berthelot's achievements in science, provides much interesting information concerning his private life and his services to France in administrative matters.

OUR ASTRONOMICAL COLUMN.

A Nebulous Background in Taurus.—In No. 3, vol. xxv. (p. 218, April), of the *Astrophysical Journal*, Prof. Barnard discusses the apparently nebulous background shown on some excellent photographs of a region in the constellation Taurus, of which two reproductions are given.

The vacant lanes among the Milky Way stars in Ophiuchus suggest from their appearance that not only are they due to the absence of stars, but that they are really darker than the rest of the sky, that is, they are probably channels in a substratum of nebulous matter. The recent photographs obtained by Prof. Barnard show that lanes of this nature are undoubtedly in a substratum of some kind, and not merely a subjective effect of contrast in a region otherwise densely packed with stars.

The region dealt with is comprised between the limits α=4h. 0m. to 4h. 34m. and $\delta=+24°$ to $28\frac{1}{2}°$, well to the east of the Pleiades, and shows numerous narrow, vacant lanes, one of which is singularly well defined, and extends for some 26m. in R.A. Another feature is a large space, nearly devoid of stars, but containing a large nebula which seems to suggest the possible existence of a larger nebula of which the outlying portions are dead or non-luminous, and therefore absorb the light of the stars behind them.

The White Spot on Jupiter's Third Satellite.—Referring to the white spot near the north limb of Jupiter's third satellite, observed by Senor José Comas Solá in November, 1906 (see Nature, No. 1942, p. 281, January 17), Prof. Barnard directs attention to the fact that he observed the same, or a similar, spot some fourteen years ago, and that, as in Senor Solá's observations, it was only seen when the satellite was *following* Jupiter. This leads to the assumption that this feature cannot be a true polar cap in the sense of its being at the pole, or it would be seen with equal facility in all parts of the satellite's orbit. Further, if this white spot is an extra-polar marking, and is only visible in certain points of the satellite's orbit with respect to the earth, it indicates that Jupiter's third moon, like the earth's satellite, always keeps the same face towards its primary.

During the observations of 1893–4, Prof. Barnard saw a similar spot at the south limb of the fourth satellite when that body was near superior conjunction (*Astronomische Nachrichten*, No. 4173, p. 327, April 27).

The Meteorite from Rich Mountain, North Carolina.—The results of a minute examination of a portion of the meteorite which was seen to fall at Rich Mountain, Jackson County, North Carolina, "about June 20, 1903, at 2 o'clock in the day," are given by Messrs. Merrill and Tassin in an abstract (No. 1524) from the Proceedings of the U.S. National Museum (vol. xxxii., pp. 241–244, April 18).

The portion examined seemed to be the nose of a larger mass, and weighed 668 grams. Metallic iron particles project from the crust, and seem to have resisted the frictional heat of the atmosphere better than did the silicate portions. Chemical analysis showed about 7 per cent. of iron, nearly 47 per cent. of olivine, about 4 per cent. of troilite, and about 40·7 per cent. of insoluble silicates. Copper was apparently absent, and, among the compounds, chromite was not found, whilst a relatively large amount of graphitic carbon was present.

Comet 1907*b* (Mellish).—In No. 4174 (p. 347, May 3) of the *Astronomische Nachrichten*, Prof. Berberich directs attention to the great similarity between the elements of the orbit of comet 1907*b* and those of the bright comet of 1742 as published in vol. clxxii. (p. 105) of the same journal.

Prof. Barnard has discovered an image of this comet on a plate taken on April 13, the day before the object was found by Mr. Mellish, and a number of other American observations are also recorded for April 14, 15, and 17 in the same journal.

The Orbits of Four Double Stars.—Recently determined orbits of the systems of ξ Scorpii, Σ 2173, Σ 3121, and μ^2 Herculis are given by Dr. Doberck in Nos. 4169–70 (p. 257, April 17) of the *Astronomische Nachrichten*. The orbits were determined by successive corrections by the least-square method, and the computed places are compared with all the available observational results; ephemerides extending to 1926 are also given. The periods given by the final elements for each of the above stars are 45·12, 46·20, 35·38, and 44·20 years respectively.

The Discovery of Variable Stars.—The value of the new method of discovering, photographically, variable stars, by superposing a negative and a positive copy of a similar negative taken at a different epoch, is illustrated in Circular No. 127 of the Harvard College Observatory. A plan has been started whereby the whole of the sky, as photographed on the Harvard Map of the Sky, will be systematically examined for variables, and the present circular deals with two regions already examined by Miss Leavitt; eight new variables were found in the one region and six in the other. A comparison of the results with those previously obtained shows that apparently all the bright variables exhibiting conspicuous changes in these two regions have now been discovered.

The Radiant Point of the Bielids.—From observations made at Stockholm in November, 1904, Dr. Karl Bohlin finds the radiant point of the Bielid shower, epoch November 21·33 (M.E.T.), to have been $\alpha=+26°\ 2'$, $\delta=+44°\ 10'$ (1900). The record of the observations and discussion of the results appear with a chart, in No. 2, vol. viii., of the *Astronomiska Iakttagelser och Undersökningar å Stockholms Observatorium*.

IRON AND STEEL INSTITUTE.

The annual meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers, Westminster, on May 9 and 10. The proceedings opened with the Right Hon. Sir James Kitson, Bart., M.P., past-president, in the chair, who explained that the president, Mr. R. A. Hadfield, having attended to present an address on behalf of the institute at the dedication of the building given by Mr. Carnegie to American engineering societies, was unable to return to England in time for the meeting.

The report of the council, which was read by the secretary, Mr. Bennett H. Brough, showed that the past year had been one of exceptional activity and progress. The membership of the institute amounted to 2052, and the joint meeting with the American Institute of Mining Engineers resulted in the presentation of so large a number of papers that it was found impossible to compress the minutes into the usual two volumes, and two extra volumes were issued. The report by the treasurer, Mr. W. H. Bleckly, showed that the financial prosperity of the institute is a matter for congratulation. The receipts amounted to 6610*l.*, and the expediture to 5915*l.*

The first act of the new president, Sir Hugh Bell, Bart., on taking the chair was to present the Bessemer gold medal to Mr. J. A. Brinell, the eminent Swedish metallurgist.

In his presidential address, Sir Hugh Bell gave a sketch of the iron trade in the last hundred years, the subject being chosen from the fact that the life of his father, Sir Lowthian Bell, begun in 1816 and ended nearly ninety years later, almost covered the period reviewed. The address is a work of conspicuous literary merit, and its value is enhanced by the addition of a carefully compiled chronological table of the more important events connected with iron and steel during the century. A vote of thanks to the president for his address was eloquently proposed by Sir W. H. White and seconded by Mr. Schneider (Le Creusot).

The first paper read was by Mr. D. Selby-Bigge (Newcastle-on-Tyne), who described the latest application of electricity to reversing rolling-mills of high power. The first mill of this kind was started on July 27 last at the Hildegarde Works, at Trzynietz, in Austrian Silesia. The mill is of 10,350 horse-power, and is provided with the Ilgner arrangement of fly-wheel converters. The discussion was well sustained, and the rival claims of electricity and steam were ably urged.

The secretary announced that Carnegie research scholarships had been awarded by the council to C. A. Edwards (Horwich), J. A. N. Friend (Germany), D. M. Levy (Bradford), A. M. Portevin (France), A. K. F. Hiorth (Norway), and B. Saklatwalla (India and Germany). For research work carried out during the past year, medals were awarded to E. F. Law (London) and Dr. O. Stutzer (Freiberg in Saxony). The reports of these two candidates, and the reports of P. Breuil (Paris), W. H. Hatfield (Sheffield), and Dr. Guillet (Paris) were found to be of sufficient merit to warrant their publication in full in the journal of the institute.

Two papers were read by Mr. Arthur W. Richards describing processes he has adopted at the works of Messrs. Bolckow, Vaughan and Co. for the manufacture of steel from high-silicon phosphoric pig iron by the basic Bessemer process, and of high-class steel from pig iron containing chromium, nickel, and cobalt.

Prof. W. A. Bone, F.R.S. (Leeds), and Mr. R. V. Wheeler (Warrington) read a lengthy paper on the use of steam in gas-producer plant. The experiments were made with a Mond gas-producer plant with the view of determining the influence of variation in the proportions of air and steam in the blast upon the composition of the gas, its suitability for furnace operations, and upon the general and thermal efficiencies of the producers. The quality of the gas obtained, though always good, steadily deteriorated as the steam saturation temperature was raised beyond 65°. An investigation of the thermal efficiency showed that the use of steam beyond that required to saturate the air blast at 60° was not attended by any increased economy of working, but rather the reverse. If, however, a gas producer be regarded primarily as an apparatus for ammonia recovery, then undoubtedly it should be worked with the highest steam saturation temperature consistent with the production of combustible gas.

The paper read by Mr. F. W. Harbord (London) is a valuable addition to technical literature. For many years it has been recognised that steels made by different processes, although practically of the same composition, varied in their tensile strength, hardness, and other physical properties, and it has been generally admitted that basic Bessemer steel was softer than acid Bessemer, and basic open-hearth softer than acid open-hearth steel. Mr. Harbord's paper gives for the first time systematic experimental results defining these various differences over a wide range of carbon content. He shows that if engineers wish to obtain rails of equal hardness from the basic open-hearth that they have been accustomed to from acid Bessemer steel, they must permit the manufacturer to increase the percentage of carbon to give the required hardness, as otherwise, although the rails may satisfactorily pass all the usual tests required by the specification, there will soon arise, under the conditions of heavy train-loads now customary, serious trouble due to spreading heads and undue wear. American engineers, in their standard specifications, have already recognised the importance of this, and they vary their rail specifications according to the process of manufacture.

A paper on the ageing of mild steel was read by Mr. C. E. Stromeyer (Manchester). The idea that steel might go through an ageing process has been scouted, but from the tests described the conclusions to be drawn are that certain steels do possess ageing qualities, that some steels tend to improve with time, others to deteriorate; and that as yet the process which gives results which are most in harmony with practical experience is to plane the edges of two samples, to nick them with a specially prepared chisel, and then to bend one sample at once and the other after waiting some weeks or after boiling.

Mr. A. J. Capron (Sheffield) read a paper on induced draught, with hot air economisers, for steel works and blast-furnace boilers. Briefly, the system consists of induced draught in combination with hot air economisers, which utilise the waste heat from the boiler in heating the air required for combustion. A fan is placed at the base of the chimney and draws the gases, as they come from the boiler, through a series of tubes which form a heating-box or hot air economiser. The system has already been adopted at several iron and steel works, and is found to result in considerable economy of fuel and absence of smoke. There is also the advantage that no high chimney is required.

A paper on the distribution of sulphur in metal ingot moulds was contributed by Mr. J. Henderson (Stockton-on-Tees). The question of the distribution of sulphur in ingot moulds made of hæmatite pig iron was recently brought to his notice by the fact that several large moulds were alleged to contain an excessive percentage of sulphur out of all proportion to the sulphur contents of the pig iron from which the moulds were made. The fact that much more sulphur is generally found in the tops of ingot moulds and other large castings is, or should be, well known to all ingot-mould makers and users. Yet in spite of this it is evident that some steel makers drill the tops of the moulds in order to ascertain the sulphur contents, and on the results so obtained condemn the moulds as unfit for use in the open-hearth furnace for melting purposes when they are scrapped. Such a method of sampling is manifestly unfair, as the results obtained by the author show that the excessive sulphur does not go deeper than the first inch, and that after the second inch there is no reason to find fault with the composition of the mould.

A paper on sentinel pyrometers and their application to the annealing, hardening, and general heat treatment of tool-steel was contributed by Mr. H. Brearley (Riga, Russia) and Mr. F. C. Moorwood (Sheffield). An indicator which can, in most cases, be placed exactly on the spot the temperature of which is required to be ascertained may occasionally be more serviceable than a fixed pyrometer of a more expensive type which registers the temperature of its immediate vicinity only. By making the indicators from materials which clearly melt at or above a definite temperature, and, after melting, also continue to show when the temperature falls to or below that point, a simple means is discovered which may claim a place amongst instruments of precision. The authors suggest that, for this purpose, no more suitable materials could be adopted than well-chosen salts of the metallic oxides.

In a paper on carbon-tungsten steels contributed by Mr. Thomas Swinden (Sheffield), a research is described having for its object an investigation of the influence of varying percentages of carbon in the presence of a constant percentage of tungsten.

Reports on research work carried out by holders of Carnegie research scholarships were also presented. Mr. P. Breuil (Paris) gave the results of a systematic investigation of copper steels from the point of view of their industrial application. Mr. W. H. Hatfield (Sheffield), in a research on cast iron, found that there is undoubtedly occasionally a great variation in the strength of cast irons of the same composition as cast; that this variation does not appear to follow any distinct rule with regard to the temperature of the casting operations; that a difference in mechanical tests is generally accompanied by a difference in the microstructure; and that the inequalities of the metal can be rectified by judicious heat treatment, *i.e.* the irregularity need not persist after heat treatment, at any rate under certain conditions. Dr. O. Stutzer (Freiberg, Saxony) gave the results of an elaborate investigation of the genesis of the Lapland iron ore deposits, showing that the phosphoric magnetite deposits of north Sweden are all associated with plutonic rocks of the syenite family, and that they have been formed in a magmatic manner, and, indeed, either as magmatic separations *in situ* or as erratic magmatic segregation. Pneumatolysis has also had considerable influence in the formation of these ores.

Mr. E. F. Law (London) dealt with the non-metallic impurities in steel. His paper is the result of an examination of more than one hundred steels. The impurities have been considered as consisting of five in number, namely, iron sulphide, manganese sulphide, iron silicate, manganese silicate, and iron oxide. Iron sulphide very rarely occurs in commercial steels, and is therefore not considered at length. Manganese sulphide is always present in steel, and is usually harmless. The only instance in which it has been found to exert injurious influence on the quality of the steel is when it segregates with phosphide of iron in the form of "ghosts." Silicates of manganese and iron are frequently found in steel, and are highly injurious to the quality of the metal. In large forgings they sometimes occur in considerable masses, but in rolled steel they are distributed throughout the mass. In either case they are responsible for many failures. No indication of their presence is afforded by ordinary commercial means, and they can only be detected under the microscope. Oxide of iron frequently occurs in Bessemer steel. It occurs in a finely divided state, and there is evidence that it is soluble in steel. As a general rule, steels which on pickling evince a tendency to blistering are high in oxygen. The effect of hydrogen on steel containing oxide is discussed, and experiments were made with the view of determining the temperature at which the oxide is reduced. The results of these experiments tend to show that the oxide is reduced at 100° C. Iron oxide differs from other impurities present in its electrical behaviour, and the influence of this difference on the corrosion of iron and steel is discussed. It has been found that the presence of oxide accelerates corrosion, and corrosion of welded iron affords an illustration of this action. Other instances of the effects of the presence of oxide may be found in the pitting of boiler plates and tubes.

The last paper on the programme dealt with the nomenclature of iron and steel. This is the report of an influential committee of the International Association for Testing Materials which was presented by Prof. H. M. Howe (New York) and Prof. A. Sauveur (Harvard) at the Brussels congress of that association. It was then proposed that the report be submitted to the Iron and Steel Institute for consideration, and the secretary will be pleased to receive written comments for publication in the journal.

The meeting concluded with the usual votes of thanks to the Institution of Civil Engineers, proposed by the president and seconded by Sir John Alleyne, and to the president, proposed by Mr. G. Hawksley and seconded by Mr. Saladin (Le Creusot).

On Friday evening the annual banquet was held, with the president in the chair. Four hundred members were present, and the speakers were the Austrian Ambassador, the Swedish Minister, Sir James Kitson, Mr. Yves Guyot, Admiral Sir Cyprian Bridge, Sir C. E. Howard Vincent, Lord Justice Fletcher Moulton, and Mr. Robert Hammond.

CHIMÆROID FISHES.

A MEMOIR on "Chimæroid Fishes and their Development," by Prof. Bashford Dean, has been issued as Publication No. 32 of the Carnegie Institution of Washington. It begins with a short review of the researches in comparative anatomy and palæontology, which led to the view that chimæroid fishes are the most primitive vertebrates or the least modified descendants of the ancestral cranium- or jaw-bearing vertebrate; that, although shark-like, they are nevertheless widely distinct from the shark; and that altogether they represent a lower plane in piscine evolution.

Admitting the importance of the grounds on which these conclusions were based, Prof. Dean refers to the incomplete nature of the evidence. The material at the disposal of investigators was inadequate for the solution of the great morphological problems involved, and especially embryological material was extremely scanty or absent. The author himself failed for several years in his efforts to obtain satisfactory materials, until his attention was directed by President Jordan to the vicinity of the Hopkins Marine Laboratory at Monterey as a promising locality for collecting *Chimaera colliei*. Under the guidance of a Chinese fisherman, Ah Tack Lee, who not only possessed a perfect knowledge of the Chimæra grounds, but proved to be a keen observer of the habits of the fish, the author obtained hundreds of specimens of the adult fish and of ova. Such of the latter as were not required for immediate examination were placed in a case, which was then sunk, attached to a buoy, in water of about five fathoms, to obtain the much needed series of developmental stages.

After having given an account of the habits and mode of propagation of the Californian Chimæra, the author enters into a full description of its egg and capsule in comparison with the ova of other Chimæroids. This is followed by a detailed account of the various stages of development of the embryo and of the post-larval growth of the fish. Next the relationships of fossil Holocephales are considered. In the chapter on organogeny, the discussion of the obscure problem of the development of the dentition and of the homologies of its component parts in living and extinct forms will be studied with particular interest.

Anatomical, embryological, and palæontological evidence, then, appears to the author to be unmistakably in favour of Chimæroids being widely modified rather than primitive forms. The recent forms retain less perfectly the general characters of the ancestral gnathostome than do living sharks. On the other hand, they have retained several characters of their Palæozoic Selachian ancestors which modern sharks have lost. The ancestral Holocephali diverged from the Selachian stem near or even within the group of the Palæozoic Cestracionts, and the many features of kinship retained by the recent Chimæroids and Cestracionts distinctly point at this line of evolution.

The memoir is illustrated by 144 excellent text-figures and eleven plates.

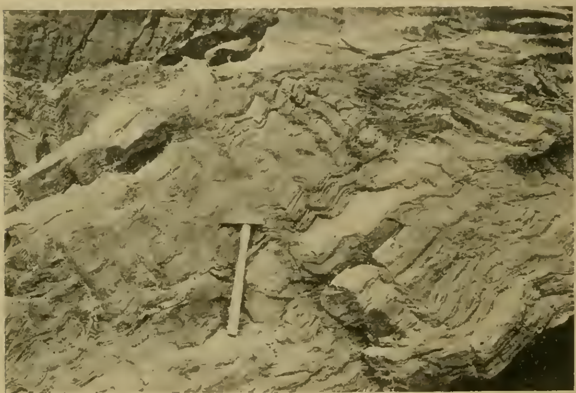
BRITANNIC GEOLOGY.

FEW teachers have utilised the study of our own islands to greater advantage than Dr. Joseph H. Cowham, of the Westminster Training College. For thirty years past he has led his pupils over the varied country south of London, and the present writer is one of those who became pleasantly acquainted at an early date with his interest in scenery and his keenness for the details of a landscape. Dr. Cowham has published in "The School Journey" (Simpkin Marshall, pp. 80, price 1*s.*) an account of his methods, illustrated in the country between Croydon and Godstone; Mr. G. G. Lewis, a former pupil, describes an excursion in the Greenwich and Woolwich area; and Mr. T. Crashaw, another pupil, shows how a class may study erosion and deposition in river-courses on the banks of the Calder, in Lancashire. These expeditions appear to be wisely accepted as part of the regular school curriculum, instead of being relegated, as sometimes happens, to the holidays. Their effect in bringing together teacher and taught is rightly insisted on, and cannot be exaggerated; and the feeling is early engendered that the class-instruction in geography relates to something real and natural, which any eye can see and any willing brain can comprehend.

It is to such teachers, and to their pupils in later years, that the long-established Geologists' Association especially appeals. In part x. of its Proceedings (November, 1906, Stanford, price 1*s.* 6*d.*) Mr. R. S. Herries describes the geology of the Yorkshire coast between Redcar and Robin Hood's Bay, which was the scene of the long excursion of 1906. Especial interest here attaches to the estuarine representatives of the Middle Jurassic series, with *Equisetum columnare* "found upright in the sandstones as it originally grew," and to the zoning of the Lower Jurassic by the abundant ammonites. The valuable "Sketch of the Geology of the Birmingham District," by Prof. Lapworth, with a contribution on petrology by Prof. Watts and one on the glaciers by Mr. W. Jerome Harrison, has now been reprinted from the Proceedings of the Geologists' Association for 1898 (Cornish Bros., Birmingham, pp. viii+104, price 2*s.* net), and will serve as a guide for generations of students in the Midlands. The region includes exposures of the famous Permian boulder-beds (pp. 60–64), on which we should now like the opinion of some South African geologist.

The Geological Survey of the United Kingdom, which is intent on bringing the knowledge of our own islands up to date, issued two memoirs, with accompanying colour-printed maps, at the close of 1906. In one, Mr. W. A. E. Ussher describes the country between Wellington and Chard (Memoirs of the Geological Survey, "Explanation of Sheet 311," pp. vi+68, price 1s. 3d.). The map, Sheet 311 of the new series, centres in the interesting watershed of the Black Down Hills, where the streams running south and west have cut through a plateau of Cretaceous rocks into the underlying Trias. The westward extension of the Selbornian beds (largely of Albian age) beyond the Rhætic and Jurassic, and their striking unconformity with these earlier strata, form interesting features in the map. The "clay with flints" appears for the first time in this region as "in part Eocene." The difficulty of selecting colours for superficial deposits which will suit all areas of our complex island is seen in the resemblance between "valley gravel and rainwash" and Triassic strata. In the index, however, this resemblance is greater than in the actual map. In the memoir we touch the work of many previous writers, including De la Beche and Fitton, and have the advantage of the views of Mr. Jukes-Browne on the correlation of the Cretaceous series.

In the second memoir ("Explanation of Sheet 346. The Geology of the Country near Newquay," pp. iv+132, price 3s.), Messrs. Clement Reid and Scrivenor describe an area in which the interest ranges from the Pliocene outlier of Saint Agnes to partly abandoned tin and copper mines. The close relation between the lodes and the metamorphic aureole of intrusive granite is at once obvious on the map. The economic section and appendix, the latter by Mr. D. A. Macalister, justly occupy forty-eight pages of the memoir. The granite cuts rocks of Lower Devonian age, which are now coloured on the map in tints of grey. The old familiar brown colour appears in the area of beds, now known to contain Pteraspis, near St. Mawgan, above which undoubtedly marine strata prevail. Interesting veins containing axinite are described by Mr. Flett in association with certain intrusive greenstones. They are attributed to "pneumatolytic" action, such as promoted the formation of tourmaline in other places, and are thus connected with the intrusion of the granite. These garnet-axinite-augite-epidote veins are held to have occurred where lime-silicates or patches of impure carbonate of lime were provided by the greenstones. The post-Carboniferous earth-movements have produced conspicuous cleavage and cross-cleavage in the Devonian shales of Watergate Bay, whereby the original bedding is at times entirely lost. Plate iii. is here reproduced, as a particularly beautiful example of cleavage-planes with secondary puckering, and no trace of true stratification.



Puckered slate showing "strain-slip," north-end of Watergate Bay, Newquay, Cornwall.

The Geological Survey of Ireland has issued a memoir on "The Geology of the Country around Limerick," by Mr. G. W. Lamplugh and the staff of the Survey, as constituted at the time of its transfer to the Department of Agriculture and Technical Instruction (Dublin, 1907, pp. vi+120, price 2s.). The drift edition of parts of Sheets 143 and 144, forming a special colour-printed map with Limerick nearly in the centre, is issued simultaneously, price 1s. 6d. The area is largely covered by Boulder-clay, but includes exposures of the interesting volcanic and intrusive rocks that are here associated with the Carboniferous Limestone. The seven photographic plates by Mr. H. J. Seymour illustrate all the important rocks of the district, and include a good example of beds of limestone carried bodily forward in Boulder-clay from the area surveyed by the author of the plate. Though the main object of the memoir was the description of the superficial deposits, a number of new observations on the underlying rocks have been added by Mr. Kilroe. The same writer has dealt with the economic geology, and particularly with the soils and subsoils.

THE COATS OBSERVATORY, PAISLEY.[1]

THIS observatory, the establishment and maintenance of which are entirely due to the munificence and public spirit of the Coats family, is situated about seven miles to the westward of Glasgow. From a meteorological point of view it occupies a very important position, being in the path frequently taken by the storms coming from the Atlantic Ocean. The observatory is now fully equipped with ordinary and self-recording meteorological instruments; there was, however, at first no intention of carrying on meteorological work, but Mr. Thomas Coats before his death, in October, 1883, having provided a standard barometer and thermometer, the committee of management afterwards supplied other instruments, and with these observations were regularly taken morning and evening. The records are preserved by the Paisley Philosophical Institution; readings have been transmitted monthly to the Scottish Meteorological Society, and the results are also separately published by the institution. The observatory was originally established for astronomical purposes, and was placed under the care of the Philosophical Institution. Mr. Thomas Coats generously offered to relieve the society of all expense in the matter, and to provide a suitable building, and he expressed the hope that the establishment would "prove a stimulus to interest the rising generation of the town and neighbourhood in the study of astronomy—a science little understood among us, but which may, under the leading spirits of our Philosophical Institution, become a subject of instruction that will be eagerly sought after." He endowed the institution with the sum of 2000l. in trust, and the observatory was opened to the public on October 1, 1883. We are indebted to the Philosophical Institution for the accompanying illustration of the observatory.

The original design was enlarged by the founder, who supplied a transit instrument, clocks, &c., and after his death his representatives intimated their desire to render the equipment still more complete, and added another

[1] "The Coats Observatory, Paisley; its History and Equipment." By Rev. A. Henderson. Pp. 48. (Paisley: J. and E. Barlake.)

2000*l.* to the endowment fund. The necessary alterations to the buildings were carried out at the expense of Mr. James Coats, who between 1892 and 1898 increased the fund by 6000*l.*, making it 10,000*l.* in all, and also made important additions to the equipment. Milne and Ewing seismographs, magnetometers, and other instruments were also ordered, rendering the observatory one of the most completely furnished in the kingdom. The seismographic observations for the year 1906 show that eighty-two earth movements were recorded.

The following results, taken from the meteorological observations for the twenty-two years 1885–1906, are interesting:—highest reading of barometer 31·002 inches, on January 9, 1896; lowest, 27·584 inches, on December 8, 1886; maximum temperature, 88°·6, on September 1, 1906; lowest, 4°·8, on February 10, 1895 (1°·0 was quoted by the institution on January 17, 1881). The mean annual rainfall is 38·29 inches, the average number of rain-days being 212; the rainfall in 1903 was 69·57 inches, and in 1896 only 24·45 inches. Polar winds prevail, on

The Coats Observatory, Paisley.

an average, on 131 days, and equatorial on 206 days in the year.

The meteorological observations have from the beginning been taken by the curator, Mr. Donald Maclean, formerly assistant to Prof. Grant, at the Glasgow Observatory.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. A. Hill has announced his intention of resigning the mastership of Downing College some time during the long vacation. Dr. Hill succeeded the late Dr. Burkitt some nineteen years ago. He is lecturer in advanced human anatomy, and is the sole representative of medicine and natural science amongst the heads of houses.

The general board of studies will shortly proceed to the appointment of a reader in forestry for a period of five years from October 1, 1907. The annual stipend is 400*l.* Candidates are requested to send in their applications, with such testimonials as they think fit, to the Vice-Chancellor on or before July 15.

The syndicate appointed to obtain plans for the extension of the Cavendish Laboratory has obtained tenders from nine firms. The lowest tender, 7135*l.* (including a provisional sum of 500*l.* for the cost of heating), was that of Mr. W. Sindall, of Cambridge. The syndicate now recommends that the Vice-Chancellor be authorised to accept the tender of Mr. Sindall. The cost of this extension will be largely met by Lord Rayleigh's munificent gift to the University of the Nobel prize.

The syndicate appointed to obtain plans for the extension of the chemical laboratory has laid its scheme before the Senate. It is proposed to fill in the gap which now exists along Pembroke Street between the medical school and the existing chemical laboratory with a three-storied building. This will provide for a large increase to the elementary laboratory, a number of smaller laboratories, and a lecture-room to seat 150 students. The cost is estimated at 13,500*l.*, and in view of the facts that in the last three years the average attendance at the University laboratory has increased from less than 200 students to more than 300 a term, and that Gonville and Caius College proposes to close its laboratory next summer, the building of the extension is urgent. The syndicate learns with regret that Prof. Liveing, who was elected in 1861, proposes to vacate the chair of chemistry some time next year. During the forty-six years he has been professor, the study of chemistry has made great advances in the University. Under his care and control the new chemical laboratory was built in 1887. The success which has attended the school at Cambridge is largely due to his untiring energy and his unselfish devotion to his subject.

The Common Seal of the University has been affixed in the presence of the Vice-Chancellor to:—(1) the certificate of appointment of Prof. Seward to represent the University at the celebration of the 300th anniversary of the death of Ulisse Aldrovandi to be held at Bologna in June; (2) the address to the Royal Swedish Academy of Sciences, Stockholm, in honour of the commemoration of the bicentenary of the birth of Linnæus to be held at Stockholm in May; (3) the certificate of appointment of Mr. F. Darwin to represent the University at the celebration of the bicentenary of the birth of Linnæus to be held at Stockholm in May; and (4) the certificate of appointment of Dr. Harmer, Mr. W. Bateson, and Mr. A. E. Shipley to represent the University at the seventh International Zoological Congress to be held in Boston in August.

Manchester.—Mr. H. Bateman has been elected to the readership in mathematical physics, endowed by Prof. Arthur Schuster to encourage research in mathematical physics, and to which we recently directed attention (Nature, January 24, vol. lxxv., p. 309). Mr. Bateman is a fellow of Trinity College, Cambridge, and was senior wrangler (bracketed), 1903; Smith's prizeman, 1905. He has already published a number of important mathematical contributions. His work in this new post will be followed with interest.

Prof. Ernest Rutherford, F.R.S., is to arrive from Montreal on May 24.

A new departure has been made in the publication of a special prospectus of advanced studies in the faculties of arts and science. A brief account is given of the provision for research in the different departments, as also of the courses of lectures, arranged for the session 1907–8, suitable for post-graduate study. It is hoped in future years to extend the scope of this prospectus so as to give a more extensive record of the resources of the University for advanced study and research.

Mr. C. G. Hewitt has been appointed to the recently founded lectureship in economic zoology.

Oxford.—The following is the text of the speech delivered by Prof. Love in presenting Prof. A. Graham Bell for the degree of D.Sc. *honoris causa* on May 2:—

Adest Alexander Graham Bell, origine quidem Scotus, diu apud Americanos scientiæ promovendæ dux et auctor probatissimus. Qui vir cum primo Physiologiæ Professor esset, dum surditatis causas et naturam diligentissime expendit, instrumenta quædam arte exquisita effinxit quibus surdi audientium more clara voce loqui docerentur: ita miserorum qui hoc incommodo laborant ægritudines aliqua ex parte relevavit. Idem mox longius progressus latiorem apud homines gloriam adeptus est. Hic ille est qui miraculum illud excogitavit, usu cotidiano iam notissimum, ut ipsa loquentis verba et vivam hominis vocem super montes altissimos et flumina latissima per immensos terrarum tractus et sub ipso Oceano transmittere et, ut aiunt, τῆλε φωνεῖν possemus. Virum igitur iure laudamus cum doctrina tum repertis præclarum, qui non solum mortalium commodis naturæ vim inservire coegit sed miseris et mærentibus malorum solamen obtulit.

In a Convocation held in the Sheldonian Theatre on Saturday, May 11, Lord Curzon was admitted and installed as Chancellor of the University. After his installation he conferred the honorary degree of D.C.L. on the Hon. F. R. Moor, Premier of Natal.

An election to the Philip Walker studentship in pathology will be made in October next. The studentship is of the value of 200*l*. a year for three years. Candidates may be of either sex, and need not be members of the University of Oxford. They are asked to send in their applications, with three testimonials, to the Registrar of the University by September 14.

The *British Medical Journal* announces that Prof. August Bier, of Bonn, has accepted a call to the chair of surgery in the University of Berlin, vacant by the death of Prof. Ernst von Bergmann.

The first annual conference of the Association of Teachers in Technical Institutions will be held in Leeds on May 23, 24, and 25. On Friday, May 24, the following papers will be read:—(1) Notes of an educational visit to the United States of America, H. Ade. Clark; (2) the preliminary training of technical students, Barker North; (3) syllabuses and examinations as applied to building subjects, J. Fitzgerald. Excursions, social meetings, and visits to works will form an attractive part of the meeting.

The Royal College of Surgeons in Ireland has sanctioned two post-graduate courses to be held annually in Dublin hospitals during the summer. The first course will extend from June 10 to July 2, and the second from September 23 to October 15. The object of these courses is to render available the whole of the clinical material in Dublin for the post-graduate student, so that he may see as much as possible during the brief time at his disposal. Ten general hospitals are included in the list of institutions at which the student may work, as well as hospitals devoted to special subjects. The tickets for the courses admit to the ordinary clinics of all the hospitals, as well as to the special work of the course. Further information can be obtained from, and all applications should be addressed to, Prof. Fraser, Royal College of Surgeons, Dublin.

Judged in the light of the results of recent examinations of the Punjab University, the study of science does not seem, says the *Civil and Military Gazette*, to be making much headway in the Punjab. Many years ago the Punjab University arranged a faculty of science with the usual matriculation, intermediate, and bachelors degree tests. A few years ago an additional test was established, viz. that for the degree of master. In 1907, whilst 3546 went up for the matriculation examination in the faculty of arts, only fifty-eight appeared in the similar examination in the faculty of science. Thirty-seven went up for the intermediate examination of the science faculty against 674 who appeared in the same examination in the faculty of arts; whilst the number of candidates in the B.A. examination was 341, only thirteen went up for the same examination in the faculty of science. This comparative neglect of scientific studies is much to be regretted, especially in India, where the object of university education is to effect a combination of the highest results of Western culture and science with the learning of the East.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 7.—"Electric Furnace Reactions under High Gaseous Pressures." By R. S. **Hutton** and J. E. **Petavel**.

Two steel chambers of 20 litres and 2 litres capacity respectively provided with valves, windows, and insulated electrode holders have been constructed and employed at working pressures up to 200 atmospheres. Inside these pressure vessels any desired arrangement for arc or resistance heating is mounted.

Apart from the influence of pressure, which was the primary object of the investigation, special attention was paid to the effect of the nature of the gaseous atmosphere upon the reactions.

Some measurements were made of the electrical constants of carbon and metal arcs in different gases at high pressures, and the rate of oxidation of heated metals was also considered. With a charge of 10 kilos. of lime and carbon the preparation of calcium carbide was studied in atmospheres of carbon monoxide, coal gas, and hydrogen under reduced and high pressures. Contrary to expectation, no unfavourable influence of carbon monoxide upon the yield was noticeable, the back reaction being limited to the surface.

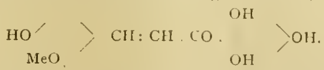
Silica fused under pressure exhibits a marked decrease in vaporisation, but no appreciable increase in fluidity and transparency. The production of carborundum under pressure is much limited, owing to this decreased volatility of silica.

The authors, as a result of a long, detailed, investigation of the reduction of alumina, conclude that this oxide is reducible by carbon at all temperatures above the melting point, but the metal is set free in the form of vapour, and can only be collected if it be protected from reaction with carbon monoxide.

Having overcome the difficulties of maintaining an electric arc in highly compressed air, it is shown that the production of oxides of nitrogen exhibits an increased efficiency attributable to pressure.

Linnean Society, April 18.—Dr. A. Smith Woodward, F.R.S., vice-president, in the chair.—The œcological functions of stolons and cleistogamous flowers: J. C. **Shenstone.** The author pointed out the advantages to the plants by the colony-forming habit, such as its more certain pollination and greater power of holding its own against competitors, instancing as examples *Bellis perennis*, *Thymus Serpyllum*, and *Mercurialis perennis.* Further examples were dwelt upon in the cases of *Urtica dioica*, *Adona Moschatellina*, and the violets, *Viola odorata* and *V. canina*, where both stolons and cleistogamous flowers cooperate in keeping the colonies compact.—The conservation of existing species by constitutional or physiological variation giving greater power of adaptation without perceptible change of structure: A. O. **Walker.** The author referred to a supposed case of two healthy men going to an unhealthy climate: one, proving immune to the local diseases, might conceivably transmit that quality to his children; the other, falling a victim to the climate, would leave no descendants. As instances he brought forward the case of *Crepis taraxacifolia*, long known in Wales as a rarity, which in 1896 onwards became extremely abundant at Colwyn Bay. He considered that this might be accounted for by a different variety, morphologically identical, yet physiologically distinct, having been introduced, which, by its ability to adapt itself to its surroundings, had rapidly extended its area of growth. Another case was of *Cardamine pratensis*, usually stated to grow in moist meadows, which is accurate as regards North Wales, but in Kent its favourite habitat is coppice woods, the second year after cutting the undergrowth. It is frequent on dry banks, on masses of roots of trees or shrubs, probably as xerophilous a station as could be imagined.—An aberrant Coccid: Hugh **Scott.** The species of Coccid, or scale-insect, described was found at the northern border of the Algerian Sahara by Mr. J. J. Lister.—Some results of inoculation of leguminous plants: Prof. W. B. **Bottomley.** In May, 1906, experiments were begun; tares, *Vicia sativa*, were chosen, and inoculated seeds set in sterilised sand, to which the requisite potash and phosphate salts had been added. A second set of pots were prepared with untreated seed, but besides the potash and phosphate, nitrate of soda proportionate to 2 cwt. per acre was added. In the last week of July the results were tested and found to be:—tares, with nitrate of soda, yielded 1·92 per cent. nitrogen; tares, inoculated, yielded 3·07 per cent. nitrogen, showing that the latter contained more than 50 per cent. more nitrogen than those grown with nitrate of soda, the food value being correspondingly increased. Specimens of field crops were obtained from Scotland to check these results, in September, and the three experimental plots proved:—Section A, no nitrogenous manure, 3·41 per cent. nitrogen; Section B, nitrate of soda, 3·75 per cent. nitrogen; Section C, inoculated, 4·04 per cent. nitrogen. Here the differences are less, due to the fact that farm soil invariably contained a certain number of the nitrogenic bacteria, which accounted for these results. Section B showed a yield of 9 tons 8 cwt. per acre, and Section C (inoculated) showed 12 tons 5 cwt. of fodder.

Chemical Society, May 2.—Sir William Ramsay, K.C.B., F.R.S., president, in the chair.—The chemical action of the radium emanation, part i., action on distilled water: Sir W. **Ramsay.** The action of the emanation alone on water decomposes it into explosive gas, mixed with excess of hydrogen; it has been shown that the emanation, when mixed with explosive gas, causes re-combination, and the rate at which the decomposition of water takes place has been measured. The reason of the excess of hydrogen has not yet been elucidated.—Freezing-point curves of the menthyl mandelates: A. **Findlay** and Miss E. M. **Hickmans.** From a study of the freezing-point curves for mixtures of *l*-menthyl *l*-mandelate and *l*-menthyl *d*-mandelate, it is found that *l*-menthyl *r*-mandelate exists as a definite, partially racemic compound having a stable melting point of 83°·7. It was also pointed out that other freezing-point curves indicate the existence of true racemates in the liquid state.—The constitution of homo-eriodictyol. A crystalline substance from eriodictyon leaves: F. B. **Power** and F. **Tutin.** Homo-eriodictyol, $C_{16}H_{14}O_6$, is isomeric with hesperitin, and similar to the latter in many of its properties, contains one methoxyl group, yields a tetra-acetyl derivative, and is hydrolysed by aqueous potassium hydroxide to phloroglucinol and ferulic acid. From these results it is concluded that homo-eriodictyol must possess the following constitution,



Eriodictyol, $C_{15}H_{12}O_6$ (m.p. 267°), a crystalline substance, which was also isolated by the authors from eriodictyon leaves, contains no methoxyl group. Homo-eriodictyol is probably a methyl ether of eriodictyol.—The relation between valency and heats of combustion. Preliminary note: G. **Le Bas.** The heat of combustion of a substance may be regarded as made up of (*a*) an absorption of heat due to the dissociation or decomposition, and (*b*) an evolution of heat due to the combination of the isolated atoms with oxygen. A study of molecular heats of combustion reveals the following law, which appears to be generally valid. The heat of combustion of an organic compound is equal to the heats of combustion of its possible dissociation products. The factor (*a*) is negligibly small as compared with (*b*). The heats of combustion of organic compounds in most cases are found to be the same as those of saturated and unsaturated hydrocarbons and hydrogen, or of mixtures of these. Similarly the factor (*a*) is negligibly small as compared with (*b*) in the case of the saturated and unsaturated hydrocarbons, and therefore their heats of combustion are sensibly those of their isolated atoms, *plus* an excess for the latter, owing to unsaturation. These relations lead to a second law which applies to all the hydrocarbons. The molecular heats of combustion of the hydrocarbons are proportional to their valency numbers.—The velocity of hydrolysis of aliphatic amides by alkali: J. C. **Crocker** and F. H. **Lowe.** The reactions of the aliphatic amides with sodium hydroxide are shown to follow the bimolecular relation

$$K=\frac{1}{\alpha t}\left[\frac{1}{c}-\frac{1}{c^{\circ}}\right],$$

where α is the degree of dissociation of the alkali.—The addition of iodine to acetylenic acids: T. C. **James** and J. J. **Sudborough.**—The chemical changes induced in gases submitted to the action of ultra-violet light: D. L. **Chapman,** S. **Chadwick,** and J. E. **Ramsbottom.** Dry carbon dioxide is decomposed by ultra-violet light. The rate of contraction of a mixture of carbon monoxide and oxygen is practically independent of the degree of desiccation of the gases, due to the fact that, though the presence of moisture causes the rate of formation of carbon dioxide to rise, it results in an equivalent reduction in the yield of ozone.—Studies of the perhalogen salts, part i.: C. K. **Tinkler.**—The interaction of cyanodihydrocarvone, amyl nitrite, and sodium ethoxide: A. **Lapworth** and E. **Wechsler.**—Contributions to the chemistry of oxygen compounds, ii., the compounds of cineol, diphenylsulphoxide, nitroso-derivatives, and the carbamides with acids and salts: R. H. **Pickard** and J. **Kenyon.**

DUBLIN.

Royal Dublin Society, April 23.—Prof. J. A. McClelland in the chair.—Pleochroic halos: Prof. J. **Joly.** The paper is descriptive of more extended observations on the subject. Both in cordierite and biotite the halos attain a like maximum radius, and appear only formed around strongly radio-active enclosures. Their origin appears to be referable to some action of the α rays. In the radial dimension it is found to agree with Rutherford's measurements of the effective range of these rays in matter of similar density.—The quantitative spectra of barium, strontium, calcium, magnesium, potassium, and sodium: Dr. James H. **Pollok** and A. G. G. **Leonard.** The authors showed photographs of the spark spectra of solutions of these elements, using gold electrodes in the manner described in a previous paper, and the progressive disappearance of the lines on continued dilution was noted, the lines surviving with 1 per cent., 0·1 per cent., 0·01 per cent., and 0·001 per cent. of the element being tabulated. The paper is part of a scheme of work designed to facilitate the use of the spectroscope in its application to ordinary analytical work. The residuary or most persistent lines of an element are not necessarily the most intense as ordinarily tabulated, and when only a small quantity of an element is present it is only those residuary lines that show, hence the importance of their determination.

PARIS.

Academy of Sciences, May 6.—M. A. Chauveau in the chair.—Study of the variations in the solar radiation: H. **Deslandres.** After a discussion of the existing state of knowledge in this subject, the author concludes that the continuous study of the distribution of brightness over the surface of the sun should be organised with great care; if it does not furnish the intensity of the variation of the radiation, it shows the existence of this variation, or at least the existence of important disturbances, in a certain and rapid manner.—An extension of the Friedel and Craft reaction: A. **Haller** and A. **Guyot.** A description of the use of aluminium chloride in the condensation of secondary amines and numerous organic substances. Among the reactions studied are indigotin and dimethylaniline, benzil and dimethylaniline, orthodibenzoylbenzene, ethylphenylglyoxylate, benzophenone, isatin, all with the same base, and other condensations with diethylaniline.—The zoological position, the affinities and development of Peneides of the genus Funchalia: E. L. **Bouvier.**—The direct hydrogenation of the fatty isocyanides: Paul **Sabatier** and A. **Mailhe.** In the presence of reduced nickel at a temperature of 160° C. to 180° C., the primary reduction product of the carbamine R.N : C is the amine $R.NH.CH_3$. Some secondary amines are obtained as bye-products.—Study of the relations between the solar activity and the magnetic and electrical variations recorded at Tortosa, Spain: MM. **Cirera** and **Balcelli.** A discussion of the records for the first three months of the present year.—Differential equations of the second and the first degree the general integral of which is with fixed critical points: Bertrand **Gambier.**—Certain congruences of lines: Ch. **Michel.**—An automatic damping arrangement for the rolling of ships: V. **Crémieu.**—Plurivalent atoms: Henri **Pellat.** By admitting the hypothesis that a plurivalent atom consists of a collection of as many monovalent atoms as there are units of valency, numerous facts in electrolysis can be explained.—A speaking condenser: Timoléon **Argyropoulos.**—Wireless telegraphy: L. **Torres.** A discussion and criticism from the point of view of priority of a recent note on the same subject by M. Gabet.—The absolute atomic weight of bromine: Gustavus D. **Hinrichs.** A re-calculation of the analytical determinations of Baxter, from which the value 80·00 is obtained instead of the value 79·953 deduced by Baxter.—The application of the method of limiting densities to the permanent gases at 0° C.; the gas constant for perfect gases: Philippe A. **Guye.** From a critical discussion of the experimental data, the author concludes that the gas constant is not strictly constant, but increases with the critical temperature of the gas, and varies 1/2800 between hydrogen and nitric oxide. This variation is regular, and can be represented by the formula $R=22,410(1+10^{-5}T_c)$.—Inactive dilactic acid: E. **Jungfleisch** and H. **Godchot.**—Decahydronaphthylketone-α and decahydronaphthylamine-α: Henri **Leroux.**—The origin of serpentine and the crystallophyllian series of Aveyron and Gard: Jules **Bergeron.**—The culture of the forage Leguminosæ: J. **Dumont** and Ch. **Dupont.**—Sucrase in musts of apples and ciders: G. **Warcollier.**—The nuclear evolution of the schizonte of *Aggregata Eberthi*: L. **Léger** and O. **Duboscq.**—The origin of the zonal anodian blastoderms: Jan **Tur.**—Researches on the labic activity of the gastric mucus and on the supposed specific labogenic action of milk: Maurice **Dehon.**—The re-establishment of the pulsations of the heart in fibrillation: H. **Kronecker.**—The law of the hæmolytic effect of the Becquerel rays: C. J. **Salomonsen** and G. **Dreyer.**—The experimental reproduction of granular conjunctivitis in the ape, *Macacus sinicus*: C. **Nicolle** and M. **Cuenod.**—The organisation and systematic position of the genus Sezannella: René **Viguier.**

DIARY OF SOCIETIES.

THURSDAY, MAY 16.

ROYAL INSTITUTION, at 3.—Spectroscopic Phenomena in Stars, (2) Motion: H. F. Newall, F.R.S.

CHEMICAL SOCIETY, at 8.30.—The Relation Between the Crystalline form and the Chemical Constitution of Simple Inorganic Substances: W. Barlow and W. J. Pope.—Experimental Investigation into the Process of Dyeing: J. Hübner.—Some Derivatives of *p*-Pyranol allied to certain Derivatives of Brazilein and Hæmatein, Preliminary Communication: W. H. Perkin, jun., and R. Robinson.—Mixed Semi-ortho-Oxalic Compounds: G. D. Lander.—The Mechanism of Bromination of Acylamino-compounds, Preliminary Notice: J. B. Cohen.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Present State of Direct Current Design as Influenced by Interpoles: F. Handley Page and Fielder J. Hiss.

FRIDAY, MAY 17.

ROYAL INSTITUTION, at 9.—Seiches in the Lakes of Scotland: Prof. George Chrystal.

THURSDAY, MAY 23.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Two Modes of Condensation of Water Vapour on Glass Surfaces, and their Analogy with James Thomson's Curve of Transition from Gas to Liquid: Prof. F. T. Trouton, F.R.S.—The Relation of Thallium to the Alkali Metals: a Study of Thallium Sulphate and Selenate: Dr. A. E. H. Tutton, F.R.S.—On the Frictional Resistances to the Flow of Air through a Pipe: J. H. Grindley and A. H. Gibson.—Chemical Reaction between Salts in the Solid State: Dr. E. P. Perman.—Studies on Enzyme Action, IX., The Nature of Enzymes: Prof. H. E. Armstrong, F.R.S., and Dr. E. F. Armstrong.—Studies on Enzyme Action. The Enzymes of Yeast: Amygdalase: R. J. Caldwell and S. L. Courtauld.

ROYAL INSTITUTION, at 3.—Chemical Progress—Works of Berthelot, Mendeléeff, and Moissan: Sir James Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Present State of Direct Current Design as Influenced by Interpoles: F. Handley Page and Fielder J. Hiss.—Hot Wire Watt Meters and Oscillographs: J. T. Irwin.

FRIDAY, MAY 24.

ROYAL INSTITUTION, at 9.—Recent Contributions to Electric Wave Telegraphy: Prof. J. A. Fleming, F.R.S.

LINNEAN SOCIETY, at 8.—Anniversary Meeting.

PHYSICAL SOCIETY, at 5.

CONTENTS.

THURSDAY, MAY 23, 1907.

MENDELISM.

Mendelism. By R. C. Punnett. Pp. vii+84. (Cambridge: Macmillan and Bowes; London: Macmillan and Co., Ltd., 1907.) Price 2s. net.

A SECOND edition of Mr. Punnett's "Mendelism" has followed the first after an interval of two years. The book gives a very good account of Mendelian work. Issuing as it does from Cambridge, the source of by far the greater part of the Mendelian discoveries of the last six years, it is the most authoritative account of this subject, and as it is eminently readable it is the very book for anyone who wants to know what Mendelism is. It is cheap and of a very convenient size, and we cannot suppress an expression of our admiration for the beautiful purple colour of the cover of the second edition.

At the same time, no good can be done by refusing to face the fact that the truth of the Mendelian doctrine is not universally admitted. No one denies the extraordinary interest of these discoveries. He must be a very callous man who is not fascinated by the way in which the proportions 9:3:4 and 9:7 and the phenomenon of reversion in certain cases have all been brought into line. But we hold that he must be a very rash man who accepts without further question the doctrine of gametic purity. Yet it is just in the sphere of interpretation that Mendelians are so certain. Once in this sphere, we can no longer be guided by facts—if we were dealing with facts we should be in the sphere of discovery—but by "such things as our mind conceives." And one's attitude should be one of continual, unceasing, and active distrust of oneself. The attitude of the Mendelian is different from this. He may reply that he is only triumphant about his discoveries; but we must remember that there is no fixed criterion by which we can say where discovery ends and interpretation begins; and we must be careful not to beg the question by defining discovery as that about which there can be no doubt.

There are those who deny the theory that the germ cells of an extracted recessive are pure in respect of the character of the organism which contains them, and who assert that the characters of the hybrid which produced it are not absent from, but latent in, those germ cells. If this were discovered to be the case, it would be regarded as a demonstration of the falsity of the doctrine of gametic purity by everyone who was not a Mendelian. But we should strongly condemn the proclamation of such a conclusion, because we think it is high time that the spirit which derives satisfaction from the victory of one opinion over another should be swept from science. There is no place for the party system in science; because it tends to make the triumph of truth the main object and truth itself a secondary one. We are not arguing that Mendelian theory is untrue, but that the attitude of anyone daring to say of anything "this is true" should be apologetic rather than victorious.

There is another and a larger point of view from which we may examine the Mendelian position: it is that which refers to the relation between the Mendelian and the material with which he deals. The differences between biometrician and Mendelian have been due partly to the fact that these two sets of workers have dealt with different sets of facts. But we are concerned with the difference between their attitudes to the same classes of facts, and with the paradox that in spite of this difference they both claim to have introduced exact methods into biology. How is it that the two schools which claim to have introduced the exact method into the study of biology are not at peace? What is the relation between the methods of the two schools? One author attempts to express the difference in the statement that the Mendelian deals with units and the biometrician with masses, and illustrates this view by saying that the difference between the relation of the biometrician and that of the Mendelian to the units with which they deal is the same as the difference between the relation of the physicist and that of the Maxwellian demon to the units (the atoms) with which they deal. The physicist and the biometrician deal with them in masses. The demon and the Mendelian deal with them separately. It is striking testimony to the callousness of biologists to general discussion that it has never been pointed out that this comparison, though plausible, is based on a fallacy. To anyone who tries to take a broad view of the matter, the truth or falsity of the statement (repeatedly made by Mendelians) that the biometrician deals with masses while the Mendelian deals with units is the most interesting question presented by this whole subject. For if the Mendelian really does deal with units while the biometrician deals with masses composed of these units, and if the Mendelian sets out with the object of enabling himself to predict what will be the result of a given union, and succeeds, while the biometrician starts on the assumption that a knowledge of the ancestry of a given pair does not enable him to predict the character of its offspring, there is little to be said for the "application of exact statistical methods to the problems of biology."

But is it really true that the Mendelian deals with the units of which the biometrician's masses are composed? We believe not. In order to see what the real state of affairs is we must try to begin at the beginning. The difference between the two schools lies in the difference between their respective attitudes to natural phenomena. The biometrician says, "We look at them as close as we can and we see nothing uniform." The Mendelian, "We look as close as we choose and we see everything uniform." The latter does not pretend that "dwarf" peas are not variable, but treats them as if they were all the same. The former does not pretend they are not all "dwarf," but treats them as if they were all different.

The exactness of the biometrician makes him count the number of hairs per square centimetre on the lower leaf surface of *Lychnis vespertina*; the exactness of the Mendelian enables him to tell at a glance in a row of hybrid stocks which are hoary and which are glabrous. The two forms of exactness correspond to the two ways in which we may try to make certain of hitting the bull's-eye of a target when we shoot at it. We may either improve our marksmanship or enlarge the bull's-eye. The latter is the only method of ensuring uniformity, of enabling oneself to predict the result with certainty. To this the biometrician justly replies, "This is no real uniformity. It is an ideal uniformity substituted for a real variability. Your shots are scattered round the centre of your bull's-eye just as mine are scattered outside mine. I never hit. My bull's-eye is a point. I keep a record of the deviation of every single shot from it. I am faithful." To which the Mendelian replies, "I always hit. I keep no such records. I am successful." We do not hold a brief for either party. A bull's-eye so large that it cannot be missed is as unfair as one so small that it cannot be seen is unpractical. All we wish to insist on is that because Mendelians can predict and biometricians cannot, it does not follow that the units with which the Mendelian deals are the units of which the biometrician's masses are composed. The Mendelian's units *are* the biometrician's masses, except when the latter exceeds his limits and includes within his masses more than one such unit. The Mendelian can no more predict about the units of which the biometrician's masses are composed than the biometrician can, except when the biometrician includes more than one Mendelian unit in his mass.

CERTAIN ASPECTS OF SCIENTIFIC WORK.

Progress of Science in the Century. By Prof. J. Arthur Thomson. Pp. x+536. (London: W. and R. Chambers, Ltd., 1906.) Price 5*s.* net.

IN a book bearing the present title it is surely unfortunate to find that progress in one branch of science, and that certainly not the least important, is wholly ignored. Yet while chemistry, physics, astronomy, geology, physiology, psychology, and even sociology each has a separate chapter devoted to it, not a word is said about the remarkable developments that have taken place in mathematical science during the century. The changes which recent times have witnessed in regard to our conceptions of the notion of space are certainly no less remarkable, and are quite as capable of being outlined in a popular work as the kinetic theory of gases or developments of theories of the ether.

The study of matter and energy is so closely connected with the study of space that a discussion of the former without some reference to the latter must give a reader an incorrect impression of the present state of physical science. But the omission of frequent and explicit mention of the work of the mathematician in certain other directions is also likely to be misleading. Why, the reader may ask, is Lord Kelvin's vortex atom theory recognised—we will not say accepted—by the scientific world while Mr. Horatio Gubbins (to use a fancy name) has been pestering secretaries of societies and editors in vain with his theories of gravitation or the ether, and no scientific man will have anything to say to him? It may be that the reader in question is Mr. Gubbins himself. If he studies the chapters on "The Scientific Mood" and "The Unity of Science," he will find in them every justification for believing that his grand discovery marks a new era in the advancement of science. If, again, he turns to p. 178 and reads the paragraph "Value of these Hypotheses" at the end of the chapter on physics, he will find the sentence:—

"These molecular and ethereal hypotheses are human imaginings—and nothing more; they are constructed in terms of one sense; that of sight; they are attempts to see that which is invisible, to invent a machinery of Nature, since the real mechanism is beyond our ken; but it must be observed that these hypotheses are not *vain* imaginings, for they prove themselves yearly most effective tools of research, and that they are not *random* guesses, for they are constructed in harmony with known facts."

This statement may be true enough, but the *suppressio veri* in the omission of all reference to the rigid framework of mathematical equations and formulæ supporting the hypotheses conveys a dangerous *suggestio falsi* to the unmathematical reader. Mr. Gubbins is perfectly convinced that his own theory, at any rate, is constructed in harmony with known facts, whatever may be said about Lord Kelvin's theories, which he not unfrequently has "*proved convincingly*" are wrong, and he may even take unto himself to say that he has at last discovered a theory which is something more than a mere human imagining. No book of the present kind should be issued which does not strongly emphasise the fact that the true test of every scientific theory is in all cases a quantitative test based on a comparison of the formulæ of the mathematician with the measurements of the experimenter. Otherwise the English reader will be led to believe that the needs of science, which are now being pressed forward, can be adequately met by the erection of laboratories and the endowment of scholarships for passing elementary examinations, while the brain workers who interest themselves in researches carried out in their own studies with ink and paper will find themselves, as time goes on, more and more unable to cope with the accumulation of unsolved problems that is being pressed on them from every quarter.

Descending to matters of detail, we find many important theories conspicuous by their absence. We need only specify the phase rule and the second law of thermodynamics as instances in point. Yet the very possibility of a world existing which is inhabited by living beings, including man, depends essentially on this neglected second law. It seems almost unnecessary, in view of this omission, that the author should apologise in his preface for the absence of any reference to radium on the ground that the book was printed before the discovery had been made.

It cannot be denied that in attempting to trace the scientific progress of a century, even in its barest outlines, in a volume of this size the author undertook an impossible task. It is probable that he would have done better if he had confined his attention to discoveries made in the earlier part of the century, merely sketching their later developments. We do not blame the author for omitting many discoveries of importance, but it is a great pity that he did not realise that the present selection gives a somewhat one-sided view of scientific aims and methods.

Having said so much about a weak point in the book, it would be unfair not to dwell on several useful features. The specialist working in one branch of science is very apt to forget what he ever learnt about other directions of scientific progress. In these days, over-specialisation and over-elaboration are being carried to greater excess every year. Even the subdivision of the Royal Society's Proceedings into two series has completely destroyed their former all-round character. A book like the present, taken up and read in a leisure hour, will recall to the specialist many interesting points in the history of different branches of science of which he would otherwise never think. If there is one class of specialist who is more likely than others to benefit by reading the book, that is the mathematician himself, and next to him, possibly, the physicist. These in particular will be brought into contact with ideas quite different from those with which they are commonly associated, and it may be hoped that the mathematician will learn a lesson, and be less prone to hide his light under a bushel, when he finds how his genius is unappreciated by the writers of popular treatises.

G. H. BRYAN.

ANCIENT AND MODERN LEICESTER.

Glimpses of Ancient Leicester in Six Periods. By Mrs. T. Fielding Johnson. Second edition, with supplementary notes. Pp. xv+439. (Leicester: Clarke and Satchell; London: Simpkin, Marshall and Co., Ltd., 1906.)

THIS book was first published in 1892 as a "History of Leicester from the Earliest Times to the End of the Eighteenth Century." The present edition has been enlarged considerably by a supplement, in which more recent developments have been dealt with. The author belongs to a Leicester family which has taken a leading part in the public life of the town for several generations. Local histories are wont to be rather dull, but in this case, thanks to a lucid and lively style, the writer has succeeded in producing a volume of more than usual attraction for the general reader.

Leicester appears to have been an important Roman settlement, of which the chief remains are a part of the old rampart, now called the "Jewry Wall"; some fine examples of tesselated pavements; and a milestone with an inscription to the Emperor Hadrian, said to be the oldest stone inscription in Britain. During Saxon times the Church of St. Nicholas was built on the site of a Roman temple. This church "still includes in the north wall of its nave portions of the identical walls of the original Saxon church, showing a quantity of material taken from the Jewry Wall and other ruined Roman buildings near the spot." "Under the Norman and Plantagenet kings, Leicester reached its highest point of importance as a mediæval borough," under its greatest earl, Simon de Montfort. Several buildings of this period are in existence; amongst them may be mentioned the Newark Gateway and the Old Town Hall. Memorials of the sixteenth century may still be seen in the Abbey and the Queen Elizabeth Grammar School.

The supplement gives an interesting account of the development of the place from a market town with a population of 17,000 at the end of the eighteenth century into an industrial centre of nearly a quarter of a million people.

In this connection reference should be made to the excellent description of the rise and progress of the present important knitting and hosiery trade. A great impulse was given to the prosperity of the town by the opening of the Leicester and Swannington Railway. This was the second railway in the country, and was built by George Stephenson in 1832. Some of the original rails and other specimens of early railway work are preserved in the town museum.

This useful institution owes its origin to the Literary and Philosophical Society, through which it gained the nucleus of its present valuable collection. The scientific activity of the town has always centred round this society, which was founded in 1835.

The attention of the reader of Mrs. Fielding Johnson's book will be attracted to the names of several of her townsmen who have attained distinction in scientific pursuits, amongst whom may be mentioned Russel Wallace, the naturalist Bates, and another, not so well known, Mr. Ludlam, who assisted Dollond in the production of achromatic lenses for his telescopes.

The history of the educational institutions of the town receives adequate treatment. Secondary education is mainly in the hands of the Wyggeston and Queen Elizabeth Grammar Schools, and Alderman Newton's School, the latter an eighteenth-century foundation. During last century a working men's college and a mechanics' institute were started. The former does useful work still, whilst the latter has developed into a fine technical school.

A special interest attaches to the new edition of this attractive work in view of the forthcoming visit of the British Association to Leicester, and intending visitors would find in it a pleasanter account of their place of meeting than the pages of an ordinary guide-book can afford. The book is admirably illustrated, and is provided with an index.

R. E. T.

A NEW LIFE OF HUXLEY.

Thomas H. Huxley. By J. R. Ainsworth Davis. (English Men of Science Series.) Pp. xi+288. (London: J. M. Dent and Co., 1907.) Price 2s. 6d. net.

MR. DAVIS has produced in small compass an account of the life and work of Huxley that is at once readable and stimulating. It was inevitable that he should draw largely upon Mr. Leonard Huxley's biography of his illustrious father, but the materials have been skilfully employed, and the book is far from being a mere abstract of the larger work. Huxley's energy, industry and fixity of purpose are brought into due prominence; while his intellectual keenness and honesty, his intolerance of pretentious ignorance, his appreciation of everything good in art and literature, his jealousy for the right use of the mother tongue, his admirable social and domestic qualities, all have ample justice done to them in the pages of this modest volume.

The attentive reader will easily discern how it is that among the great names of the Victorian epoch few take a higher place than that of Huxley. Eminent as an original worker in science, whose investigations covered an unusually wide field, he was scarcely less distinguished as a philosopher and as a practical man of affairs. By dint of unwearied industry, of a single-minded love of truth and of a nature at once candid and fearless, he made for himself a reputation in the intellectual life of the last century which will outlive many of those that, for the time being, bulked more largely in the public view.

In controversy, as Mr. Davis often reminds us, Huxley was a strenuous but never ungenerous adversary, though it sometimes seemed hard for him to realise that his opponents might hold their convictions as sincerely as he did his own. The popular notion of Huxley as an intellectual pugilist who found his chief delight in propounding dogmas, the more startling the better, in science and philosophy, is scarcely borne out by the facts of his career. It is true that in his own judgment he was "rather prone to jump at conclusions," and when he felt sure of his ground no man could speak with greater confidence. But questions, even of the first magnitude, as to which the data were not in his opinion sufficient for a solution, were by him left open to the end.

Perhaps the most conspicuous instance of this truly "agnostic" attitude was the position he took up in reference to Darwin's theory of natural selection. Curiously enough, while his acceptance of the fact of evolution was hastened, if not caused, by the publication of the views of Darwin and Wallace, he never committed himself to an unqualified approval of those views. He was converted *by*, but not *to*, the doctrine of natural selection. This, however, did not prevent him from acting as Darwin's champion against attacks dictated by ignorance and prejudice, nor from treating the Darwinian hypothesis as "the most powerful instrument of investigation which has been presented to naturalists since the invention of the natural system of classification, and the commencement of the systematic study of embryology."

It is probable that we here touch upon one of Huxley's limitations. Unrivalled as he was in many departments of biology, it is clear that field natural history did not come to a great extent within his sphere of mental activity. Had this been otherwise, and had his attention been more directed to the study which now goes by the name of bionomics, it seems fair to conjecture that his views as to the validity of Darwin's theory might have undergone some modification.

There are certain slips in Mr. Davis's book which should be remedied in a future edition. We note a few, as follows:—*Ephestia elatella* (*recte* elutella) is not a "small beetle," but a Phycid moth. In the letter given on pp. 204–5, Huxley wrote "inconceivable," where Mr. Davis has "conceivable" with much detriment to the sense of the passage. Finally, Duns Scotus we know, and Scotus Erigena we know, but who is Scotus Erigenus?

F. A. D.

PHYSICAL AND INORGANIC CHEMISTRY.

(1) *Practical Physical Chemistry*. By Dr. Alex. Findlay. Pp. xii+282; illustrated. (London: Longmans, Green and Co., 1906.) Price 4*s*. 6*d*. net.

(2) *Physical Chemistry in the Service of Medicine*. Seven addresses by Dr. Wolfgang Pauli. Translated by Dr. Martin H. Fischer. Pp. ix+156. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 5*s*. 6*d*. net.

(3) *Vorlesungen über anorganische Chemie für Studierende der Medizin*. By Dr. Ernst Cohen and Dr. P. van Romburgh. Pp. viii+431; illustrated. (Leipzig: Wilhelm Engelmann, 1906.) Price 15 marks.

(1) SLOWLY but surely the necessity of systematic laboratory instruction in the methods of physical chemistry is being recognised. One of the causes which may have contributed to the absence of such instruction in many university courses of chemical study has been the lack of a suitable practical textbook. With the appearance of Dr. Findlay's work this regrettable deficiency in laboratory literature can, however, be no longer said to exist. The apparatus required for the measurement of density, viscosity, surface-tension, refractive index, molecular weight, conductivity, transport numbers, electromotive force, velocity of chemical change, solubility, transition temperatures, and thermal changes is described, and instructions for the carrying out of the measurements are given in an easily intelligible form.

The course is modelled on that of the Leipzig school, which for many years occupied a unique position as the Mecca of students of practical physical chemistry. This is doubtless partly due to the author's personal association with this particular school. It may perhaps account for the omission of several important types of experimental exercises. In particular, electrochemical experiments involving the estimation and separation of the metals and the preparation of different classes of compounds afford many valuable applications of physicochemical principles, and the omission of chapters dealing with these phases of the subject is regrettable. Some difficulty may be experienced in interpreting what is meant by the term "maximum apparent error" in the first chapter. With a vocabulary of errors in which relative, absolute, possible, probable, and apparent errors may be spoken of, a careful definition of terms is essential. In the dilatometric determination of transition temperatures (p. 274), Glauber's salt is not nearly so suitable as some other substances for the purposes of a laboratory exercise.

Of the usefulness of the book as a laboratory guide there can, however, be no doubt; it should be in the hands of every serious student of the science.

(2) Dr. Pauli's volume is a collection of seven addresses delivered at various times by the author, and deals with the application of physical chemistry to various branches of medicine—physiology, pharmacology, and pathology—an application rendered possible more particularly by the recent advances made in the study of organic colloids. The problems discussed are of fundamental importance, and even though it be true that "life can perhaps be completely understood only through life itself," yet the volume before us indicates that many great advances may be expected by the proper utilisation of the instruments afforded by physical chemistry. In the separate chapters an account is given of the physical chemistry of cells and tissues, the colloidal state and the reactions in living matter, the relations between ions and their medicinal and therapeutic effects, the changes effected in pathology by recent chemical work, and the significance of the electrical charge of protein. The entire omission of literature references to the large number of investigations by authors whose names are quoted is most unfortunate. The translation is good, although it is not difficult to recognise in it the work of a medical man rather than that of a physical chemist. In medical circles the book should be of general interest.

(3) A distinctive feature of the lectures on inorganic chemistry is the authors' attempt to minimise the number of chemical compounds described, and to illustrate by carefully selected examples the most important general phenomena and the laws which regulate them. In the opinion of one who has had some little experience in the chemical training of medical students this is a distinctly gratifying feature. Whether it is not possible greatly to improve the training of the medical student by demanding a smaller knowledge of isolated facts and a more extended acquaintance with general principles is a question which demands serious consideration. In the twenty-eight lectures, into which the subject-matter is divided, the attention of the reader is continually directed to general relationships in discussing particular facts, and this cannot but have a satisfactory effect on the chemical aspect of the future medical man. For 430 pages of elementary inorganic chemistry fifteen marks is a singularly high price to have to pay, and may be prohibitive to many would-be purchasers.

H. M. D.

OUR BOOK SHELF.

Practical Coal Mining. By Leading Experts in Mining and Engineering. Edited by Prof. W. S. Boulton. Divisional, vol. i. Pp. vii + 160. (London: The Gresham Publishing Company, 1907.) Price 6s. net.

THIS is the first instalment of a work which, when completed in six volumes, is intended to cover the whole ground of modern coal-mining practice. Each of the sections into which the work is divided will be written by a different author, fourteen leading authorities cooperating with the editor in his task. This division of responsibility among many contributors, and the fact that orders are accepted for complete sets only, render it difficult to judge from the first volume what the value of the work as a whole will be.

In the first volume there is undoubtedly a certain want of harmony in treatment of the subject-matter. There are three sections and part of the fourth, dealing respectively with the geology of the Coal-measures, the composition and analysis of coal, trial borings, and shaft sinking. The section on geology, written by the editor, covers sixty-six pages, and contains much useful information. It is questionable, however, whether, in a treatise on practical mining, it is possible to deal usefully with so comprehensive a subject or to give sufficient detail to render the geological manuals superfluous. As an illustration, the information regarding foreign coalfields, which has had to be compressed into a single page, is not nearly so full as that contained in Geikie's "Text-book of Geology."

The editor's literary style, too, is far from faultless. His opening sentence, for example, cannot be regarded as elegant in composition. It reads as follows:—"While some knowledge of geology is necessary for all mining engineers and others connected with coal mining, and especially the ability to construct and interpret geological plans and sections, there are certain branches of the science which bear upon coal mining only very indirectly, and which at present are of theoretical rather than practical importance, and which, therefore, it has been thought advisable to omit in the following pages."

The second section, on the composition of coal, has been written by Mr. C. A. Seyler. It describes the author's new system of classification, or rather of new chemical terms, and does not seem likely to commend itself to practical men, who would probably find such expressions as "sub-para-bituminous-pseudo-anthracitic species" somewhat cumbersome. The third section, on trial borings, which has been written by Mr. H. F. Bulman, is admirable. It contains as much practical information as could possibly have been compressed into thirty pages. The fourth section, on shaft sinking, as far as published, is equally good. Written by Prof. H. Louis in excellent literary style, the information is clearly given, and its value is increased by the introduction of hitherto unpublished details of cost, and by the fact that the illustrations, unlike others in the volume, have in every case an indication of the scale to which they are drawn.

Morale de la Nature. By M. Deshumbert. Pp. 74. (London: D. Nutt, 1907.) Price 1s. net.

THE first part of this essay is devoted chiefly to the thesis that the object of all creation is to produce those forms of life which are the most active, intelligent, and moral possible, that is, life in its most complete form. Good is that which contributes to the increase of life in its high development, and evil is that which has a contrary effect. The latter half of the essay consists of ethical aphorisms which we commend to the notice of the Moral Instruction League.

Spring Harbingers and their Associations. By M. G. B. Pp. 62. (London: Elliot Stock, 1907.)

THE writer of these six short essays on the snow-drop, violet, daffodil, cowslip, daisy, and rose, not only loves flowers, but evidently has made a practice of recording references to her favourites made by the poets she has read—and these are a goodly company.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Structure of the Ether.

THE recent interesting communication of Sir Oliver Lodge to NATURE (March 28) and the *Philosophical Magazine* on the density of the ether recalls an objection to theories of the ether which identify magnetic intensity with resultant ethereal velocity that does not seem to have received the attention it deserves. The objection arises when the distribution of momentum in the system is taken into consideration.

It will be remembered that Sir Oliver Lodge commences by pointing out that the volume occupied by the electrons which constitute a mass of platinum is small compared with the volume of the platinum itself, whence it follows, if the mass of the electrons is that of the ether they carry with them, that the density of the ether must be enormous compared with that of platinum. This conclusion appears to be inevitable if we are to have a hydrodynamical theory of the ether. I do not wish to contest the contention that the density of the ether is enormous.

The second method used by Lodge to evaluate the density of the ether assumes that the magnetic intensity at any point is always proportional to the speed of the ethereal flow. By equating the mechanical and magnetic expressions for the energy of the field, and assuming that the ethereal circulation at the equator of an electron is equal to the velocity of its forward motion, Lodge arrives at the relation

$$e=4\pi a^2\sqrt{\frac{\rho}{4\pi\mu}},$$

where e is the charge and a the radius of an electron, and ρ is the density and μ the magnetic permeability of the ether. This may be combined with the known values $e^2\mu=10^{-40}$ gm. cms. and $a=1\cdot2\times10^{-13}$ cms. to give $\rho=3\cdot83\times10^{10}$ gms. per c.c. This gives for the velocity of ether drift in a magnetic field of intensity equal to 1 electromagnetic unit the value $w=1\cdot44\times10^{-6}$ cms. per sec. These figures enable us to calculate the momentum due to any given magnetic distribution.

A moment's consideration of the simplest possible case, that of a moving charged sphere or an electron, will serve to show that this distribution of ethereal velocity leads to impossible results. We have seen that $\rho=e^2\mu/4\pi a^4$, and by making use of the expression for the magnetic field due to a moving charged sphere of radius a we find that the velocity of ethereal flow w, at a point the coordinates of which are r, θ with respect to the electron and its line of motion, is given by

$$\tfrac{1}{2}\rho w^2=\frac{\mu e^2u^2\sin^2\theta}{8\pi r^4}$$

or

$$w=\frac{a^2}{r^2}u\sin\theta.$$

Hence the momentum per unit volume at a point r, θ from the centre of a sphere of radius a and charge e moving with velocity u is given by

$$\rho w=\frac{e^2\mu u}{4\pi a^2}\,\frac{\sin\theta}{r^2}.$$

Since the momentum is distributed in circles round the line of motion there is no resultant momentum, but if the above expression be integrated it will be seen that there is an infinite quantity of momentum in the field for any finite value of u, and, moreover, there is an infinite moment of momentum about the line of motion. The existence of this momentum would make it impossible to set a charged sphere in motion; the same result would be arrived at by any theory which makes the velocity of the ether proportional to the magnetic force.

Electrodynamic theory has led to an expression for the momentum per unit volume of the ether by ways which are less speculative. This expression is $1/4\pi$ times the product of the electric and magnetic displacements, and it has the merit of making the momentum in the ether equal to the product of the (electric) mass and velocity of the moving charge. If we are to have a hydrodynamical theory of the ether it seems reasonable to make this agree with the fluid momentum. We thus get for the case of the charged sphere

$$\rho w=\frac{\mu e^2u\sin\theta}{4\pi r^4},$$

and from the energy expressions

$$\rho w^2=\frac{\mu e^2u^2\sin^2\theta}{4\pi r^4},$$

whence $w=u\sin\theta$ and $\rho=\mu e^2/4\pi r^4$. This result makes the velocity of flow of the ether independent of the radial distance from the electron, but the amount moved varies inversely as the fourth power of the distance. It has been pointed out by J. J. Thomson that this result can be interpreted hydrodynamically by supposing that the ether is carried along by the tubes of electric force, and that the extent to which the ether is "gripped" by the tubes of force is proportional to the square of their concentration. If we suppose the whole of the ether to be carried along at the equator of the electron, this method would give the same estimate for the density of the ether as that found by Lodge. If only part of the ether were carried along by the tubes of force even at the equator of an electron, the density of the ether would have to be correspondingly increased, so that this method can be regarded as giving the value $\rho=\mu e^2/4\pi a^4=3\cdot85\times10^{10}$ gms. per c.c. as an inferior limit to the density of the ether. The actual value may be much greater than this.

The hypothesis of no ether slip at the equator of the electron leads to what seems to be a difficulty, at present at least. From what has been said it will be seen that it definitely establishes the relation $e=4\pi a^2\sqrt{\rho/4\pi\mu}$, so that the charge on an electron is equal to its superficial area multiplied by a quantity which depends only on the properties of the ether. Thus the size and mass of any electron are determined as soon as its charge is known, and any one of these quantities is determined by any non-identical combination of the others. The experiments of Bragg on the stopping power of different substances for α rays lend support to the suggestion, first put forward by H. A. Wilson, that these are positive electrons. Now the experiments of Rutherford have shown that the value of e/m for the α rays emitted by a large number of radioactive elements is very nearly 5×10^3 e.m.u. per gm. This value of e/m leads, on the hypothesis of no equatorial slip, to the value $e_2=10^{-13}$ e.m.u., or 10^7 times the charge on the negative electron. It would be difficult to make an electron with a charge of this magnitude the foundation of atomic structure. This difficulty occurs with at least equal force on the assumption of magnetic ether flow.

The argument of the last paragraph, so far as it is deserving of weight, tends to show that the ethereal density is greater than the limiting value. The considerations brought forward earlier would appear to show that the ethereal flow, if it exists, is at right angles to, and not along, the lines of magnetic force, and that the effect sought for experimentally by Sir Oliver Lodge is not to be expected. O. W. RICHARDSON.

Princeton, N.J., May 12.

Radium and Geology.

WITH apologies to Prof. Joly (p. 55), I think my estimate of a gradient of 1° F. for 98 feet in the Simplon Tunnel will bear examination. From a contemporary notice in the *Daily Mail* of October 3, 1904, it is clear that the heat in the tunnel was endurable until the hot spring was tapped. The water is stated to have been at 131° F., which agrees *exactly* with 55° C., "the highest temperature" of Prof. Joly. Surely, then, this was the temperature of the spring, and not of the rocks.

I would also remark that Mr. Strutt considered that the amount of radium in the igneous rocks examined by him would, on his theory, account for a gradient as high as 1° in 42·2 feet, a very different thing from the 1° in 70 mentioned by Mr. Fox. O. FISHER.

Graveley, Huntingdon, May 17.

Eye Migration in Flat-fishes and Lamarckianism.

MR. R. H. LOCK, in his recent book on "Variation, Heredity, and Evolution" (reviewed in NATURE of April 27), has, in common with many other writers, adduced the phenomenon of eye transposition in flat-fishes as a cogent argument in favour of the transmission of acquired characters, remarking that "an alternative hypothesis is lacking." I venture to dispute this position, believing it to be decided evidence in support of the potency of natural selection to accumulate small mutations. I quote a part of the passage (p. 35) that my argument may be the better understood:—

"In the adult condition these fishes lie flat on one side; and during their development from the young condition that eye which, if it remained in its original position, would look directly downwards travels round the head until it comes to lie quite upon the upper surface. . . . The very young fish whilst still symmetrical, are known sometimes to fall upon one side, and when in this position to twist the lower eye forcibly upwards. Darwin himself therefore supposed that the origin of the adult structure is to be attributed to the inherited effect of efforts of this kind."

This misinterpretation of the phenomenon seems to me to arise from an inadequate appreciation of the nature of the actual variation, *i.e.* the *capacity to twist the eye*, which is exhibited by the young fish. The young of some other fish are known to exhibit the same muscular control over the orbit ("Origin of Species," p. 292), and we need only to suppose that the forerunner of the modern race of flat-fishes possessed it as a fortuitous variation to the extent of making vision just possible whilst in the recumbent position; and this would seem to be the case, for it is recorded in the "Origin of Species" that a young fish has been observed to "raise and depress the eye through an angular distance of about seventy degrees." In the transmission of the original variation to the offspring it is not the *effect* of the movement which is passed on, but the *structural arrangements which enabled it to initiate the movement*, the amplitude being increased in successive generations by the aid of natural selection.

This contention may be supported by citing a peculiar muscular capacity possessed by myself. I am able to raise and depress the right eyebrow independently of the left, but I have no such control over the other. To test whether this power may not be induced by practice, I have striven to raise the left whilst holding down the right, but find myself quite unable to accomplish it. Herein we see that the capacity to make the movement is of itself a distinct mutation; and assuming that in the case of the flat-fish mobility of the optic aperture was so far possible as to be of advantage to it, natural selection would operate in preserving those of the progeny which were able to retain the eye in the advantageous position with the least possible effort.

I have ventured to tender this explanation to the readers of NATURE because the phenomenon is very generally used as a good illustration of Lamarck's doctrine, and as being "inexplicable on the theory of natural selection."

Bournemouth, May 10. ARTHUR J. HAWKES.

TWO WORKS ON INDIAN ETHNOGRAPHY.[1]

MR. CROOKE'S book appears in a series edited by Mr. N. W. Thomas which, to quote the general preface, "is intended to supply in handy and readable form the needs of those who wish to learn something of the life of the uncivilised races of our Empire." To Mr. Crooke has been entrusted the task of describing the races of northern India, and we may at once state that he has achieved very considerable success. The area covered, extending from Afghanistan to the Chinese frontier, is so great, and its aspects are so complicated, that not even such an authority as this distinguished scholar could venture into details within the limits of the two hundred and fifty odd pages at his disposal; but he has given a broad general view, sketching in with a few accurate and telling strokes the more prominent features of the landscape, so that the whole presents a satisfactory and attractive summary of the racial characteristics of an important section of the British Empire.

After a brief account of the country and of the influence of its environment upon the people, Mr. Crooke describes its three main physical race-types—the Mongoloid, the Dravidian, and the Indo-Aryan. The last-named leads him to the consideration of the castes of the great plains, to the Indian village and its industries, and to the home life, including the occupations of women, together with the games and amusements of the children. Turning to the religion of the people, we have first an account of the birth, marriage, and death rites, and then a general description of the popular religion, magic, and witchcraft. There are more than thirty admirable full-page illustrations, the value of which is somewhat impaired by the binder having placed them at approximately equal distances from each other throughout the book, without consideration of the context to which they refer, and which, in spite of a good index, it is not always easy to find. In other respects, too, the mechanical execution of the work leaves room for improvement. Proper names are not always spelt correctly. The well-known Norwegian philologist appears as Dr. "Steinkonow," and the proof-reader's ideas of the spelling of the name of a writer on Chota Nagpur oscillate between "Bartley-Birt" and "Bradley-Birt," the latter, of course, being the correct form. Worst of all, the numbering of the plates was evidently altered after the text had been printed off, so that not a single reference in the text to the plates is correct.

These are, however, but minor matters, which can easily be set right in the next edition, and for the work as a whole, although we may differ on a few controversial points, we have nothing but praise. Mr. Crooke, while following Mr. Risley in his conclusions as to the race-origins of the Indian people, shows a wise caution in accepting his opinion with regard to details, and, like other scholars, enters a protest against his undue extension of the name "Dravidian" (properly a linguistic term) to the entire mass of the population of northern India which is not Aryan or Mongolian. He himself, on the other hand, seems to have misunderstood the results of the latest philological researches when he states that it has been recently proved that the two great non-Aryan linguistic families of India, the Munda and the Dravidian, are mutually connected. He quotes Dr. Grierson's authority for this; but we are under the impression that, in his latest writings, that scholar has strongly maintained the distinct origin of these two groups of speeches, and the researches of Pater Schmidt, of Vienna, have shown that the Mundas are related, both ethnically and linguistically, to the Mon-Khmer tribes of Further India, and perhaps even to the inhabitants of Polynesia. As for the Dravidian languages, it seems not improbable, although positive proof is yet wanting, that they are connected with those of the aborigines of Australia. The fact that the speakers of Dravidian languages and the speakers of Munda languages have the same physical type has not yet been satisfactorily explained, but Dr. Sten Konow's theory that the common type is really Munda, and has been acquired by the Dravidian-speakers through intermarriage (just as the Indo-Aryan type of the Lower Ganges

[1] "The Native Races of the British Empire. Natives of Northern India." By W. Crooke. Pp. xiv+270. (London: A. Constable and Co., Ltd., 1907.) Price 6*s*. net.

"The Khasis." By Major P. R. T. Gurdon, I.A. With an Introduction by Sir Charles Lyall, K.C.S.I. Pp. xxvii+227. (Published under the Orders of the Government of Eastern Bengal and Assam. London: D. Nutt, 1907.) Price 7*s*. 6*d*. net.

Valley has been similarly altered) is at least worthy of attentive consideration.

In dealing with the general race question, Mr. Crooke adopts the only scientific method (too often neglected) of commencing at the bottom with the so-called aborigines and working upwards through the mixed tribes to the pure Indo-Aryan. His account of the wild hill-tribes, whether Mongoloid or Dravidian, is excellent, and brings together a mass of information that has hitherto been scattered through a number of not always accessible memoirs. When he comes to the Gangetic plains he is on his own ground, and writes at first hand. His unrivalled acquaintance with the people of the United Provinces, their customs, and their religion, makes this the most valuable section of the book. The

FIG. 1.—Raja of Rampur, with attendants, Punjab Hills. From "Natives of Northern India."

thorny question of the origin of caste could not be adequately discussed without trenching on space which might more legitimately be devoted to other purposes, and he contents himself with stating his own opinion, which is a modification of that put forward by Mr. Risley. He considers that castes owe their inception partly to crystallisation of occupation and partly to the persistence of the idea of tribe. He gives the reader a vivid picture of the home-life of the plains villages. It is one with which most Indian officials and missionaries are familiar, but which has seldom been put in print. The existence of an Indian agriculturist is a laborious one, with little to relieve its monotony except a rare pilgrimage or the occasional chance of the greatest luxury of all, a lawsuit. Perhaps Mr. Crooke lays too much stress on his alleged ignorance of any literature. While books are almost unknown to him, he has not only ballad poetry, much of it of real excellence, but is more or less familiar with the works of the great religious writers of his country, such as Kabīr or Tulsī Dās, and has had their best verses ready on his lips since childhood. Here, too, we may point out that while Mr. Crooke's account of Indian village religion is, so far as it goes, masterly, it only illustrates one side of the subject, the worship of local deities. He has failed to take into consideration the results of the great reformation of Hinduism which swept over northern India in the

FIG. 2.—A Panka, Dravidian Weaver, Southern Hills. From "Natives of Northern India.

sixteenth century, and which has, in Rāma, given the village people a personal supreme deity, whom they can and do worship, and who is above all the local gods and godlings. The essence of the reformation was the discovery of the Fatherhood of God, and that fact alone has had immense influence in moulding the general character of the population of the Gangetic Valley.

If we have criticised a few of Mr. Crooke's statements, we freely admit that they deal with points of detail, some of which are objects of controversy. We can strongly recommend his book to the general reader who desires information regarding the native races of northern India. His style is always interesting, and there is not a dull page from beginning to end of the volume.

Major Gurdon's work is the first of a series of monographs on the more important tribes and castes of Assam now being issued by the Government of that province. While Mr. Crooke deals with the broad outlines of the ethnology of the whole of northern India, this work is confined to a single tribe numbering less than two hundred thousand souls. Although they are so few, the Khasis are a race deserving special study. Half a century ago Logan showed their relationship to the distant Mons of Pegu and Khmers of Cambodia, but his researches lay hidden in a local magazine, so that, until Kuhn revived the question in 1883, it was the general impression that the tribe was an isolated survival from prehistoric times, whose language formed a distinct family by itself, and which had no connection with any other known race. The researches of Kuhn, and, later on, of Schmidt, have placed the whole subject on a new and sure footing. We now know that Khasi is a member of an important group of languages including forms of speech, such as Palaung and Wa, closely allied to Mon and Khmer, and also Nicobarese and the Munda tongues of India proper. Moreover, not only are the languages connected, but the speakers all possess the same racial characteristics. This language-group Schmidt has named the "Austro-Asiatic" subfamily, and he maintains that it is related to the "Austro-Nesic" subfamily spoken in Indonesia, Polynesia, and Melanesia—the two together forming, under the name of the "Austric" family, the most widely spread collection of allied speeches upon the face of the earth. A special and minute study, therefore, of the speakers of one of the members of this great family is just now well-timed and of considerable interest, and Major Gurdon, the superintendent of ethnography in Assam, is exceptionally fitted to undertake the task.

For the benefit of those who are not familiar with Indian ethnography, it may be stated that the Khasis are a tribe inhabiting the Khasi and Jaintia Hills in the Indian province of (as it is now called) Eastern Bengal and Assam. They are surrounded on all sides by alien peoples, Tibeto-Burman and Aryan, and are believed to be a survival of a primitive Austro-Asiatic race that once occupied the whole of eastern India until they were conquered and dispossessed in prehistoric times by an invasion of Tibeto-Burmans. The tribal constitution is strongly matriarchal. Inheritance is through the female line, the youngest daughter being the chief heir of her mother; ancestral property can only be owned by women, and the only property which a man can possess is that which is self-acquired. The chief deities are all female. So is the sun, while the moon is represented as a man, and in the grammar and vocabulary the feminine element is much more prominent than the masculine.

Besides chapters discussing introductory and miscellaneous topics, Major Gurdon's work is divided into five sections, dealing respectively with domestic life, laws and customs, religion, folklore, and language. Each subject is treated in great detail, and the book contains much new and valuable matter not hitherto recorded. We may direct special attention to the account of the remarkable memorial stones, menhirs, dolmens, and cromlechs scattered over the country, and also to that of the curious custom of egg-divining (ᾠοσκοπία). The chapter on folklore is also most interesting. It contains a number of stories, both in the original text and in translation. These form part of a larger collection placed at the author's disposal by the Rev. Dr. Roberts, and we are glad to learn that there is a prospect of the entire series being published at some future date. The full-page illustrations of the book are numerous and in their right places, and it is further enriched by an introduction from the accomplished pen of Sir Charles Lyall.

There have been Welsh missionaries among the Khasis for more than sixty years, and to them we owe the fact that the language has been reduced to writing. Under their fostering care the tongue of a once rude and barbarous people has been given an alphabet, a fixed system of spelling (based on Welsh), and a literature. It is now recognised by the Calcutta University as sufficiently cultivated to be offered as a subject for examination by candidates from Khasi-land.

We congratulate the Eastern Bengal and Assam Government on the successful inception of what promises to be a most interesting and useful series of monographs.

ASTRONOMICAL OBSERVATIONS IN PRAGUE, 1900–1904.

THE Astronomical Observatory of Prague, like many other similar institutions which might be mentioned, has its work considerably restricted by the fact that the city in which it is situated has grown. The restricted horizon, the smoke, and the glare of the illuminated air all have tended, year by year, to cut down the amount of useful work such an observatory is capable of doing, and it is quite possible that the time will soon come when it will

Tycbo Brahe's Observatories. A, On the island Hveen (Uranienberg); B, in Wandsbeck; C, in Benatek; D, in Prague (Ferdinandeum); E, in Prague (Curtius's House).

be transferred to a site where its sphere of activity can be extended.

The volume[1] before us contains, therefore, some of the results of observations which can be carried out under such restricted conditions. Of these may be mentioned an excellent series of observations of the culmination of the moon and the crater Mösting A. The determination of the latitude of the observatory was also undertaken. The result obtained, namely, 50° 5′ 16″.02, was in complete agreement with the value obtained by Prof. E. von Oppolzer from observations made in the period 1889 to 1899. Other work here described refers to the observations of Jupiter's satellites, Nova Persei, shooting stars, &c.

The appendix contains, further, a series of useful papers by Prof. Weinek. These, for the most part, deal with some graphical explanations of the theory of the sextant, precession, planet-transits across the sun's disc, cometary orbit determinations, &c.

October 24, 1901, being the 300th anniversary of the death of Tycho Brahe, some very interesting historical notes are given relating to his two years' activity (1599–1601) in Prague. The reader may be reminded that this celebrated Danish astronomer died in Prague, and in the Teynkirche there a handsome gravestone marks his resting-place.

During his lifetime Tycho Brahe had five different observatories, and these were situated (*a*) on the island of Hveen (Uranienberg), (*b*) in Wandsbeck, (*c*) in Benatek, (*d*) in Prague (Ferdinandeum), and (*e*) in Prague (Curtius's House). These are shown in the accompanying illustration, which is taken from one of several of the fine reproductions inserted in this volume.

Others to which reference may be made are a fine coloured reproduction, in colours, of Tycho Brahe from an oil painting in the Prague Observatory; the Belvedere of Ferdinand I. (Ferdinandeum), where he observed; the Teynkirche, where he was buried; his two sextants, and other interesting reproductions of the Prague of to-day.

The volume concludes with a useful summary of the chief lunar maps and photographic moon atlases, commencing with Lohrmann (1824) and finishing with W. Pickering's atlas which was published in 1903.

[1] "Astronomische Beobachtungen an der k.k. Sternwarte zu Prag, in den Jahren 1900–1904." Auf öffentliche Kosten herausgegeben von Prof. Dr. L. Weinek. (Prag: K.U.K. Hofbuchdruckerei A. Haase, 1907.)

THE DISCOVERY OF STONE IMPLEMENTS OF PALÆOLITHIC TYPE IN VEDDAH CAVES.

DRS. F. AND P. SARASIN recently made an expedition to Ceylon for the express purpose of investigating the caves now and in past times inhabited by the Veddahs, to see whether any stone implements could be discovered. Their earlier researches proved the Veddahs to belong to a lower and older type than the other inhabitants of Ceylon, and it is conceded that they must represent the few remnants of the aborigines who were met with by the Sinhalese on their first arrival, and by whom they were called Yakas, according to the tradition preserved in the Mahawansa. Presumably, these autochthones were at that time living in their Stone age; but no record of Veddah stone implements occurs in anthropological literature. From an article in the *Ceylon Observer* of April 22, written by these indefatigable travellers, we find that on this, their fourth, expedition into the Veddah country they were lucky enough to find a cave near the village of Nilgala, which until very recently was inhabited by Veddahs, the soil of which contained in great abundance stone implements of a very rough kind. Further investigations of some other caves, one near Kattragam, the other near Kalodai, led to an identical result. They also succeeded in discovering upon the hilltops of the country of Upper Uva the same rough stone implements in great quantities and still well preserved. Not only the autochthony of the Veddahs can be regarded as a proved fact, but also their former distribution over probably the whole island, including the low country as well as the mountainous districts.

The shape of the chips, knives, lance points, scrapers, and fragments of bone awls enables this stone-industry to be described as analogous to that of the Madelaine period of the Palæolithic age. "Yet," as the cousins Sarasin remark, "this industry is to be denoted as a special *Facies Veddaica*, inasmuch as white quartz (mainly of an ice-like transparency) furnished the principal part of the material." Besides this, they also found a red, yellow, and black variety of quartz (jasper) employed in great profusion, which contrasted strangely with the monotonous grey gneiss of the caves themselves. On the whole, these implements are of small size, suited to small hands, and therefore employed by a small race of men. The stone hammers which were used to strike chips off the cores are of a remarkably small size. The Sarasins conclude their article with these words:—"We, furthermore, may already venture to say that the second main-period of the Stone age, the Neolithic one—viz. that characterised by the polished stone axe—is entirely wanting in the island of Ceylon, the Veddahs having made the step directly from the Older Stone Age into the Modern Age of Iron, which was brought them by the Sinhalese, or perhaps by another people of the Indian continent."

It is believed by some in Ceylon that there are only some hundred Veddahs existing, and Dr. Sarasin informed a *Ceylon Observer* representative that there are but a small number of Veddahs of pure blood to be found, perhaps only about fifty or sixty. These chiefly occur in Nilgala, Bibile, and the Putipola hill in Moligala, where there are only three small communities of the purest blood. Most of them build small, primitive huts, while some live in the open, sometimes in caves, but not always; those who have families build huts. Their own language is lost; being a small tribe surrounded by thousands of Sinhalese they have learnt a simple dialect of Sinhalese. They have no knowledge of their history. There is no chief, but the oldest man is called the speaker; he has, however, no privileges, and is not empowered to issue orders. They no longer know how to make stone implements, and now buy iron from the Sinhalese. Dried flesh and forest fruit are eaten. They have no religious ceremonies, but some believe in ghosts, whom they call *yakas*, though others disbelieve in their existence. Idolatry is not practised, nor do they worship stones or trees, or pray to them; indeed, the majority deny that they know anything about them. The Veddahs are strictly moral, there are no thieves among them, they never take alcohol, and they never tell lies.

A. C. H.

AN ITALIAN MONUMENT TO LINNÆUS AT THE END OF THE EIGHTEENTH CENTURY.

IN these days, when all the world of science unites in celebrating the memory and glory of the great Swedish naturalist, it is interesting to recall from the utter oblivion in which it has remained until now the monument and inscription dedicated to Linné in Naples at the end of the eighteenth century, presumably in 1778, the year of Linné's death.

The monument, which probably consisted only of the marble inscription, was not a public monument, but was raised by the fervour and admiration of Domenico Cirillo, the Neapolitan friend and correspondent of Linné, to whom the latter had dedicated the heathers of the genus Cyrilla, now included in the family of the Cyrillæ.

The Cirillo had been for long a family of doctors, naturalists, and artists. It is said that Domenico Cirillo, who was born in 1739, and graduated in 1759, was the twentieth doctor of medicine belonging to the Cirillo family. At the beginning of the eighteenth century, Nicola Cirillo, who in 1718 became a Fellow of the Royal Society of London, formed in his own private grounds in Naples a botanical garden which continued to be the scientific centre of Neapolitan naturalists until its destruction and the dispersion of the collections and herbarium in the fatal year 1799. In the sack of Cirillo's house were lost the letters written by Isaac Newton to Nicola Cirillo, and the famous herbarium of Ferrante Imperato, preserved since the sixteenth century, before which Martyn Vahl, Linné's friend and disciple, had knelt in admiration when he visited Naples in 1783.

The garden of Cirillo was the rallying point for the flower of Neapolitan thought and science, soon to be decimated and dispersed by royalist persecution during the storms of the Revolution of 1799. Many of the most distinguished men of Naples must have stood round Cirillo when the following inscription was raised in honour of Linnæus:—

CAROLI LINNAEI
Animam sapientissimam
Terris divinitus impertitam
ut
Naturae universae arcana
Declararet patefaceret
Illustraret
Postea
per dephlogisticatam
Aethercam regionem
Obvolitantem
Ne quid respub. Botanicorum
Detrimenti capiat
Vos
Fragrantissimae, soporiferae
Tetrae, spirantes
Ambrosiacae, Aphrodisiacae
Perennis voluptatis ministrae,
Herbae, Arbores, Plantae
Odoribus, Effluviis, aromate
Sistite, involvite, detinete.

The mob destroyed this inscription, together with Cirillo's house and collections, and Cirillo, with many of the noblest thinkers and benefactors of his country, was hanged in the market-place of Naples on October 29, 1799.

The inscription by Domenico Cirillo is one of the first memorials erected in a botanical garden to the memory of Carl Linné. Perhaps it may be raised again in Naples, a memorial not only of Linné's glory and of Cirillo's devotion, but also of that brotherhood of science to which Linné and the societies that bear his name have so much contributed.

ITALO GIGLIOLI.

DR. ALEXANDER BUCHAN, F.R.S.

WITH the death of Dr. Alexander Buchan on Monday, May 13, after a brief illness, a long industrious life and a distinguished scientific career were brought to a close; a genial and striking personality has become a memory.

Born at Kinnesswood, Kinross-shire, in 1829, educated at the Free Church Normal School and the University of Edinburgh, he became a schoolmaster at Banchory, Blackford, and subsequently at Dunkeld. He had, at the same time, an independent taste for field botany and meteorology.

An affection of the throat proved to be an embarrassment in his scholastic work, and in 1860 he was called to Edinburgh to be secretary of the Scottish Meteorological Society. It was a time of remarkable activity; indeed, it was a notable period in the development of the modern science of meteorology. In Paris, Leverrier had traced the progress across Europe of the celebrated Crimean storm. In London, FitzRoy was busy with the daily comparison of reports by electric telegraph from a number of stations in the British Isles. The British Association was maintaining a physical observatory at Kew, in the superintendence of which Balfour Stewart had just succeeded Welsh, a pioneer in meteorological ballooning. In this enterprise Welsh was soon followed by the intrepid Glaisher, under the auspices of a British Association Committee, with the active support of Lord Wrottesley. The Master of Trinity included the design of an anemograph among his achievements. In Scotland, Thomas Stevenson, Milne Home, and Sir Arthur Mitchell, with the support of the great Scottish physicists, formed the nucleus of the energetic society which, under Buchan's management, became one of the most important centres of meteorological investigation, the focus for the collection of observations from all parts of Scotland, and the controlling body for a network of volunteer stations. The work of examination and tabulation, conducted almost wholly by Buchan and his niece, Miss Jessie Hill Buchan, received official recognition as supplying many of the summaries of observations at stations of the second order in Scotland required by the Meteorological Office in London for international purposes, and as preparing the meteorological reports for the Registrar-General for Scotland on lines somewhat similar to, but not identical with, those prepared for the Registrar-General for England and Wales by James Glaisher, first as a member of the staff of the Royal Observatory, and subsequently on his own account.

A few words as to Buchan's scientific work must suffice. With Baxendell, of Manchester, he was largely instrumental in securing the general acceptance of Buys Ballot's principle of the relation of wind to air pressure. He had the faculty of statistical insight, and realised that by the appropriate combination of many observations it was possible to trace the interdependence of phenomena which might be affected separately by a number of independent causes. This insight is illustrated in a remarkable way by his papers with Sir Arthur Mitchell upon the relations of climate and health in London. Such a method of investigation does not always commend itself to the student of physics, who, fortunate in having the conditions under his own control, is accustomed to trace the direct connection between cause and effect in each separate experiment. But the remarkable results of Buchan's work, which still remain to be followed up, enable one to understand the enthusiasm for collecting observations, and more observations, that seem purposeless to some of those who look on.

His "Handy Book of Meteorology," published in 1867, followed by a second edition in 1868, and now long since out of print, though a new edition has always been looked for, and his "Introductory Textbook of Meteorology" (1871) are ample evidence of his general grasp of meteorological work, but his favourite method of meteorological investigation was the map. Beginning from the time when the reduction of the barometer to sea-level for synchronous charts and the identification of closed isobars as cyclonic and anticyclonic areas were novelties, he was the first to trace the course of a "depression" across the Atlantic; and subsequently, by the collection and discussion of data from all parts of the world, to give in a paper before the Royal Society of Edinburgh "the mean pressure of the atmosphere and the prevailing winds over the globe."

This was followed by the monthly charts and tables representing the atmospheric circulation in the volume contributed to the *Challenger* Reports and published in 1889, and the corresponding results for "oceanic circulation" in 1895.

His monthly maps of forty-year averages for the British Isles developed likewise (with the assistance of Dr. A. J. Herbertson) into the compilation of the wonderful atlas of pictorial meteorology published by Bartholomew in 1899. Therein is, indeed, a worthy representation of Buchan's meteorological method.

It was by the method of the map that he proposed to deal with the outstanding results of the Ben Nevis observations, which were collected largely under his own supervision, and have been already the subject of numerous papers. His capacity for dealing in this way with huge masses of figures was amazing. I have often gone with him over the details of daily maps exhibiting the results for Scottish weather at official stations, lighthouses, and private stations to trace some generalisation which had been suggested by his work. His programme was to correlate these daily maps with the observations at the summit and base of the mountain. The methodical care in ordering the entries, and their arrangement as regards colour or design to bring out any salient features, were thoroughly characteristic of his work.

From 1877 until last year, when it was arranged that he should continue the work upon the Ben Nevis observations instead, he was inspector of Scottish stations for the Meteorological Office. Throughout Scotland he succeeded in eliciting from the observers an enthusiasm for accurate work that is truly remarkable. Last year I followed myself the course of his rounds, and was interested to verify the eulogistic phrases about the Scottish stations which used to be characteristic of the reports of the annual visitation.

In 1887, Buchan succeeded Stokes as a member of the Meteorological Council. Sir R. Strachey, Sir W. Wharton, Sir G. H. Darwin, Mr. Galton, Mr. E. J. Stone, and subsequently myself, were his colleagues.

The period of his tenure almost synchronises with that of the final form of the work on Ben Nevis, which was brought into full activity by the endowment by the council of the base observatory at Fort William in 1890. It may also be regarded, not inaptly, as the period during which the interest of meteorological work passed from the geographical extension of observations over the earth's surface to the exploration of the upper air, begun by Welsh, continued by Glaisher, but afterwards allowed to drop. The great enterprise of maintaining a station of the first order at the highest point of the British Isles absorbed practically all the energy of the Scottish society during Buchan's membership of the Meteorological Council. Ultimately it proved to be a greater charge than the society could support, and appeal was made first to the council, who were themselves experiencing the pinch of straitened circumstances, and then to the Government, who after a lengthy inquiry by means of a committee arrived at a misunderstanding; and the closing of the observatories was the result.

Indeed, the course of the negotiations began, as it ended, in a misunderstanding. The financial position of the office was well known; but at the time the National Physical Laboratory was in course of formation, and it was supposed that, being itself in receipt of Parliamentary aid, it would maintain its physical observatory at Kew out of its own resources. The annual sum of 400*l.* voted by the Meteorological Council would thus become free for meteorological enterprise elsewhere. But it was ordered otherwise; the payment to Kew still goes on.

In the course of the appeal some hard things were said of the council in its corporate capacity, but they were not followed by any diminution of mutual respect between its members. The only real difference of opinion was as to the ways and means of enlisting the practical support of Parliament for meteorological work. The motives which actuate the decisions upon such matters are not even now sufficiently clear to obviate legitimate difference of opinion upon the subject.

However one may regret the termination of a great enterprise, it is fair to say that the only possible conditions for its continuance were a sufficient supply of funds. All are agreed that a precarious existence under financial conditions involving semi-starvation of the work of research could not be regarded as an alternative.

Buchan was an honorary LL.D. of Glasgow, and a Fellow of the Royal Societies of London and Edinburgh. He was curator of the library and museum of the latter, and received the Makdougall-Brisbane prize from the society in 1876, and the Gunning prize in 1893. He was the first recipient of the Symons medal of the Royal Meteorological Society of London in 1902. He served for some time on the committee of the Government grant for scientific research. He was president of the Botanical Society of Edinburgh in 1870–1. He was also an honorary member of the Royal Society of Sciences of Upsala, of the Philosophical societies of Manchester, Glasgow, and Emden, and of the meteorological societies of Austria, Germany, Mauritius, Algiers, &c.

In Edinburgh society, and indeed throughout Scotland, he was a well-known figure. His striking appearance, his geniality, his familiar acquaintance with Scottish literature and literary men, and his enthusiastic devotion to his work, easily account for the high degree of respect and affection with which he was regarded in the Scottish capital. He was at his best at the hospitable gatherings of the Royal Society Club, with the management of which he was associated for many years.

He married in 1864 Sarah, daughter of David Ritchie, of Musselburgh, who died also on May 13 seven years ago. He leaves a son, Dr. A. Hill Buchan, with whom he lived, and who was his companion on many journeys.

In thus taking leave of a kindly master and a valued friend, it is not too much to say that the work of Buchan's life has contributed largely to justify the claim of meteorology to be regarded as a separate scientific subject, entitled to separate academic recognition. The physics of the atmosphere has its geographical aspect, but it is not a branch of geography; it has its mathematical aspect, but it is not a branch of mathematics; it has its experimental aspect, but it is not a branch of experimental physics. The constitutional affection of the throat prevented Buchan from using his natural powers of exposition to their full extent, but may we not hope that the University of Edinburgh will see her way to recognise the devotion of her distinguished alumnus by providing the subject of his devotion with a voice among the sciences which she fosters? W. N. SHAW.

NOTES.

We regret to see the announcement that Sir Benjamin Baker, K.C.B., F.R.S., died suddenly on Sunday, May 19, in his sixty-seventh year. We have also to deplore the death of Sir Joseph Fayrer, K.C.S.I., F.R.S., on Tuesday, May 21, at eighty-two years of age.

M. de Lapparent has been elected permanent secretary of the Paris Academy of Sciences in succession to the late M. Berthelot.

The second annual meeting of the American Association of Museums will be held at the Carnegie Institute in Pittsburg on June 4–6.

The *Observer* states that the honorary freedom of the City of London is to be conferred on Lord Lister. The proposal will come formally before the Corporation probably at its first meeting after the Whitsun recess.

The section of geology and geography of the American Association for the Advancement of Science will hold a summer field meeting from July 3 to July 10 in New York State in the region between Lake Champlain and the Adirondacks.

An exhibition of reflex cameras at present on the market, and of photographs illustrating the use of reflex cameras, is to be opened at the house of the *British Journal of Photography* on June 13, and will remain open until July 6.

The will of Mr. C. T. Yerkes, who died at New York on December 29, 1905, has just been made known. The testator bequeathed 20,000*l*. for the upkeep of the observatory at Lake Geneva, Wisconsin, to the University of Chicago, with the condition that the observatory shall always be known as the Yerkes Observatory.

Dr. W. S. Bruce is organising an Arctic expedition, with the special object of completing the exploration of Prince Charles Foreland, Spitsbergen, which he began last summer, in company with the Prince of Monaco, in the *Princess Alice*. The expedition will proceed in the first instance to Tromsoe, in Norway, and from there to Spitsbergen, in a specially chartered steamer.

The German steamship companies Norddeutscher Lloyd and the Hamburg-Amerika Linie will allow a reduction for passage tickets on different lines to members attending the fourteenth International Congress for Hygiene and Demography to be held at Berlin next September. The office of the Hamburg-Amerika Linie in Berlin has undertaken to procure rooms in different hotels for members of the congress. Detailed information concerning the reduction in price for tickets, and means of communication with Berlin, will shortly be published, and is obtainable at the bureau of the congress, Berlin 9 W., Eichhornstr. 9.

On Tuesday next, May 28, Prof. G. H. F. Nuttall will deliver the first of two lectures at the Royal Institution on "Malaria, Sleeping Sickness, Tick Fever, and Allied Diseases," and on Saturday, June 1, Sir William White will begin a course of two lectures on "The Contest between Guns and Armour." The Friday evening discourse on May 31 will be delivered by Mr. A. Henry Savage Landor, on "Recent Journey Across Africa," and on June 7 by Sir James Dewar, on "Studies in High Vacua and Helium at Low Temperatures."

On Friday afternoon, May 17, an earth tremor—possibly due to some shift of strata not wholly unconnected with extensive mining operations—took place in the Rhondda Valley, Glamorgan, and is described by those who felt it as more severe than last year's earthquake. The vibration was very distinctly felt by the miners underground, who estimated its duration at half a minute. Householders also felt the shock, and noticed crockery rattle. The vibration was not noticed anywhere else in South Wales. Similar local shocks have been felt before, notably one in the same spot on October 16, 1896.

In a letter published in the *Times* of May 18, Sir James Blyth suggests the formation of an Imperial Council to continue and elaborate the work which has, with the end of the Colonial Conference, been suspended for a time. Among the subjects calling for investigation by such an Imperial Council, Sir James Blyth includes, with many others, State-aided organisation, where needed, of agricultural activities, such as the improvement of the breeds of cattle and horses, dairy, forestry, seed selection and supply, and the promotion of technical and scientific education, with the endowment of research, in both of which we are greatly behind other nations. This permanent Imperial Council would "act as eyes and ears to the Empire as a whole," and would greatly assist scientific procedure in government.

The Pasteur Institute of South India at Coonoor was opened, the *Pioneer Mail* states, by Sir Arthur Lawley, Governor of Madras, on April 25. The Governor, in the course of a short address, sketched the history of the institute, and said that Lord Ampthill was the originator of the scheme. The consummation of the work was due to the generosity of an American millionaire, Mr. Henry Phipps, who placed one lakh of rupees at the disposal of the Madras Government. The institute will involve annually considerable expense; and the Indian Government has undertaken to bear the chief part of this, but the committee of the institute and the Government look for support to the public and the neighbouring States. His Highness the Nizam of Hyderabad has set an example of generosity by promising, for at least ten years, to give a substantial contribution to the annual expense.

The cold days of May have this year been more than usually pronounced, and for five consecutive days, from May 17 to May 21, the shade temperature in London did not exceed 55°, while on May 19 and 20—Whit Sunday and Monday—the maximum temperature was 51°, or about 15° below the average. The observations of past years commonly show low day temperatures after the middle of the month, although the occurrence is not sufficiently frequent to be exhibited in any marked manner in the mean readings for any considerable number of years. In London and in many parts of England night frosts were frequently registered by the exposed thermometer during the past week, and a very keen north and north-east wind was blowing. The cold snap was more severely felt, following so closely on brighter and warmer weather: the shade temperature in London on May 12 was 28° higher than on May 19 and 20.

With the object of bringing the Smithsonian Institution at Washington into closer touch with the representative national scientific organisations of the United States and to create a new channel for the diffusion of knowledge, the secretary of the institution, Mr. Charles D. Walcott, recently sent an invitation to the National Academy of Sciences and to the American Association for the Advancement of Science to make the Smithsonian Institution their headquarters. The authorities of both the National Academy and the American Association have accepted the offer with thanks, and the step taken will assist greatly to make the Smithsonian Institution a clearing-house of national scientific learning for the United States.

In connection with the second centenary celebration of the birth of Linnæus, the opening article of the April number of *Naturen* is devoted to a sketch of the life and work of the great naturalist, by Mr. J. Holmboe. It is illustrated by reproductions of Hoffman's portrait and C. F. Inlander's medallion.

The practical work of the members of the Australian Ornithologists' Union during the sixth congress, held last November and December in exploiting the bird-life of Mount Wellington, Tasmania, forms the subject of the chief article in the April number of the *Emu*. Among the illustrations to this article is one of a group of Eucalyptus trees showing the manner in which the great black cockatoo strips off the bark in long streamers in order to feed upon the grubs of certain bark-burrowing insects. It is stated that only dead timber is attacked by the cockatoos, which are thus exceedingly useful in keeping in check insects injurious to the forests.

Insects injurious to barley and other grain when in store form the subject of a paper by Mr. W. E. Collinge published in the Journal of the Institute of Brewing, vol. xiii., No. 3. The statement, on the authority of Miss Ormerod, that in the winter of 1884–5 a sum of between 1000*l*. and 2000*l*. was lost on a single cargo of Russian barley by the ravages of *Calandra granaria* gives an idea of the magnitude of the evil, and the list of five-and-twenty injurious species given by the author serves to emphasise the seriousness of the situation. Worse still is the statement that the number of species and of individuals of such pests has notably increased in this country during the last few years. Gauze-covered windows, cleanliness, and fumigation with carbon disulphide are the chief remedies suggested by the author.

In a paper on the so-called renal portal system, published in the April issue of the Proceedings of the Zoological Society of London, Mr. W. Woodland concludes that the structures thus called are misnamed, and that there is really no "portal system" connected with the kidneys. He accordingly proposes to replace the terms "renal portal system" and "renal portal vein" by "renal cardinal meshwork" and "post-renal vein." As the renal cardinal meshwork appears to have no excretory function, the association of kidney and vein is probably functionless, and thus, in a sense, accidental. The meshwork seems, in fact, to be merely "an instance of the extension of a growing organ in the direction of least resistance; in other words, a mechanical product having no direct relation to the physiological needs of the animal."

The *Popular Science Review* for May contains the first connected account of the Jamaica earthquake which has reached us. From this description, by Prof. C. W. Brown, we learn that the earthquake was not remarkable for its violence, as this is not put at higher than 9·5 degrees; of what scale is not stated, but whichever was used, this is far short of that attained by really great earthquakes. The shock, as distinguished from the damage, was not so localised as appeared from telegraphic accounts; there seem to have been independent centres, of lesser violence, on land, and the submarine cable was broken at two places, about four and about twenty miles from Bull Bay, a couple of miles or so of cable being so thickly covered with débris that they had to be abandoned. At several places along the edge of the harbour the bottom has sunk from its old level, the maximum difference being more than six fathoms, but this subsidence was confined to a belt of from a hundred to three hundred yards in breadth, surrounding the harbour and located on the shore or slightly off shore; the middle portion of the harbour and the entrance channel were unchanged.

One of the principal functions of the International Association of Botanists is to provide critical notices of papers and books on botany in their journal, the *Botanisches Centralblatt*. An extension of this review work has given rise to the "Progressus Rei Botanicæ" for the publication of summaries prepared by acknowledged authorities in different branches of botany. The first part, issued in November, 1906, contained articles by Prof. E. Strasburger, on cell-ontogeny; by Dr. D. H. Scott, on Palæozoic botany; and by Dr. C. Flahault, on botanical geography. The second part, lately received, also contains three articles. Dr. L. Laurent reviews the progress of palæobotany with reference to angiosperms, Mr. W. Bateson deals with the subject of genetics, and Dr. F. Czapek writes on the physiology of nutrition. With regard to Dr. Laurent's contribution, he explains that it is concerned with the development of the angiosperms in the Cretaceous and Tertiary periods. Besides recording new observations, the author discusses methods employed and the general trend of results. A noticeable feature of Mr. Bateson's review is the general combination of zoological and botanical facts. Dr. Czapek starts from the date of the publication of the first volume of Pfeffer's "Plant Physiology," and follows that author in his arrangement. Among the subjects receiving special notice are the water-current in plants, methods of absorption, assimilation of carbohydrates and enzymes.

A monthly list of the publications of the U.S. Department of Agriculture is sent to all who apply for it, and is received by us. The activity of the department in obtaining information upon every branch of scientific agriculture and making it available in reports, bulletins, circulars, and other publications, issued at the nominal price of a few cents, is really remarkable. The monthly list now before us is a six-page leaflet containing the titles of many publications of importance, and including as new no fewer than nineteen bulletins, twenty-one circulars, and two farmers' bulletins on flax culture and experiment-station work. Our Board of Agriculture and Fisheries issues many useful leaflets, but its work cannot be compared with that of the United States Department of Agriculture, which is continually obtaining new knowledge. It could not be otherwise under the present conditions; for while a few hundred pounds a year represent the contribution our Board is able to make for agricultural research, the expenditure on investigations under the U.S. Department of Agriculture amounts to more than two hundred thousand pounds annually, exclusive of salaries of permanent officials and expenses of publications. Our politicians profess regard for British agriculture, but they do nothing to provide for the development of the knowledge which is even more necessary in the old country than it is in the new.

Dr. V. Conrad made some interesting experiments on the ionisation of the air at the Säntis Observatory, Switzerland (altitude, 8200 feet), in August, 1905, the results of which are published in the Proceedings of the Vienna Academy for July 12, 1906. The author found that the daily variation in the amount of positive ions exhibited quite a different type from that of the negative ions. The daily range of the amount of positive ionisation showed a principal maximum at 11h. a.m., that of the negative at 3h. a.m. The minima agreed fairly well in time, the positive occurring at 3h. p.m. and the negative at 2h. p.m. A secondary maximum of the positive at 4h. a.m. occurred near the time of the principal negative maximum, while a secondary maximum of the negative, at 11h. a.m., occurred at the time of the principal positive maximum.

In *Meteorologische Zeitschrift* (No. 12, 1906) Dr. A. de Quervain urges several arguments in favour of the real existence of the inversion of temperature at the height of 8–13 kilometres, upon which doubt has been thrown by several persons. M. Teisserenc de Bort instituted a number of ascents at Trappes (near Paris) during the night or early morning, so that the unmanned balloons might reach their greatest heights before sunrise, which seem to show without doubt the real existence of the inversion. Dr. de Quervain points out that in the international ascents made during the daytime at Strassburg, St. Petersburg, and Zürich (as well as other places), every possible care has been taken to eliminate the effect of radiation, and that the results also fully support the reality of the inversion. There is also the fact that a stratum of air is frequently found above the inversion zone, where the temperature again decreases decidedly with increasing altitude.

We have frequently had occasion to refer to the useful work of the Zi-ka-wei Observatory, near Shanghai, in issuing timely notice of the approach of dangerous storms. At the present time it receives telegraphic reports from several of the Chinese stations, and telegrams twice or thrice daily from thirty-two foreign stations, obligingly forwarded with the consent of their respective Governments. Telegraphic storm warnings are sent from Zi-ka-wei to some fifteen of the principal Chinese ports, nearly all of which have semaphores which exhibit storm signals; notices are also transmitted to Vladivostock, Tokio, Formosa, and Indo-China. The Inspector-General of Chinese Customs has, at the urgent request of the director of the observatory, further sanctioned the erection of semaphores at twenty-five selected lighthouses not yet electrically connected, to which, from May, 1907—about the time of the beginning of the typhoon season—captains of ships leaving port are invited to repeat, during the daytime, the warning notices they have seen in the harbours for the benefit of the fishing and other small craft in the offing.

In view of the approaching tercentenary of the discovery of logarithms, Dr. F. H. Loud contributes a note to the semi-annual Bulletin of the Colorado College Observatory in which he proposes several rapidly converging series, and shows how they might be used for the re-calculation of logarithms to a large number of decimal places. A table is given of logarithms of primes below 110 to eighteen places.

Mr. Charles Urban issues a pamphlet recommending the use of the kinematograph for scientific and educational purposes. He has published a large number of rolls demonstrating living objects, such as pond life as seen through the microscope, and it is suggested, among other uses, that the kinematograph may be applied to take records of important surgical operations for future use in class demonstration, and also to exhibit to medical students the details of experiments on living animals without repeating the actual experiments before every fresh batch of students.

Prof. E. Wiedemann is well known for many contributions he has made to the subject of Arabian astronomy. In a recent communication to the Physikalisch-Medizinischen Society of Erlangen he gives the translation of a paper from the Qâsid al Irschad, "Guide to the Aspiring," to which his attention had been directed by Prof Nallino, of Palermo. The original author, who seems to have been indifferently known as al Ansârî or al Sachâwî, was a competent exponent of the astronomy of his day. Astronomy he describes as the science which teaches the nature of separate bodies, their figures and positions, the distances between them, the motions of the planets, and the magnitude of the heavenly bodies. Four fundamental parts are recognised. In the first is investigated what is common to all spheres or orbits, the words seem to have the same significance, to the relations between them, and the proof that they all move, the earth remaining at rest. In the second is demonstrated the character of the motions of the heavenly bodies, how many there are, the divisions of the zodiac, and the phenomena of the eclipses. The third treats of the earth and of the climate in different places, and of the differing lengths of the day and night according to latitude. The fourth part considers the magnitude and the distances of the stars. References are made to classical works in which these subjects can be studied at greater length. Further subdivisions follow, having reference to the calculation of ephemerides, the calendar, the method of observing, the projection of the sphere, and problems connected with the gnomon. Into these it is scarcely necessary to follow either the learned Arabian or his able translator. The paper is interesting, but its scientific value is mainly confined to the elaborate notes with which the author has enriched his translation. These notes are both philological and historical.

Students of the early history of science will find an elaborate and interesting discussion of Petrus Peregrinus de Maricourt's "Epistola de Magnete," by Prof. S. P. Thompson, in vol. ii. of the Proceedings of the British Academy. Petrus Peregrinus, we learn, was a native of Picardy, a friend of Roger Bacon, and a man of very varied knowledge for his time. The "Epistola" is believed to have been written in August, 1269, while its author was assisting in the siege of Lucera, in southern Italy. Peregrinus's chief claim to distinction, in Prof. Thompson's opinion, was his invention of improved forms of the compass. One form, like earlier compasses, was floated in water, but it was the first to possess the equivalent of a "lubber" line and a divided circle. A second form was pivoted, and may be regarded as the precursor of the azimuth compass. An even more curious instrument, which, though illustrated, was presumably never materialised, was to consist of a light pivoted circle, having a number of inwardly directed iron teeth, with a fixed lodestone at its centre. Peregrinus's hope was to secure perpetual motion. There seems here almost an anticipation of one idea at least embodied in the dynamo, but Prof. Thompson is too experienced a writer to enter on this theme with an audience where his remarks would be liable to misconstruction. The discovery of the declination of the compass from true north has been ascribed by some to Peregrinus, but this Prof. Thompson says is a mistake, arising from a spurious addition made to a Leyden MS. of the "Epistola" about the end of the fifteenth century. In Appendices A and B Prof. Thompson enumerates the various MSS. and printed versions of the "Epistola." Of the twenty-eight MSS. enumerated, it is surprising to find that no fewer than twelve are in libraries situated in the United Kingdom, seven being in the

Bodleian and two in Prof. Thompson's own possession. Some of the scientific aspects of Peregrinus's work received a somewhat fuller treatment recently at the hands of Dr. L. A. Bauer (U.S. Coast and Geodetic Survey's "Magnetic Declination Tables and Isogonic Charts," 1902, pp. 16–20), but the present discussion is much more complete on the literary side.

The magazine of photographic art known as the *Practical and Pictorial Photographer*, so ably edited by the Rev. F. C. Lambert, was until quite recently published by Messrs. Hodder and Stoughton. This monthly has now been acquired by Messrs. Robert Atkinson (London), Ltd., and will in future be published at their offices in 10 Essex Street, Strand. From the editorial notes it is gathered that some changes have been contemplated in the new issues, and the March and April numbers point out the direction in which such alterations have been made. The modifications include an attempt to issue the publication on the first of each month; one long or a collection of small articles dealing with one subject in a comprehensive manner in each issue; a change in the inks and paper employed for the illustrations to secure more transparent and luminous shadows in the reproductions; a detachable card which deals with all the constant needs of the dark-room, such as standard developing formulæ for negatives as given in the March number. Another important innovation is the insertion of the text and a page of illustrations in connection with the great National Photographic Record Survey that is being so well taken in hand now all over the country. The reader will therefore gather that the future issues of this excellently illustrated magazine will have an added interest, and the March and April numbers should be seen to fully appreciate the changes made.

The twelfth of a series of Bulletins published by the Engineering Experiment Station of the University of Illinois embodies a detailed report, by Prof. A. N. Talbot, on tests of reinforced concrete T-beams. The tests were made with the object of determining whether the width of the slab is a controlling element in the strength of the beam, and to ascertain the efficacy of vertical reinforcing stirrups in resisting web stresses.

In the Journal of the Franklin Institute (vol. clxiii., No. 4) Mr. Persifor Frazer discusses the application of scientific methods to the study of handwriting, and shows that when the province of this study is recognised as within that of experimental psychology, entirely capable of being conducted like other investigations of the human faculties by exact measurement and numerical statement, the shallow pretenders who have from time immemorial infested it will disappear.

An interesting account of the work of the United States Reclamation Service is given by Mr. C. J. Blanchard in the *National Geographic Magazine*, Washington (vol. xviii., No. 4). The vast expenditure on national irrigation is the outcome of an Act passed in 1902 which provided that the money received from the sales of public lands in fourteen arid States and two Territories should be used as a reclamation fund for the construction of the works necessary to irrigate arid lands in those regions. In the same issue Miss E. R. Scidmore reproduces twenty-five admirable typical illustrations, of great anthropological interest, of women and children of the Far East.

Messrs. A. Gallenkamp and Co., Ltd., have added to their "technical" series of physical apparatus ten useful pieces of apparatus which will greatly assist the practical study of heat. The catalogue describing the instruments shows how satisfactory results may be obtained and used to illustrate principles.

Mr. Edward Stanford announces for early publication a new edition of his "Geological Atlas," which will deal with Great Britain and Ireland in place of Great Britain alone as formerly. The maps and text have been revised, and among the new features is a full list of the figured fossils, with indications of their zoological position and range in time.

Part v. of Mr. Charles Stoneham's elaborate work on "The Birds of the British Islands" has been published by Mr. E. Grant Richards. The work will be completed in twenty parts, and its general character was described in a review of the first part in Nature of October 18, 1906 (vol. lxxiv., p. 607). We shall notice the publication again when the whole of the parts have reached us.

Messrs. W. and A. K. Johnston, Ltd., have placed upon the market a form of their "world-wide sectional pad" which is likely to be of service to surveyors, military men, and others. The side of a small square represents a hundred yards, and intervals of a thousand yards are indicated by slightly darker ruling. The scale of the paper is such that a mile is represented by 1 inch. This form of sectional paper will prove useful to teachers of geography who exercise their pupils in the construction of simple plans. The price of the pad is 1*s*. 6*d*. net.

The new catalogue of microscopical lenses and apparatus issued by Messrs. Voigtländer and Son, whose manufactory is in Brunswick, Germany, is conveniently arranged and beautifully illustrated. Mr. F. G. Phillips, 12 Charterhouse Street, Holborn Circus, E.C., is the sole agent for Great Britain and the colonies. The tabular arrangement adopted in the catalogue makes it easy at once to discover prices, sizes, and other particulars.

Attention is frequently directed in these columns to the valuable preparatory work in observational science which is being accomplished by natural history and similar societies in the secondary schools of the country. An excellent instance of this useful work is provided by the seventy-third annual report of Bootham School (York) Natural History, Literary, and Polytechnic Society. In addition to the encouragement given to field work in natural science, the boys are afforded every facility to study the science of photography, are offered inducements to practise literary expression, and are provided with lectures on scientific subjects. The authorities are to be congratulated on the good year's work described in the report.

A "Guide to the Great Game Animals (Ungulata) in the Department of Zoology, British Museum (Natural History)," has been printed and published by order of the trustees of the museum. The guide has been compiled by Mr. R. Lydekker, F.R.S., and he has devoted the descriptive portion chiefly to the characteristics of the different genera and families. The scientific names employed in the guide are those adopted in the museum, and are, Prof. E. Ray Lankester points out in a preface, "to some extent a compromise between extreme views." The text is illustrated by fifty-three figures, most of which are printed from half-tone blocks. The guide, the price of which is one shilling, will provide the visitor with just the information necessary to enable him to take an intelligent interest in the exhibits.

OUR ASTRONOMICAL COLUMN.

Comet 1907*b*.—From a note published in No. 4175 (p. 366, May 10) of the *Astronomische Nachrichten* we learn that the comet discovered by Mr. Mellish on April 14 had been previously seen by Mr. Grigg, of Thames, New Zealand, on April 9. A set of elements computed by Mr. Merfield from observations made on April 9, 10, and 11 is given.

In the same journal Dr. Ebell continues his ephemeris for this object up to June 19, showing that the comet is now approximately half-way between ι and θ Ursæ Majoris. R.A. = 9h. 2·6m., $\delta = +51° \ 18'$.

The Value of the Solar Parallax.—The discussion of the Greenwich photographs of Eros, the results of which were communicated to the Royal Astronomical Society (*Monthly Notices*, vol. lxvii, No. 6, p. 380) at its April meeting, gave $8''{\cdot}800 \pm 0''{\cdot}0044$ as the value of the solar parallax. This result was obtained from the measurement of 151 plates taken with the Astrographic 13-inch refractor and 103 plates taken with the Thompson 26-inch refractor, between October 14, 1900, and January 15, 1901, and agrees very closely with the value, $8''{\cdot}802 \pm 0''{\cdot}005$, published by Sir David Gill in 1897.

Early and Late Perseids.—In a paper recently communicated to the Royal Astronomical Society Mr. Denning gives a list of the apparent paths of probable and possible Perseids observed by him during the periods July 7 to 22 and August 17 to 25 inclusive, from 1876 to the present time. The observations suggest that true Perseids may be looked for after the first week in July, but not until July 19 does the stream become conspicuous enough to enable a good radiant to be determined. Mr. Denning asks other observers to supply data from which the radiant during the earlier period might be determined with more certainty; at present there is reasonable doubt that the shower commences so early as July 7. Similarly the extension of the date of apparition to August 25 is in question, although Mr. Denning is sure that true Perseids have been observed as late as August 20.

A list of the radiants determined is also given, and the author states that quite possibly the shower extends over a period of fifty nights (*Monthly Notices*, vol. lxvii., April, p. 416).

New Elements of Jupiter's Seventh Satellite.—From twelve observations distributed evenly along the observed arc passed over by Jupiter's seventh satellite during the period January 3, 1905, to September 25, 1906, Dr. F. E. Ross has computed a new set of elements for that satellite. The principal perturbations have been included, and the observations are represented by the elements with an average error of only $0'{\cdot}4$. The inclination of the satellite's orbit, referred to the earth's equator for the epoch January 0·0, 1905 (G.M.T.), is given as $25° \ 18'{\cdot}6$, whilst referred to Jupiter's orbit the inclination is $27° \ 58'{\cdot}3$. The period, according to these elements, is 260·06 days.

Observations secured by Prof. Max Wolf on December 22 and 23, 1906, and by Prof. Perrine on November 23, are not consistent with these elements, the respective residuals in R.A. being $+10'{\cdot}0$ and $-3'{\cdot}3$ (*Astronomische Nachrichten*, No. 4175, p. 359).

The Computation of Cometary Orbits.—In Circular 128 of the Harvard College Observatory, Prof. E. C. Pickering points out what needless duplication occurs in the computation of cometary orbits. For comet 1907*a* three almost identical sets of elements were communicated to the Harvard College Observatory, whilst others, giving similar values, were published elsewhere. To obviate this waste of energy Prof. Pickering suggests that these computations should be carried out on some cooperative system, each computer taking them in turn, and further suggests that the labour thus saved might with advantage be expended on the computation of orbits of minor planets, of which objects so many are now being discovered regularly.

Astrographic Catalogue Work at the Perth Observatory (W.A.).—Although most of the Government Astronomer's report of the work performed at the Perth (W. Australia) Observatory during the year 1905 is devoted to meteorological observation, Mr. Cooke has a few words to say about the regrettable delay in the prosecution of the Astrographic Catalogue work undertaken by the West Australian Government.

The zone apportioned to the observatory was from 32° to 40° south declination, and includes 1375 regions; of these 145 remained to be taken at the date of the report. But the operations of measuring and reducing the plates were not then commenced, and there is a grave possibility that the plates may deteriorate sufficiently to render them useless. The taking of long-exposure plates for photomechanical reproduction was commenced, but was afterwards stopped on account of the expense. Some 10,000 standard stars have to be observed by means of the transit circle, and Mr. Cooke suggests that "this will form the basic work of the Perth Observatory, probably for centuries."

The Total Solar Eclipse of August 30, 1905.—During the total eclipse of August 30, 1905, Prof. Schwarzschild, of the Göttingen Observatory, together with Prof. Runge, made observations with a prismatic camera and a coronagraph at Guelma, in Algeria. Part xxx. of the *Astronomische Mitteilungen der königl. Sternwarte zu Göttingen* contains a complete discussion of the results obtained. The brightness and spectral photometry of the corona are first dealt with at some length, and then the spectra obtained are discussed, the origin, wave-length, intensity, and extension of each arc being given; the region photographed was from λ 4590 to λ 3330, and the identifications include the elements Yt, Zr, La, Ce, Nd, and Yb.

THE ERUPTION OF KRAKATOA AND THE PULSATION OF THE EARTH.

The vibration of the earth may be caused by volcanic eruptions and earthquakes, but it is doubtful if any regular pulsation can be called forth by a sudden impulse such as an earthquake or paroxysmal outbursts of volcanoes. If any rhythmic pulsation ever comes into existence, it is most probably due to some exciting cause of long duration, such as volcanoes of continuous activity giving rise to occasional explosions, thus causing frequent blows to the earth. The eruptions of Krakatoa afford an example of such a method of excitation, and we have reason to believe that there were pulsations with a period of about 67m.

The exact time of several minor explosions before the great outburst at 10 a.m., August 27, 1883, is not well known, but if we assume that the air was simultaneously affected, the record of the gasometer at Batavia gives us valuable information as to the sequence of the numerous explosions beginning on August 26. The regular succession of remarkable excursions in the indications of the gasometer, reproduced in the Royal Society report on Krakatoa eruption, is at once evident from the following table:—

	h. m.		Time interval h. m.	h. m.	m.
August 26 ...	5 20	p.m.	6 49 =	3 24·5 × 2 =	68·2 × 6
,, 27 ...	0 9	a.m.			
	1 55	,,	3 20 =	66·7 × 3	
	2 38	,,			
	3 30	,,			
	4 41	,,			
	4 55	,,	3 27 =	69·0 × 3	
	*5 43	,,			
	*6 57	,,			
	8 25	,,	3 22 =	67·3 × 3	
	9 42	,,			
	**10 15	,,	1 00 =	60	
	*11 15	,,			

The great explosions are marked with asterisks, while the sign is doubled for the principal outburst.

The whole interval = 67·2m. × 16. The mean interval of successive explosions on August 27, if those at 1h. 55m. and 2h. 38m. and at 4h. 41m. and 4h. 55m. are counted as a single phenomenon, is also 67m. The recurrence of several explosions at multiple intervals of 67m. shows that they were not always irregular, but had a rhythmic character. Another remarkable fact is the recurrence of explosions at intervals of about 3h. 20m. Recent investigations in surface seismic waves show that the principal phase of world-shaking earthquakes travels once round the earth in about 3h. 19m., which almost coincides with the recurrence intervals in the several explosions of Krakatoa. Thus the outburst of the volcano after the explosion of 5h. 20m. p.m. happened after the surface wave had made two complete revolutions round the earth. In the absence of the seismograph records at that time, we are quite ignorant of the existence of seismic waves during those explosions, but the magnetograph records at Batavia show distinct evidence of the vibrations of the ground. The repetition of explosions at regular intervals of time, which has such significance in the propagation of seismic waves, does not seem to be a mere chance coincidence. The surface seismic wave requires nearly the same time in traversing the different major arcs of the earth, so that they will meet at the antipodal point almost simultaneously, and in returning will again coalesce at the centre of excitation, in the same manner as the Krakatoa air waves. The disturbance at the origin must therefore re-accumulate at the interval of about 3h. 20m., and tend to call forth a new explosion, if the preceding explosion has already excited the seismic waves. This will probably account for the repeated occurrence at such stated intervals. Without laying too much stress on the effect of the seismic waves, which may have been associated with the spasmodic activity of the volcano, we have another reason to believe that the ground vibrated with the period of about 67m.

In spite of the numerous theories which may be advanced as to the cause of the Krakatoa sea waves, a simple hypothesis of the existence of vibrations with a period of about 67m. both before and after the explosion removes most of the difficulties that will be felt in accounting for the definite periods observed in tide-gauges scattered in different parts of the world. The activity of Krakatoa continuing from May to August 27, 1883, the exciting causes would naturally have been numerous during that interval of time to start sympathetic vibration of the earth. Whether the movement of the ground was confined to the region in the immediate neighbourhood of the volcano or extended round the whole earth could not be easily answered, and whether the period coincided accidentally with the natural mode of vibration of the earth or not is a matter of doubt, but the various data hitherto accumulated as to the rigidity of the earth from various phenomena connected with it tend to show that such supposition is efficacious as a working hypothesis.

The examination of mareograms in different parts of the world shows that the times of arrival of the Krakatoa waves are by no means definite, and the diagrams are sometimes markedly different from each other. In some the waves are blended together with the proper oscillations of the bay in which the instrument was placed, while in others they appear as regular secondary oscillations. In all cases they present long-continued disturbances; the more conspicuous waves are, with the exception of that at Batavia, preceded by minor oscillations, which sometimes merge insensibly into the higher waves, so that it is difficult to decide where the disturbance begins. According to the recent investigations by Messrs. Honda, Terada, and Yoshida, the secondary oscillations in numerous bays on the Pacific coast of Japan can be looked upon as forced oscillations by the waves of the same periods, which already exist in the surrounding ocean. During the Krakatoa eruptions the waves made their way into the surrounding seas and ocean, and the regular succession of waves in bays is to be attributed to the effect of forced vibrations.

The periods of Krakatoa waves recorded on mareograms are:—in Batavia, 122m.; Port Blair, 63m.; Negapatam, 68m.; Madras, 81·2m.; Dublat, 65m.; Beypore, 58m.; Karachi, 69m.; Aden, 67m.; Port Alfred, 64m.; Port Elizabeth, 70m.; Table Bay, 62m.; Port Moltke, 61m.; Colon, 70m. The average period of this wave series, with the exception of Batavia and Madras, is about 66m., which almost coincides with the mean period of explosions from 0h. 9m. to 11h. 15m. on gasometer records. This remarkable coincidence can be corroborated with simple physical experiments in the following manner.

When a pendulum with a magnet attached to it is set in vibration by intermittent current acting underneath, the period is double that of the exciting current, or when the pendulum support vibrates in a vertical path, the frequency is half that of the vertical motion. The well-known experiment of Melde, by which a string is set in sympathetic vibration by a tuning-fork of double frequency, and the crispation produced by the vertical vibration of the support, as observed by Faraday, are examples of forced vibrations with period double that of the exciting force. In the application to the Krakatoa eruption, we notice that the motion of the sea-bed near the place of eruption was nearly vertical; consequently, if the sea vibrates in an analogous manner as a pendulum, the period of the excited wave would be double that of the exciting body. The tide gauge at Batavia shows a big wave of 132m. $(=2\times66\text{m.})$ after the great eruption, and the mean period of the successive fourteen waves is 122m., which is nearly double the mean period of previous explosions. It is quite remarkable that if the rigidity of the earth lies between that of steel and that of glass, the mean fundamental period of spheroidal oscillation is about 67m.

According to Lord Kelvin, the tidal effective rigidity of the earth is about the same as that of steel. I have also lately shown that the prolongation of the Eulerian period to the Chandler period of about 430 days is closely connected with the velocity of seismic waves, and tends to point to the same conclusion as regards the rigidity of the earth. According to Bromwich (Proc. London Math. Soc., xxx., 1899), the periods of fundamental spheroidal vibration of an incompressible elastic solid sphere of the size of the earth are 55m. and 78m., when the rigidity is equal to that of steel and of glass respectively. In the above calculation the effect of gravity is also taken into account, which is to reduce the period by a considerable amount; with the rigidity of steel, the period is 66m. without gravity. The period of 67m. is the mean value when the rigidity lies between that of steel and of glass.

The prevalence of waves of the said period in the tide gauges scattered over the different parts of the earth's surface is a striking coincidence, and may be explained by assuming that the source of the waves was excited by vibrations corresponding to the fundamental mode of oscillation of the elastic gravity waves propagating round the earth. That most of the mareograms show continued disturbance before the appearance of big undulations suggests the probable existence of previous vibrations. Since such vibrations are radial and tangential, the waves appearing in bays at some distance from the exciting source would have mostly the same period as the source, while those observed in the neighbourhood of the eruption, as Batavia, would be double. Some doubts may be expressed as to whether the observed period is not peculiar to these bays, so that whatever may be the period of the exciting source, such undulations should invariably appear. With the exception of Aden and Colon, the proper period of the above-mentioned bays generally differs from that of the Krakatoa wave.

The above considerations favour the view that the vibration of the ground near Krakatoa was extremely slow, and had a period of about 67m. Whether this vibration extended all over the earth, or was confined to the vicinities of the volcano, is a question still to be solved. If the said period is really due to the spheroidal vibration of our planet, we shall have opportunities of determining more exactly the period of vibration when volcanic eruptions of the same character as those of Krakatoa take place, or sometimes even with world-shaking earthquakes. It will be worth examining seismograms, if great earthquakes do not give signs of the existence of vibrations of very long period by enhanced disturbances at regular intervals corresponding to the period of vibration of the earth. Another means of detecting the presence of such vibrations would be to examine the mareograms in bays with the proper period of about 67m. Long-continued observation in such bays will probably reveal the nature of the spheroidal pulsation of the earth, if such really exists.

H. NAGAOKA.

REPORT ON ARCTIC MAGNETIC OBSERVATIONS.

THIS report,[1] which was printed under the auspices of the Videnskabs-Selskabet of Christiania, at the expense of the Nansen Fund for the Advancement of Science, deals with magnetic observations made in the Polar expedition of 1898–1902 under the command of Captain Otto Sverdrup. The observations were taken by Messrs. V. Baumann and G. Isachsen, and reduced by Mr. Steen. A large part of the report is occupied by the reduction of the observations, which were not in reality very extensive. The following abstract of the mean results at the four stations where observations were made comprises the principal facts summarised on p. 81:—

Station	Rice Strait	Havne Fjord	Gaase Fjord	Gaas Fjord
Latitude N.	78° 46′	76° 29′	76° 49′	76° 40′
Longitude W.	74 57	84 4	88 40	88 38
Epoch	1899·2	1900·5	1901·6	1902·5
Declination W.	103° 4′	116° 47′	129° 33′	128° 51′
Inclination N.	86 0	87 1	87 41	87 53
Horizontal Force	0·04031	0·03315	0·02518	0·02353

The observations, as is evidenced by the smallness of the horizontal force, were taken at no very great distance from the magnetic pole, and the instruments, as Mr. Steen explains with regret, were not well adapted for use under such conditions. Captain Sverdrup's original programme, which had to be largely modified, would have taken him further from the magnetic pole, but, even if circumstances had been propitious, a modification in the outfit would seem to have been desirable. However zealous the observers, as Mr. Steen justly remarks, they can hardly be expected to retain their full interest in the work unless the behaviour of the instruments gives them confidence that the results being accumulated are trustworthy; and, it may be added, however competent those reducing the observations, the outcome of their efforts must be accepted with some reserve unless reliance can be placed both in the instruments and the observers. In the present case, economic grounds seem to have been largely accountable for the instrumental deficiencies. After the experience gained during the last few years, those responsible for expeditions to the neighbourhood of the magnetic poles will have small grounds for excuse if they fail to exercise due foresight in the choice of magnetic instruments and the training of magnetic observers in their use.

C. CHREE.

DEVELOPMENT OF LEMUROIDS.

THE development of the tarsier (*Tarsius spectrum*) and the slow loris (*Nycticebus tardigradus*) forms the subject of the seventh fasciculus of Prof. F. Keibel's "Normentafeln zur Entwicklungsgeschichte der Wirbelthiere," now in course of issue by G. Fischer, of Jena. The part before us is the joint work of Prof. A. A. W. Hubrecht and the editor. Although the text is necessarily of an extremely technical nature, the beautiful illustrations of embryos permit the student to see for himself how essentially different are the early phases in the development of these two strange Malay animals, which are included by most zoologists in the order Primates.

Prof. Hubrecht has for several years past devoted special attention to the developmental history of the tarsier, on which he has published papers from 1895 onwards. He has regarded the genus as the most primitive phase of the Primate type, sundered very widely indeed from all other lemuroids, with which it was formerly so closely associated. His unique material has been generously placed at the disposal of his coadjutor for the purpose of illustrating this fasciculus of the "Normal Plates," in connection with such material for the developmental history of the slow-loris as could be obtained—material, unfortunately, much less rich than that available in the case of the tarsier.

While Prof. Keibel, as already indicated, worked out the history of the tarsier, Prof. Hubrecht undertook that of the loris, and has likewise written the general account and the comparison of the two forms.

In the concluding section support is given to Prof. Hubrecht's original suggestion that, in view of the marked and radical divergence of their development, it is illogical to include the loris and the tarsier in the same mammalian order. Before their relative positions can be definitely determined and a thoroughly satisfactory classification of mammals in general formulated, it is necessary that the series of these normal plates of development should be very greatly extended, and our knowledge of the ontogeny of such forms as Manis, Galeopithecus, Hapale, and Chrysochloris and other insectivores very largely augmented. As an instalment to this most desirable end, the fasciculus before us is all that could be desired.

R. L.

MARINE BIOLOGY ON THE WEST COAST.[1]

YEAR by year the report on the Lancashire Sea Fisheries Laboratory increases in bulk, and the fifteenth of the series is again rather thicker than its predecessor. It contains fourteen scientific papers, as against eleven in the previous volume, and in the present case two or three gentlemen other than members of the staff have contributed.

As usual, the volume opens with a general report and review by Prof. Herdman, the honorary director of the scientific work. This is followed by twenty pages by the same author upon sea-fishery research, in which he reviews the present situation and the nature of the work done in the international investigations of the North Sea, and criticises the value of that work from the point of view of the fisheries. Without either agreeing with or dissenting from Prof. Herdman's views, we can say that he has set forth a very clear statement of his case.

Mr. Andrew Scott's report on the sea-fish hatching at Piel again records the liberation of several millions of fry, and again lacks any word as to the results of thus increasing the fish population of the area. In another paper on sea-fish hatching in Norway, however, Captain Dannevig discusses what appear to him to be the results of liberating artificially hatched cod larvæ, but his conclusions are traversed by Mr. K. Dahl, whose paper on the same subject suggests that the increase of cod in the district shows no relation to the liberation of the fry, but is dependent upon variations in the currents of water which are responsible for the distribution of the eggs. Thus the value of "interfering" with the natural reproduction of the food-fishes still remains to be proved.

Mr. Scott also reports, as usual, upon the tow-nettings for the year, and we cannot but admire the amount of trouble taken; at the same time, we are inclined to be sceptical as to whether the value of such work is equal to the labour expended upon it.

The same author contributes a short paper upon the food of young fishes. In this paper also, Mr. Scott illustrates his capacity for taking pains, and there is no doubt that such work will prove valuable, especially when taken in conjunction with work upon the food of mature fishes, such as Mr. R. A. Todd has contributed to the North Sea investigations.

Mr. James Johnstone's paper upon this subject deals only with the plaice and dab, and is upon the same lines as the one he contributed last year upon the same subject. He has now, however, gone more carefully into detail, and shows that, although the dab is less particular than the plaice in its choice of food, both the species depend mainly upon lamellibranch molluscs, especially Solen, and his observations on this point agree well with those of Mr. R. A. Todd on the same species in the North Sea.

The fish-marking experiments were continued during

[1] Report of the Second Norwegian Arctic Expedition in the *Fram*, 1898–1902, No. 6. "Terrestrial Magnetism." By Aksel S. Steen. Pp. 82. (Christiania, 1907.)

[1] No. xv., Report for 1906 on the Lancashire Sea-fisheries Laboratory at the University of Liverpool and the Sea-fish Hatchery at Piel. Pp. 269; illustrated. (Liverpool, 1907.)

1906, and Mr. Johnstone's results agree with his previous ones in so far as they show an off-shore migration in the summer and an along-shore movement in the winter. A number of other movements were observed, just as in the North Sea, where individual fish moved long distances, *e.g.* to the east and south coasts of Ireland, but such movements appear to be irregular according to present knowledge.

The same author also gives a valuable contribution on sewage pollution of shell-fish, and in this connection we regret that Prof. Herdman has not been able to give us a report upon the action of copper in connection with the purification of infected shell-fish, of which a preliminary statement appeared last year.

As usual, there is no lack of charts, tables, and illustrations, and the volume certainly shows very well Prof. Herdman's idea as to the association of scientific research and fishery problems.

FRANK BALFOUR BROWNE.

INCANDESCENT ILLUMINANTS.[1]

A LITTLE more than twenty years ago Auer von Welsbach, who was engaged on researches on the rare earths, invented the modern incandescent mantle. His first mantles were made of zirconia and yttrite earth in the proportion to make a normal zirconate. Shortly afterwards he found that the best material has a basis of thoria. Pure thoria, which requires care in its preparation, gives very little light, but if a small percentage of a coloured and permanent oxide, such as ceria, is added, it gives good illumination.

There has been much discussion about the theory of the incandescent mantle. It has been generally assumed that the temperature of a Bunsen burner is too low for a mantle to give the light it does by simple radiation unless it is much hotter than the flame. Unfortunately, the temperature of the flame is generally taken with a thermocouple, and this gives far too low a reading, as the thermocouple never reaches the real temperature of the flame; but, admitting that the temperature of the flame is high, it is still urged that the light given by the thoria with a small percentage of ceria is so great that there is something more than mere thermal radiation. It is said that the ceria acts as a catalytic agent, and that it oscillates between two states of oxidation. Ceria does act somewhat in the same way as platinum; for instance, if a ceria mantle is put on a lighted burner, the burner turned out, and the gas turned on again, the ceria mantle will glow and finally light the gas. It is odd that this is not brought forward by the advocates of the catalysis theory; but the opponents might urge that zirconia will do the same thing, and the zirconia mantle gives very little light. This does not prove that ceria does not increase the rate of combustion, however.

According to the simple radiation theory, the light depends only on the emissivity, or blackness of the mantle, and its temperature. Its temperature must be lower than that of the flame, as it must be robbing the flame of the heat it radiates. In order to give the flame every chance of supplying the heat, the threads of the mantle have to be made very fine, so that the flame can rush through the meshes, and the hot gas should be in brisk movement through the interstices of the mantle. By using a special draught arrangement, known as the intensive system, about twice the light per cubic foot of gas can be obtained. In order to get the highest temperature the emissivity should be low, that is to say, the mantle should be very white; but then, though it would get to a high temperature, it would give very little light. On increasing the emissivity the light will first increase, but this means a lower temperature, so that as the emissivity is increased from white to black the total radiation increases, but as that means a greater abstraction of heat from the flame, the mantle is cooler, and therefore radiates a larger proportion of the energy as heat and a smaller proportion as light, so the mantle gets redder and gives less light. This is just what happens in practice, whether ceria or any other coloured oxide is used.

It has been urged that, as pure ceria is white, adding it cannot make the mantle blacker; but ceria is white only when cold. A mantle may look quite white cold, and be darker in colour when hot. Rubens has devised an experiment to show this. The mantle is strongly illuminated by an arc and condenser, and its image is thrown on the screen. It looks quite white, of course. On lighting the gas, the mantle, instead of becoming still brighter, at once becomes dull. Again, alumina, which is white, gives little light. Chromium oxide is so dark that it gives only a dull red glow. But on adding a little chromium oxide to the alumina, a dark red light is first given, because the chromium oxide is too dark, but as soon as it combines with the alumina to make a light pink mantle a good light is obtained.

The incandescent mantle is now applied, not only to the ordinary Bunsen burner, but to an inverted form, which lends itself to decoration, and to the petroleum lamp. It is now also applied to air carrying a little hydrocarbon gas, and this application is said to provide an extraordinarily cheap light, which is especially useful for country houses.

One of the drawbacks to gas, compared with electric lighting, is that merely turning on does not light gas. This difficulty has been largely overcome by the use of the bye-pass, but further advances have been made. Welsbach has discovered that an alloy of cerium and iron gives off sparks on being scraped or filed, and a burner has been designed in which the act of turning on the gas scrapes a little wheel of this alloy, causing a spark which lights the gas. This overcomes the drawback of having a little jet always burning. Another invention allows the gas to be lighted from a main tap. Each burner has an attachment which lets the gas straight through to the burner when the pressure is on, but on turning the main supply off, and allowing a little gas to pass at the controlling tap, the attachment to each burner turns off the burner and lights a little pilot jet, which keeps alight until light is wanted again. On turning on the main tap the pilot jets light the various burners and go out themselves. By this means burners can be fully lighted up by turning one tap at the door of the room.

The electric incandescent light is undergoing a great change. Carbon is being replaced by metal wires. It has been found possible to make wires of high enough resistance of tungsten, osmium, tantalum, and a few other metals and compounds. The osmium lamp was the first of these, but there was difficulty in making it of high enough resistance. The tantalum lamp is now in great demand. It is made for 100 volts to 130 volts, and is much more efficient than the carbon lamp. It will not last long on alternating currents, however. The wires of a lamp that have been run for some time on a direct current show a curious notched or crinkled appearance under the microscope; but a wire that has been run on an alternating circuit looks as if the metal had been melted into short cylinders with round ends, and these cylinders had stuck together end to end without their centres being in a line. Sometimes the little cylinders are nearly separated, merely touching at a corner. This action is very extraordinary, and has never been explained. In addition to this, when a lamp breaks down on an alternating circuit, the wire sometimes goes at one point and sometimes it breaks in several places, and tangles itself up in an extraordinary way; at other times it breaks up into numerous little pieces, which will be found lying on the inside of the globe. Some of the other lamps show a change under the action of the current, but it is not so marked as in the case of tantalum.

One of the most interesting of the new lamps is the zircon. It is said to be made of zirconium and tungsten, and lamps of this material have been made for 200 volts, a matter of the greatest importance from a distribution point of view. It is possible that the conductor is really a zirconide of tungsten, and this opens up a new series of compounds. A zircon lamp for 100 volts has really six separate loops of wire mounted in series inside a bulb. A recent improvement is to provide an extremely

[1] Abstract of a Discourse delivered at the Royal Institution on Friday, April 26, by Mr. J. Swinburne, F.R.S.

light spring for each loop, so as to keep it taut. The lamp can then be used in any position.

Tungsten seems to be the favourite metal, as it gives a very high efficiency. It is probable the lamp of the future will have an efficiency of nearly a candle per watt, and this is promised by the use of tungsten. At the same time, it must be admitted that to make a wire with a resistance of 500 ohms small enough to give twenty candles with 20 watts is a triumph of inventive skill.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The board of anthropological studies recommends in a report to the Senate (1) that a diploma in anthropology be established; (2) that an advanced student who has studied some branch of anthropology under the direction of the board, and has presented a thesis, which thesis has been approved for a certificate of research, shall, on the payment of such fees as the Senate may from time to time determine, be entitled to a diploma testifying to his competent knowledge of anthropology; (3) that any member of the University having graduated before the date of the establishment of the diploma, who has presented a thesis on some branch of anthropology, which thesis has been approved by the board, shall, on the payment of such fees as the Senate may from time to time determine, be entitled to a diploma testifying to his competent knowledge of anthropology.

The John Winbolt prize for engineering for 1907 has been awarded to J. E. Sears, St. John's College, for his essay "On the Longitudinal Impact of Metal Rods with Rounded Ends."

The special board for biology and geology has nominated Mr. A. E. Shipley the representative of the University on the council of the Marine Biological Association from the annual meeting of the association in 1907 to the annual meeting in 1908.

Manchester.—The provision for study and research in metallurgy has been recently very materially increased. The equipment for metallography, as also for the heat treatment and mechanical testing of metals, has been brought up to date. Dr. H. C. H. Carpenter, late of the National Physical Laboratory, was elected professor of metallurgy a short time ago, and Mr. C. A. Edwards (Carnegie scholar of the Iron and Steel Institute) has just been appointed demonstrator and research assistant.

Sheffield.—The University council has appointed Mr. Arthur Holden to the post of assistant lecturer and tutor in mathematics. Mr. Holden, who was a scholar of Queens' College, Cambridge, is at present lecturer in mathematics at St. Mark's College, Chelsea. He will enter upon his new duties next session.

The plans for the restoration of the main building of the Merchant Venturers' Technical College, Bristol, have now been approved by the Society of Merchant Venturers; they involve very considerable changes in the arrangements of the original building. From the description of the provision to be made in the new building, it appears that the governors are concentrating the work of their college so as to provide a much more extensive equipment for those departments which train civil, mechanical, electrical, and mining engineers, and prepare for the B.Sc. degrees of the University of London in science and engineering. With this end in view, they will discontinue certain portions of the work formerly undertaken by the college.

Representatives of the University of London to the number of nearly a hundred are this week paying a visit to the University of Paris. The party includes Sir Edward Busk (Vice-Chancellor of the University), Sir Philip Magnus (the Parliamentary representative of the University), Sir Arthur Rücker (the Principal), Dr. Pye-Smith (ex-Vice-Chancellor), members of the Senate, Deans of the several faculties, Mr. P. J. Hartog (Academic Registrar), and other guests. On May 21 the visitors assembled in the grand amphitheatre of the Sorbonne under the presidency of M. Briand, Minister of Public Instruction, who with M. Liard, Vice-Rector of the University of Paris, delivered addresses of welcome, and Sir Edward Busk replied. Prof. Alfred Croiset and Prof. Gardner, Dean of the Faculty of Arts of the University of London, also spoke. Afterwards the English visitors were entertained at lunch by the municipality of Paris, and in the afternoon paid a visit to Versailles. A reception in honour of the visitors was given by the British Ambassador in the evening. On May 22 there was an excursion to Chantilly. To-day is to be devoted to an inspection of the various departments and laboratories of the Paris University; in the afternoon a reception will be given in honour of the visitors at the Elysée by the President of the Republic and Mme. Fallières. In the evening the English visitors will be the guests of the University of Paris at dinner at the Sorbonne, when the French Ministers of Public Worship and of Foreign Affairs are expected to be present. The dinner will be followed by a concert in the great hall, and a conversazione in the reception rooms of the Sorbonne. The party will return to London to-morrow.

The urgent needs of the University of Oxford led to an important meeting being held on May 16 to consider a scheme for raising a fund to meet them. Lord Curzon, Chancellor of the University, presided over a large and distinguished assembly, and in the unavoidable absence of the Lord Chancellor proposed a resolution:—"That a fund be raised, entitled the Oxford University Appeal Fund, to meet the needs of the University as set forth in the letter signed by the Chancellor and Vice-Chancellor, which was published in the newspapers on May 2, 1907." Speaking in support of the resolution, Lord Curzon announced that the fund was being started with promises and gifts amounting to 57,000*l.*, which includes 10,000*l.* from Mr. Brassey, 10,000*l.* from Mr. W. W. Astor, 2500*l.* from Mr. W. F. D. Smith, 2000*l.* from Lord Curzon, and five donations of 1000*l.* Following the Chancellor's eloquent appeal, the Chancellor of the Exchequer seconded the resolution (which was eventually carried unanimously), and took the opportunity to point out several directions in which the work of Oxford University needed development to keep the University abreast of modern needs. The Archbishop of Canterbury moved:—"That a body of trustees of not less than nine, nor more than twelve, be appointed for the administration of the fund, composed of one-third resident and two-thirds non-resident members of the University, and that the hebdomadal council be requested by the Chancellor to nominate the University representatives, and that the Chancellor and Vice-Chancellor be authorised to consult with the leading supporters of the movement as to the appointment of non-resident trustees." Lord Milner seconded the resolution, and it was carried. A further resolution was adopted appointing a committee to consider the best means of raising subscriptions to the fund. Though we are of opinion that the provision of adequate funds for our universities is a State duty, we hope that until that duty is recognised by the Government our men of wealth will see to it that the work at Oxford is not hampered by the want of what is really a modest amount when compared with the greatness of the needs of the University.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 14.—"The Purification and Testing of Selenion." By R. **Threlfall**, F.R.S.

The paper deals with the purification and testing of considerable quantities of selenion with the object of investigating the electrical constants of the element in the pure state. It was found that Ekman's and Petterson's method is suitable and satisfactory as a means of purification of selenion from other known elements, with the possible exceptions of mercury, tellurium, and arsenic. The analytical separation of selenion from tellurium was investigated, and it was found that the most satisfactory method is by fractional sublimation of the dioxides. It is shown that a sharp separation can be made by subliming a mixture of the oxides containing one part of tellurium to ninety-nine parts of selenion at a temperature of 360° C. The sublimate contains certainly less than one-tenth per cent. of tellurium, and probably less than one-fortieth per cent., the extreme limit of analytical discrimination.

A thorough investigation showed that tellurium cannot be detected in presence of selenion in quantity by spectroscopic analysis. Details as to the method of carrying out Ekman's and Petterson's purification are given. The purified product was tested for arsenic with constant reference to check and blank trials, and it was found that arsenic was present to the extent of 0·00038 per cent. Mercury was sought for by the method suggested by Marcel, and also by Dr. Sand with a special electrolytic apparatus, but none was found.

The remaining difficulty in regard to a possible solubility of selenion dioxide in selenion was not entirely overcome, though it is shown that by distillation of a mixture of selenion and selenion dioxide in an inert gas nearly, if not all, the dioxide can be separated, but there does not seem to be any perfectly satisfactory criterion as to the complete absence of dioxide. This uncertainty prevented the subject of the conductivity of really elemental selenion from being undertaken, but the highly purified material obtained was examined by Messrs. Vonwiller and Mason with respect to its specific inductive capacity. The material employed by these observers was returned to the author for re-examination, and it is shown that no material amount of impurity was introduced during the necessary meltings and treatment which it had undergone.

Royal Microscopical Society, April 17.—Mr. G. C. Karop in the chair.—The Podura scale: E. M. **Nelson.** The author traced the efforts of previous observers to interpret the markings on the scales, giving figures—which were drawn to an enlarged size upon the board—to illustrate the various interpretations, including the result of his own observations.—The root bacteria of pulse: Dr. Antonio **Rodella.**

Zoological Society, April 23.—Dr. J. Rose Bradford, F.R.S., vice-president, in the chair.—The ears of the African elephant as a race character: R. **Lydekker.** To illustrate this paper, a large number of photographs and several specimens were exhibited. The author considered that there must be many more local races than those already named by Dr. Matschie, although, with the present material, he hesitated to give separate designations to several of these. He ventured, however, to propose new names for the elephant of the eastern side of Cape Colony; for that of Mashonaland, as typified by a head in the Imperial Institute; for that of the Lake Rudolf district, as represented by a head presented to the British Museum by Mr. H. S. H. Cavendish; and for the Somali elephant, as typified by a head in the collection of S.A.R. le Duc d'Orléans at Wood Norton, this last race being characterised by the very small ears, which, however, were quite different in shape from those of *E. a. knochenhaueri*. The author also directed special attention to a skull from the Albert Nyanza district, for which he had previously suggested the name *E. a. albertensis*. Differing in many points from those of other African elephants, this skull showed a remarkable resemblance to that of the extinct Indian *E. planifrons*, thus suggesting the descent of the African elephant from that species.—Descriptions of three new species and five new subspecies of Siberian birds: S. A. **Buturlin.**—A list of small mammals obtained in the islands of Saghalien and Hokkaido by Mr. M. P. Anderson for the Duke of Bedford's exploration of eastern Asia: Oldfield **Thomas.** Fourteen species were recorded from Saghalien and thirteen from Hokkaido. The faunas of the two islands proved to be very similar to each other, although in some cases subspecific differences between the representative forms in each were perceptible. In one genus only, Micromys, the relationship of Hokkaido seemed to be with the main island of Japan rather than with Saghalien.—A list of the cold-blooded vertebrates of Saghalien: G. A. **Boulenger.**—Notes on hybrid bears: H. **Scherren.** The author referred to cases that had occurred in the society's gardens, the long series bred by Herr Nill in his zoological garden at Stuttgart (now broken up), and a recent case in the garden at Halle-an-der-Saale. Reference was also made to cases said to have occurred at Cologne and Hanover, but for these the evidence was not conclusive.—Some new species of earthworms of the family Eudrilidæ, belonging to the genera Polytoreutus, Neumaniella, and Eminoscolex from Mt. Ruwenzori: F. E. **Beddard.**—South American pseudoscorpions of the family Cheliferidæ in the collections of the British and Copenhagen Museums: C. J. **With.**

Physical Society. April 26.—Prof. J. Perry, F.R.S., president, in the chair.—Electrical conduction produced by heating salts: A. E. **Garrett.** The experiments described are divided into two series. The first, of a preliminary nature, consisted in testing a large number of inorganic compounds up to a temperature of 360° C. Several compounds, chiefly halogen salts, were found to produce easily detected conductivity when heated. In the case of zinc iodide, conductivity could be detected at the ordinary temperatures of the laboratory. The second series was confined to special cases in order to ascertain the causes of the increased conductivity. It was found that in all the cases tried a formula of the form $I = a\theta^{\frac{1}{2}}e^{-\frac{b}{\theta}}$, where I = saturation current, a and b constants, and θ the absolute temperature, represents with fair accuracy the connection between the saturation-current and the absolute temperature.—Solenoids which will move under the action of the earth's magnetic field: W. B. **Croft.** In showing Ampère's experiments, it is not very easy to complete the theory of magnetism by making a solenoid point to the north. Many years ago Ritchie made a solenoid with an iron core, which acted as a motor with the help of a mercury commutator. A copper solenoid without core was shown which had been made to rotate in this manner. The method is unsatisfactory and uncertain, owing to the rigidity assumed by the skin on the surface of mercury in certain conditions. The ampere mercury contacts cause no difficulty when a wire rotates on its own axis, but there are strong hindering forces when the wire is pushed through the mercury, partly from the skin and partly from amalgamation. The best pattern for a solenoid is suggested by the moving coil of an electrodynamometer. Two of such were shown, which were conveniently worked by four dry cells in series. Each of these was hung with very thin metal strip by bifilar suspension, the threads about 5 inches long and 1/10th inch apart. The bifilar control makes the movements manageable; it is convenient to set the coils N. and S., or the axis of the corresponding magnets E. and W., so as to make these swing up to the meridian when a current is sent through the coils.—The influence of pressure upon convection currents, and a criticism of J. Stark's relation between kathode fall of potential and temperature: W. S. **Tucker.** Stark employed as kathode a wire mounted radially in a globe-shaped vessel. The wire was heated electrically, and its resistance, and hence its temperature, determined. He refers to the weaknesses of the method:—(1) the conduction of heat away from the wire by its leads causes the observed mean temperature to be too low; (2) the error made in assuming the kathode dark space temperature to be that of the heated kathode. The author's apparatus was devised to show how seriously these weaknesses affect Stark's results.—A simple apparatus for mechanically illustrating the tangent and sine laws: J. A. **Tomkins.**

Geological Society, May 1.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—The xerophytic character of coal-plants, and a suggested origin of coal-beds: Rev. Prof. George **Henslow.** It is held that the characteristic feature of the great coal-forests was xerophytic, and the vegetation appears to be of an upland type. Illustrations are given from recent and Carboniferous plants to show the characters of leaf, root, and stem which separate these classes of plants. The position of coal-seams is accounted for by the action of earth movements in late Carboniferous times; these threw the forest-bearing surface into shallow waves and troughs, which became gradually accentuated, the latter being gradually filled with sediment, upon which, during intervals of rest, new forest growth took place.—Petrological notes on the igenous rocks lying to the south-east of Dartmoor: H. J. **Lowe.** The rocks described are contained in the Newton Abbot district, the region east of the Dart and south of the Teign. They are most nearly related, both geologically and petrologically, to those of south-west Devon, or the Plymouth district described by Worth.

Society of Chemical Industry, May 6.—Mr. R. J. Friswell in the chair.—An apparatus for the estimation of carbonic acid: H. W. **Rowell.** The sample of carbonate is decomposed by a suitable acid and boiling, and the carbon dioxide collected and weighed in potash bulbs. The apparatus consists of a 70 c.c. flask with a ground-glass stopper carrying a stoppered funnel, for admitting acid and subsequently air, and a bulb water vapour trap. An air washing tube, drying tubes, potash bulbs, and a supporting stand and aspirator complete the apparatus.—The works chemist as engineer: O. **Guttmann.** All chemical works have a large number of engineering problems to solve, and, as a rule, the chemist will have to look after them. The author explained in detail the selection of a site, the disposition of buildings and plant, the erection of buildings to standard sizes, materials, plant, &c., in view of the products to be worked and any special risks attached to them. The installation of a power-house and the many engineering details which are of advantage in the economy and control of the production of power, smoke preventers, automatic stokers and special grates, as well as water softeners and feed-water heaters, were dealt with. The author emphasised strongly that "works operations were not simply laboratory operations writ large." In his opinion it was useless to teach chemical technology with the help of beakers and test-tubes. To train a chemist properly, he ought to go to college better prepared, and have at least four years of study, with more mechanics and physics in the beginning and a proper course of chemical technology in the end. After that it is only necessary that manufacturers should realise that a works chemist is not solely an analyst, but a highly useful practical technologist, who, given a little confidence, will in a short time repay his salary many times over. The paper concluded with the sentence:—"We have heard too much about the many chemists engaged on research in the large colour works of Germany. Highly valuable as they are and important as their discoveries were, the German chemical industry is infinitely more indebted to that far greater number of works chemists, who patiently and thoroughly investigated the manufacturing processes, who had the ability to devise improvements and economies, and who found generous manufacturers and their college-trained sons to give them their confidence. It is on these lines that we must progress."

Paris.

Academy of Sciences, May 13.—M. A. Chauveau in the chair.—A functional equation occurring in the theory of certain equations on derived partials: Émile **Picard.**—Theory of the speaking condenser of M. Argyropoulos: Marcel **Deprez.** Explanation of the theory of the condenser in the secondary coil of transformer of microphone described by M. Argyropoulos on May 6.—The glucose coming from the "potential sugar" (*i.e.* the glucosides) of the blood: R. **Lépine** and M. **Boulud.** Experiments on dogs showing the effect of invertin and fibrin on the quantity of glucose which is set free in defibrinated blood from the glucosides present (compare Lépine and Boulud, *Comptes rendus*, October 8, 1906).—The employment of potassium permanganate to remove sodium thiosulphate (so-called "hyposulphate") in photography: Albert **Granger.** The author points out that the preservation of photographic positives and negatives obtained by means of silver salts depends upon the total elimination of the thiosulphate ("hypo") used for fixing them. Many oxidising agents have been introduced to destroy the last traces of thiosulphate, for example, the perborates and persulphates. These salts are, however, very inconvenient. They are expensive, and they tend tn spoil either positives or negatives if allowed to act beyond a certain time. It is difficult to tell, too, when they have completed the oxidation of the thiosulphate. Potassium permanganate is free from these disadvantages, and the following method of procedure is suggested for ordinary work. The positive or negative, after rinsing two or three times for about a minute with water, is placed in a porcelain or glass dish, and for half-plate size 250 c.c. of dilute permanganate, made by diluting 10 c.c. of a solution containing 1 gram per litre, is added. If the solution turns brownish add more permanganate until a pink tint remains. Then place the print in a 1 per cent. oxalic acid solution to remove any faint brown deposit. Wash with ordinary water until clear. Oxalic acid gives a precipitate with ordinary water, thus giving an indication when washing is completed.—Observations of the new planet ZB made at the Marseilles Observatory: M. **Coggia.**—The expedition to Turkestan for the observation of the solar eclipse of January 14, 1907: Milan **Štefánik.**—Approximate convergence in mathematical analysis: Ernst **Fischer** (compare M. Riesz, *Comptes rendus*, March 18).—A general method for the solution of Dirichlet's problem: S. **Bernstein.**—The representation of equations of the fourth nomographic order with three and four variables: Maurice **d'Ocagne.**—The resistance of air to the movement of bodies: M. **Canovetti.**—The rapidity of detonation of explosives: M. **Dautriche.** This is a continuation of work already published (*cf. Comptes rendus*, vol. cxliii., p. 641).—The alteration of the absorption bands of crystals, and the law of variation of delay of movement of electrons at different temperatures: Jean **Becquerel.** Nernst's theory and the values of the differences of potential at the point of contact of two electrolytes in solution: J. **Guyot.**—The liquefaction of air: Georges **Claude.**—The phosphorescence of calcium compounds containing manganese.—Influence of the constitution and mass of the molecules on the wave-lengths of the radiation emitted: L. **Bruninghaus.**—Action of fluorine on selenium. Preparation of tetrafluoride of selenium: Paul **Lebeau.** Working with metal vessels, so as to prevent any chance of oxyfluorides being obtained, the author prepared tetrafluoride of selenium by direct union, and found it to be a colourless liquid, boiling about 100° C., and forming a white crystalline solid at about −80° C. Brought into contact with water, the compound decomposes with evolution of heat, giving a solution containing selenious and hydrofluoric acids,

$$SeF_4 + 2H_2O = SeO_2 + 4HF.$$

The compound behaves as if saturated, so that the hexafluoride of selenium mentioned by Prideaux (Chem. Soc., vol. lxxxix., p. 316) might require further investigation.—Spontaneous oxidation of cobalt hydrate in alkaline solution: André **Job.**—The silicates of aluminium and calcium: O. **Boudouard.**—The constitution and properties of samples of steel containing boron: Léon **Guillet.**—Condensation of oxalic esters with tertiary aromatic amines: A. **Guyot.**—Some caoutchouc-bearing plants of the south of Madagascar: J. **Constantin** and H. **Poisson.**—Observations on the constitution of the membrane of the Péridiniens: Louis **Mangin.**—The delimitation and relations of the principal species of *Illipées*: Marcel **Dubard.**—The influence of light on the assimilation of the reserve organic matter of plants and bulbs by the plantules in the course of their germination: W. **Lubimenko.**—The function of sieve tubes (botanical): M. **Molliard.**—The comparative effect on the heart of different potassium salts of the same molecular concentration: H. **Busquet** and V. **Pachon.**—The occurrence of iron in animal and vegetable tissues: A. **Mouneyrat.** The author states that he has found iron in all tissues, and that, in fact, iron seems to be a constant constituent of all living cells.—The extraction of the pigments from batrachians: A. **Magnan.**—The adipose tissue replacing the vibratory muscles of the wings after the nuptial flight in queen-ants: Charles **Janet.**—The glacial formations of the Chaux-d'Arlier: Paul **Girardin** and Fritz **Nussbaum.**—The oceanic lithology of ancient seas: J. **Thoulet.**

Cape Town.

South African Philosophical Society, March 27.—Mr. S. S. Hough, F.R.S., in the chair.—A property of symmetric determinants connected with the simultaneous vanishing of the surface and volume of a tetrahedron: T. **Muir.**—The development of the ovary and embryo-sac in *Cassia Tomentosa*: W. T. **Saxton.**—The fertility of snme colonial soils as influenced by the geological conditions: C. F. **Juritz.** Chemical analyses of the soil may be of three different types, according as they show (1) how much plant food exists in a form immediately available for plants; (2) what proportions are present as a reserve stock; or (3) the aggregates of the plant-food constituents in the soil. The third type of analysis may have its value for the geologist, but only the first and second afford the farmer any indications of the land's worth, the former indicating its immediate productiveness and the latter its permanent value. Until recently sufficient samples had not been analysed by a method that could be taken as a trustworthy means of ascertaining the reserve stock of plant food in the colony's soils, nor had the Geological Commission progressed to an extent sufficient to enable it to be used as a working basis. Furthermore, the soils that had been analysed had been selected from definite fiscal divisions without regard to geological conditions. Some 200 soils had, however, been selected from the number hitherto analysed and taken as fairly representative of various geological formations. Of the soils derived from the pre-Cape rocks, those from the Malmesbury slates in the south-western part of the Colony were found to be poor all-round on the average. In the northern portion of the country, where the Campbell Rand series extended over a large area, the soils were rich in lime. The soils derived from the Table Mountain series, which were the lowest rocks of the Cape system and consisted of little else than silica, lacked all the essential mineral ingredients of plant food. Above the Table Mountain series lay the Bokkeveld beds, and these produced soils with satisfactory proportions of plant food. The highest rocks of the Cape system, namely, the Witteberg series, produced soils which may be anticipated to resemble those of the similar Table Mountain series, and the few that had been analysed bore out this view. This was the district in which bone-diseases in cattle prevailed. Of the soils of the Karroo system, those derived from the Burghersdorp beds and Stormberg series were found to be well supplied with potash and phosphates, and contained large proportions of lime. This was also the case with the soils formed from the Uitenhage series, in the Cretaceous system. For hundreds of miles fertile silts were transported by rivers in flood. To the silts thus brought down from the Karroo, the Oudtshoorn division owed its fertility, and the soil of that division was now undergoing transportation to the sea, except where deposited in the Riversdale and Mossel Bay divisions en route.—Some new fossil reptiles from Victoria West: Dr. R. **Broom**. A description is given of three new reptiles found by Mr. T. J. R. Scholtz at Victoria West, in beds which are believed to correspond to the Lystrosaurus beds of Colesberg, Middelberg, and Cradock. Hitherto almost the only fossils known from these beds have been the aquatic Lystrosaurus and fish.—Solifluction: Prof. E. H. L. **Schwarz**. Solifluction is a term coined by Andersson for the flow of saturated soil down mountain sides. Originally used only for regions covered with ice and snow, the object of the present paper is to show that the same action goes on in temperate countries, only to a smaller extent, producing stone courses in the mountainous districts, and a gradual downward creep of soil and subsoil in parts of the country which have less relief. Under the same term must be included the flow of volcanic ashes saturated with water, which are characteristic of the so-called mud-volcanoes in South America, Java, &c.

DIARY OF SOCIETIES.

THURSDAY, MAY 23.

ROYAL SOCIETY, at 4.30.—The Relation of Thallium to the Alkali Metals: a Study of Thallium Sulphate and Selenate: Dr. A. E. H. Tutton, F.R.S.—On the Frictional Resistances to the Flow of Air through a Pipe: Dr. J. H. Grindley and A. H. Gibson.—Chemical Reaction between Salts in the Solid State: Dr. E. P. Perman.—Studies on Enzyme Action, IX., The Nature of Enzymes: Prof. H. E. Armstrong, F.R.S., and Dr. E. F. Armstrong.—Studies on Enzyme Action. The Enzymes of Yeast: Amygdalase: R. J. Caldwell and S. L. Courtauld.—On Light Elliptically Polarised by Reflection especially near the Polarising Angle: a Comparison with Theory: Prof. R. C. Maclaurin.

ROYAL INSTITUTION, at 3.—Chemical Progress—Works of Berthelot, Mendeléeff, and Moissan: Sir James Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Present State of Direct Current Design as Influenced by Interpoles: F. Handley Page and Fielder J. Hiss.—Hot Wire Watt Meters and Oscillographs: J. T. Irwin.

FRIDAY, MAY 24.

ROYAL INSTITUTION, at 9.—Recent Contributions to Electric Wave Telegraphy: Prof. J. A. Fleming, F.R.S.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

PHYSICAL SOCIETY, at 5.—On the Measurement of Mutual Inductance by the Aid of a Vibration Galvanometer: A. Campbell.—Note on the Rate of Decay of the Active Deposit from Radium: W. Wilson and W. Makower.—Exhibition of Apparatus for Relay Working of Long Submarine Telegraph Cables: S. G. Brown

MONDAY, MAY 27.

ROYAL GEOGRAPHICAL SOCIETY, at 3.—Anniversary Meeting.

SOCIOLOGICAL SOCIETY, at 8.—Functional Relations of the Family and the City: Dr. W. Leslie Mackenzie.

VICTORIA INSTITUTE, at 4.30.—Mencius: Rev. F. S. Turner.

TUESDAY, MAY 28.

ROYAL INSTITUTION, at 3.—Malaria, Sleeping Sickness, Tick Fever, and Allied Diseases: Prof. G. H. F. Nuttall, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.

SOCIETY OF ARTS, at 8.—Sheffield Plate and Electro Plate: Sherard Cowper-Coles.

FARADAY SOCIETY, at 7.50.—Annual General Meeting.—At 8.15.—Contributions to the Chemistry of Gold: F. H. Campbell.—Reduction of Oxides, Sulphides, &c., by Means of Metallic Calcium: Dr. F. Mollwo Perkin.—Exhibit of Thermostatic Apparatus: Dr. T. M. Lowry.

WEDNESDAY, MAY 29.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.—Mr. C. Michie Smith on his Work at Kodaikânal.

SOCIETY OF ARTS, at 8.

THURSDAY, MAY 30.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Solubility of Air in Fats, and its Relation to Caisson Disease: Dr. H. M. Vernon.—Mitosis in Proliferating Epithelium: Dr. J. O. Wakelin Barrett.—An Experimental Inquiry into the Nature of the Substances in Serum which Influence Phagocytosis: George Dean.—The Correlation of Ovarian and Uterine Functions: E. S. Carmichael and F. H. A. Marshall.

ROYAL INSTITUTION, at 3.—Chemical Progress—Work of Berthelot, Mendeléeff, and Moissan: Sir James Dewar, F.R.S.

SOCIETY OF ARTS, at 4.30.—Irrigation Colonies in India: Laurence Robertson.

FRIDAY, MAY 31.

ROYAL INSTITUTION, at 9.—Recent Journey Across Africa: A. Henry Savage Landor.

CONTENTS.

THURSDAY, MAY 30, 1907.

ALCOHOLISM.

The Psychology of Alcoholism. By George B. Cutten. Pp. xvi+357. (London and Felling-on-Tyne: The Walter Scott Publishing Co., Ltd., 1907.) Price 5s.

The Drink Problem in its Medico-Sociological Aspects. By Fourteen Medical Authorities. Edited by Dr. T. N. Kelynack. Pp. viii+300. (London: Methuen and Co., n.d.) Price 7s. 6d. net.

MR. CUTTEN writes lucidly and well. He has delved deeply in a somewhat dreary field of literature. All men know that alcohol when taken in excess is very injurious, and may be lethal. It has contributed much to the gaiety, but more to the gloom, of nations. In the present work many of the physical and apparently all the mental ill-effects ever alleged by anyone as due to alcoholism are set forth in detail. A large part of the book consists of quotations, some of which (*e.g.* footnotes, pp. 210 and 211) obviously controvert, and were intended by the original writers to controvert, the opinions in favour of which they are quoted. There are some errors. It is stated (p. 1) that

"The use of alcohol is universal. . . . Some form of intoxication has always been found by the investigators of the most primitive people."

Doubtless all peoples who have been in a position to obtain alcohol have abused it, but until recently it has been beyond the reach of various savages, for example, the Esquimaux and Tierra-del-Fuegians.

"Moderate drinking has rarely been carried out successfully, for it almost invariably develops into excess; but to-day there appears to be less and less control, the moderate drinker passing very quickly into the impulsive, violent consumer" (p. 2).

As a fact, all races (*e.g.* Red Indians) when first introduced to drink are "furious drinkers, furious in their drink." But during the lapse of many generations they grow more moderate, as witness the Jews and south Europeans, who were drunken anciently, but to whom alcohol is now "like the taste of sweetness whereof a little more than a little is by much too much." The statement that in England "the women drunkards equal or exceed the men in number" is an exaggeration.

The author gives a very full account of the mental effects of acute and chronic alcoholism, but passes lightly over that vital matter, the psychology of the *potential* drunkard. Why do men drink? Presumably because the act promotes pleasure or surcease of pain or discomfort. Why do some men drink in moderation and others in excess? Formerly it was believed that moderation depended entirely on self-control. But almost any moderate drinker may satisfy himself by introspection that he exercises little restraint. He drinks, as a rule, as much or nearly as much as he desires. At least he has not to struggle against that dire longing that drives the dipsomaniac to destruction as with the force of a tempest. A headache or two, and a little experience of "hot-coppers," suffice to secure his sobriety. A drunkard faces them every day, and ruin, ill-health, and death as well. Men differ, therefore, in their susceptibility to the charm of alcohol. Those who are most tempted tend on the average to drink most, and so to perish. In the course of ages the survival of the fittest results in a race of moderate drinkers, such as the inhabitants of the vine belt in Europe and of the palm-toddy region in Africa. Neither climate, strength of beverages, civilisation, nor race has any influence. Drunken races are found in all zones of the earth; peoples (*e.g.* some savages) who have experience of only very dilute solutions in scanty quantities are very drunken when opportunity serves; some civilised and some savage races are drunken and some are temperate; and all races which now are temperate were anciently drunken. The invariable rule is that every race that commands a sufficient supply of alcohol is temperate (*i.e.* resistant) precisely in proportion to the duration and severity of its past experience of alcohol. The same is true of opium and every lethal disease. Thus, of all peoples that are in the habit of indulging in opium, the natives of India, who have used it longest, are most temperate, and of all peoples exposed to malaria, the natives of tropical Asia, Africa, and America are the most resistant to the disease.

By way of demonstrating that parental drunkenness is a cause of filial degeneration, Mr. Cutten quotes the opinions of various physicians who have proved that it is not uncommon amongst the ancestors of asylum patients. Unfortunately, the extent to which it has prevailed amongst the ancestors of people in the same class of life who are not insane has not been ascertained. No race that has long used and abused drink shows any signs of degeneracy. Thus Italians, south Frenchmen, and Germans are not more degenerate than Tierra-del-Fuegians or Australian Blacks. The protective evolution of races which have been exposed to narcotics or disease is not seriously disputed nowadays. It is difficult to understand, therefore, how races can grow stronger in each generation through the survival of the fittest, and yet, as implied by the authorities quoted by Mr. Cutten, weaker through the inherited effects of parental drunkenness. Obviously, natural selection has no scope if every child is inferior to the parent.

"The Drink Problem," though shorter, is more comprehensive than Mr. Cutten's book, and is altogether a valuable, practical, and readable volume, refreshingly free from fanaticism. Dr. Harry Campbell discusses very interestingly drinking amongst ancient peoples and primitive races, and traces the natural evolution of sobriety. Prof. Sims Woodhead deals with the pathology of alcoholism, and Dr. Claye Shaw with its psychology. Dr. Hyslop discusses alcoholism and mental disease. Other interesting essays are "Alcohol and Public Health," "Alcohol and Life Assurance," and "Alcohol and Pauperism."

Naturally amid much agreement is some conflict of opinion, a fact which has its humorous aspect. Thus, at the close of his essay on "The Criminology of Alcoholism," Dr. Sullivan, who believes that parental alcoholism "has a very high degree of importance . . . in the genesis of those conditions of arrested or perverted development which characterise the moral imbecile and instinctive criminal," refers the reader to the essay on heredity. When, however, we turn to that essay, we find no reference to the alleged effects of parental intemperance on the morals of offspring, but a statement that "we should expect those communities which for the greatest number of consecutive generations have had opportunities for chronic drunkenness—or what comes to the same thing, those possessing the most ancient civilisations—to be the most disposed to temperance."

BERNTHSEN'S ORGANIC CHEMISTRY.

A Text-book of Organic Chemistry. By A. Bernthsen. Edited and revised up to date by Dr. J. J. Sudborough. Pp. xvi+658. (London: Blackie and Son, Ltd., 1906.)

THE new issue of Bernthsen's text-book, which has been edited and revised by Prof. Sudborough, is a great advance on former editions. Although the general arrangement of the contents has been preserved, the amount of additional material has so much extended the scope of the original work that, in its present form, it is practically a new book. Some of the more prominent alterations and additions may be briefly noticed. In the first place, there are frequent references to physical chemistry and its application to problems of organic chemistry which are interesting and suggestive. Secondly, more than 100 additional pages at the end of the book are devoted to topics which have undergone recent development, such as the alkaloids, the terpenes, resins, glucosides, and proteins; there is a section on reagents, a section on stereochemistry, and one on physical constants in relation to structure. Though highly condensed, they are clear and explicit, and are furnished with full and useful references (which, by the way, would be more convenient and less disturbing to the reader at the foot of the page than embodied in the text). Finally, the system of nomenclature has been modernised The term "atomic," applied to alcohols, phenols, &c., has been replaced by "hydric"; "ether," used in connection with organic salts, becomes "ester"; "alcohol radical" is changed to "alkyl," and the word "radical" is properly spelt. The editor seems to have been in doubt about *isomer* and *isomeride*, and *oxy* and *hydroxy*, which are used indiscriminately. The writer entirely sympathises with this uncertainty in the use of certain terms, for the chemist often finds himself awkwardly placed. Not only does he feel obliged to respect the nomenclature adopted by foreign chemists, which is not always happily chosen, but he must conform in some measure to the system laid down by the Chemical Society. The purine derivatives offer a case in point. E. Fischer derives uric acid from purine and calls it a "trioxy" purine, though the usual formula is innocent of hydroxyl groups. The English equivalent, "trihydroxypurine," is consequently misleading. He is therefore confronted with the alternative of either using German nomenclature which is not official or confusing the reader with its English equivalent.

Another example is that of the carbohydrates, to which the term "saccharide" is applied in Germany by analogy with "glucoside." This analogy is lost in the case of the hexose group of sugars, which are not anhydrides in the ordinary sense. The editor in this case has wisely employed the termination "-ose," and divided the group into mono-, di-, tri-, and polysaccharoses. Incidentally, it should be pointed out that the terms monose, biose, triose, &c., which he employs as synonymous with the above are also used to distinguish the sugars by the number of their carbon atoms, with the result that triose is applied equally to raffinose, with eighteen carbon atoms, and glycerose, with three. It is a little unfortunate that the Chemical Society does not tackle these questions of terminology as soon as they arise, and, by a sensible and authoritative revision, remove a real difficulty in the way of writers on organic chemistry. One cannot but think that a generic terminal syllable denoting a particular class of compounds has much to recommend it, and had this been recognised such a word as "proteose" could not have crept into the new *protein* nomenclature.

The defects of the volume before us seem to be few in comparison with its many excellences, and where so much information has been collected and arranged it may appear hypercritical to find any fault.

The following omissions and corrections, however, seem important, and may perhaps be rectified in a future edition. The modern methods used in the manufacture of potassium cyanide, potassium ferrocyanide, and cyanamide are omitted; so are Piloty's synthesis of glycerin, Lawrence's synthesis of citric acid, Bertrand's method for obtaining dihydroxyacetone and other ketonic alcohols, and the citric acid fermentation of glucose. The following errors should also be corrected. The product obtained by Fischer from glycerin by oxidation is mainly dihydroxyacetone, and not glyceric aldehyde (p. 306); in the conversion of pseudouric acid into uric acid, hydrochloric acid, and not oxalic acid, is now used (p. 291); it is not true that all the chlorinated products of benzene up to C_6Cl_6 can be obtained by chlorinating benzene (p. 253), for some of the isomers are not formed in this way; in preparing the esters of the amino acids from the hydrolytic products of protein substances Fischer and Speier's method is not employed, but the alcoholic liquid is saturated with hydrogen chloride (p. 576).

It only remains to add that, in the writer's opinion the new edition of Bernthsen may claim to be one of the best, if not the best, text-books of organic chemistry for advanced students in the English language.

J. B. C.

PRACTICAL PHYSICS.

A Text-book of Practical Physics. By Dr. William Watson, F.R.S. Pp. xvi+626. (London: Longmans, Green and Co., 1906.) Price 9*s.*

SMALL books on practical physics have been very plentiful of recent years since the subject has taken a place in schools, but the number of large and complete treatises in English embracing all branches is still few. Looking back, the present writer can recall to mind as the earliest an English translation of Kohlrausch's "Leitfaden" by Waller and Procter, published in 1873, and the book, in two volumes, by E. C. and W. H. Pickering, on "Physical Measurements," published in 1873 and 1876. The latter was founded on the course of practical physics conducted at the Boston School of Technology by the authors, who have since become two of the foremost astronomers of the United States. After these two books we have to pass to 1884, when Glazebrook and Shaw's "Practical Physics" was published. It was founded on the elementary practical course conducted in the Cavendish Laboratory, Cambridge, and is still in use, and is perhaps the one book on practical physics which has had the widest influence on English laboratory methods. All these books placed the side of accurate measurement before the student, and omitted demonstrations and showy lecture experiments from their contents. They were written for the student's use in the laboratory, and formed a great advance on the descriptive books in which physics and chemistry were mixed, and which constituted the science of the popular lecturer of the early and middle Victorian period.

Later came a treatise by Balfour Stewart and Gee, which contained very detailed descriptions of experiments in properties of matter and in magnetism and electricity. The book came from the Owens College Laboratory at Manchester, and was, we believe, the first in which precise descriptions of magnetic methods appeared. Then from the same laboratory, published in 1901, we received a course of experiments by Schuster and Lees. This book contained only selected exercises from different branches, as the authors considered it sufficient to put before the students a short course of typical experiments.

Now we have before us the latest book on the subject, a complete treatise by Prof. W. Watson, of the Royal College of Science, South Kensington, and it is framed on a plan different from those we have mentioned. Prof. Watson calls it a book of reference for the student when working in the laboratory. It is not intended that any one class shall work through all the experiments, but that the teacher shall select from it according to the requirements of the pupil and the resources of the laboratory. The descriptions and hints apply to almost any form of apparatus suitable for the particular experiment.

As to the contents of the book, the first chapter contains a general discussion of the theory of the treatment of experimental data, the use of logarithmically divided papers, the consequent determination of exponential laws, and the description of calculating machines, including arithmometers and planimeters. It would take too long to go in detail through the entire contents of the book, but to illustrate its scope we may mention that thirty-four chapters are required to cover the whole field of physics. At chapters xxxii. and xxxiii. we are brought to magnetic induction and permeability. The comparisons and absolute measures of the induction coefficients are treated very fully indeed, and in chapter xxxiv. the use of the Dolezalek form of quadrant electrometer and the measure of the saturation current through air in the presence of uranium oxide are described. It will be evident that the author has made the field covered by the book very wide, and has brought into prominence the methods of recent research. We cannot omit to mention the excellent chapters which occur earlier on magnetic measurements and on the constants of terrestrial magnetism, subjects in which the author is a well-known authority.

At the end an appendix, probably one of the most useful parts of the book, contains an account of laboratory arts, glass-blowing, working in quartz, silvering, and other necessary processes. To these descriptions we feel very confident in referring the student, for the great excellence of the Royal College of Science in the branch of laboratory arts is well known. There is also a collection of useful tables.

The book is printed in very clear type, and the diagrams are excellently drawn. The whole setting of the book is of the same high standard as that of Prof. Watson's large work on physics.

Judging from the short experience which we have had of the use of the book in the laboratory, we may conclude by saying that it has proved most acceptable to the students, and we have been able to recommend it to those studying for university degrees. Schoolmasters should have a copy for reference and for their higher work.

S. S.

CLASSIFICATION OF SOUTH AFRICAN STONE IMPLEMENTS.

The Stone Implements of South Africa. By J. P. Johnson. Pp. 53. (London: Longmans, Green and Co., 1907.) Price 7*s.* 6*d.*

THIS is a useful addition to our acquaintance with the Stone age of South Africa. Mr. Johnson has exceptional qualifications for the task he has undertaken, being a trained geologist and surveyor, and a competent observer in the field, whilst his travels have given him the opportunity of examining large sections of South Africa, the collections of implements described having been obtained by himself from localities so widely separated as the valley of the Zambezi, the Transvaal, Prieska, in the north-west of Cape Colony, the Orange River Colony, Algoa Bay, and various intermediary stations.

In this volume, which contains 258 illustrations, Mr. Johnson has confined himself to coordinating the various discoveries of stone implements he has made during the past four years in South Africa, with descriptions of the deposits from whence they were derived; he, however, makes no attempt to review the abundant literature on the same subject already published. The exceptional value of the author's work rests in the fact that he makes little or no direct reference to surface finds or to specimens of man's handiwork which, in the shape of flakes, cores, and implements, are scattered over the surface of South Africa, in extraordinary profusion in some localities; but in every instance in which he describes his "finds" he takes us to the actual deposits from which he extracted the implements, whether it be the high plateau gravels in the neighbourhood of Johannesburg, the river gravels of the Zambezi, Vaal, and Orange rivers, the more recent alluvial deposits of the country, or the middens on the coast of Algoa Bay.

The author divides the stone implements of South Africa into three groups, which he considers well defined, namely, Primitive, Palæolithic, and Advanced; these are, in his opinion, the South African equivalents of Eolithic, Palæolithic, and Neolithic. The artificial character of the implements of the primitive group is, the author admits, still a matter in dispute, but when we come to the Palæolithic group we reach sure ground. If the old level gravels of the Zambezi, below the Victoria Falls, from which undoubted Palæolithic implements have been derived, were deposited prior to the retrocession of the present falls, and there is strong evidence in favour of such being the case, then the presence of man in South Africa is relegated to a past, bewildering in its antiquity. Similar conclusions are arrived at from the presence of Palæolithic implements in the old river gravels of the Vaal and Orange rivers. When we compare the more carefully fashioned implements (which, however, are not represented in Mr. Johnson's illustrations), notably from the Cape Flats, the laterite beds of Natal and Zululand, from rock shelters and the caves and middens of the coastline of Table Bay and Algoa Bay, with the rude weapons of the old river gravels, we unquestionably find a progressive element in their making, though they are not comparable in artistic merit with those found so abundantly in Egypt, for instance. This perhaps may be due to the stone-implement makers of South Africa not having had at their disposal equally suitable material to work on.

Though Mr. Johnson's division of the stone implements of South Africa into three definite groups may be considered by some as perhaps premature in our present state of knowledge, yet it is a step in the right direction, and this volume with its useful illustrations will certainly be welcomed by students of South African prehistoric archæology.

OUR BOOK SHELF.

Pocket-Book of Aëronautics. By Hermann W. L. Moedebeck, in collaboration with O. Chanute and others. Authorised English edition, translated by W. Mansergh Varley. Pp. xiii+496. (London: Whitaker and Co., 1907.) Price 10s. 6d. net.

In this handy little volume we have an excellent comprehensive summary of the whole subject of aëronautics, and the English reading public have to thank Major Moedebeck for producing such a work which has been so capably translated by Mr. Varley.

Although called a pocket-book, the book might really be described as a treatise on the subject, so ably and so well arranged is the mass of material dealt with. In fact, the book takes a very broad view of aëronautics, and leads off with chapters on the physical properties and technology of gases, the physics of the atmosphere, meteorological observations in balloon ascents, and the computation of results. Such a beginning is an indication of the very scientific and complete way in which the author set about bringing the matter pertaining to aëronautics to a focus, and his various collaborators, ten in all, have succeeded notably in their task.

Further, the historical survey of previous attempts to gain the supremacy of the air is by no means omitted, and admirable summaries are included which give the reader a comprehensive and intelligent view of the steps taken in each mode of attempted flight.

To give some idea of the contents and authors who have contributed to the book, it may be mentioned that the subjects referred to above are from the pens of Dr. R. Emden, Lieutenant J. Stauber, and Prof. V. Kremser. The articles on the technique of ballooning, on ballooning, on military ballooning, historical account of artificial flight, and on air-ships, are treated by the author. Prof. W. Köppen deals with kites and parachutes. Dr. Miethe deals with balloon photography, while Prof. W. Kutta gives an account of photographic surveying from balloons. The articles on animal flight by Prof. Karl Müllenhoff, artificial flight by the late Otto Lilienthal and Mr. Octave Chanute, flying machines, motors and air-screws by Major Hermann Hoernes, complete the various sections of the subject. A list of aëronautical societies, numerous appropriate and useful tables, and an index conclude the volume.

In the preface it is stated that the suggestion of translating this work is due to Mr. Alexander, the well-known authority on aëronautics. English speaking aëronauts, therefore, doubly owe to him their gratitude, for the translator's work is not only excellently done, but he has adapted various tables for the use of English readers, and has added an index.

Blackie's Nature-drawing Charts. (London: Blackie and Son, Ltd., n.d.)

This is a series of fifteen sheets bearing coloured drawings of twigs or portions of a plant to show the nature of the flowers or fruit for use in art schools, more especially in schools of design. It is intended that the charts should be used in combination with living specimens, being displayed to serve as a guide in noting essential features and in producing an artistic drawing. Small figures are given of parts suited to conventional treatment, and several examples of conventionalised designs are presented on each chart. These show the adaptation of plantforms for such purposes as brush-work ornamentation and the design of stencils, wall-papers, tapestries, &c.

A book of instructions is supplied to explain which charts or designs are suitable for different standards, and to provide other suggestions as to their utility. The more elementary drawings reproduce the laurel, snowdrop, tulip, and oak; the buttercup, poppy, and wild rose are considered suitable for a higher standard, and the blackberry, narcissus, and marguerite daisy are selected for the most difficult studies. The representations of the plants are botanically satisfactory, except the beech-fruits, that fail in colour and shape. In a few of the adapted designs, while making allowance for conventional treatment, there is unnecessary departure from the natural arrangement. For instance, the opposite insertion of the leaves in the privet is natural and characteristic, and should be maintained; similarly with regard to the pinnate leaves of the rose. It would have been useful to include in the explanatory booklet a short account of such botanical facts as the forms and insertion of leaves, the parts of a flower, their cyclic and acylic arrangements, and similar details. For the most part, however, the designs do maintain and emphasise the natural characteristics, thereby fulfilling the purpose of training students to derive their artistic conceptions direct from nature. The production of the charts is highly creditable, the drawings are bold, and the colour contrasts effective.

Problems in Surveying, Railroad Surveying, and Geodesy, with an Appendix on the Adjustments of the Engineer's Transit and Level. By Howard Chapin Ives and Harold Ezra Hilts. Pp. ix+136. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 6s. 6d. net.

With such a full title-page this book fairly well describes itself. The authors have been engaged in teaching engineering and surveying, and have found this graduated series of simple problems useful for sustaining the interest of their students in their work and for covering the course required by the faculty. The book is addressed to those who are professionally interested in such matters, or who wish to acquire the capacity to carry out certain operations in the field with facility, and with that amount of accuracy which the nature of the work demands. Consequently, there is little reference to theory. We have the ordinary methods of measuring by chain and problems connected with levelling. The compass, theodolite, and sextant come under review, and the mechanical adjustments of these instruments are described, but with no great minuteness. Greater care might have been bestowed on some of the formulæ given; those on p. 36 have apparently been misprinted. The railroad surveying problems are more satisfactory, and seem to be of practical utility.

A chapter on astronomical problems of a most elementary character has been added. In the preparation of this chapter the authors acknowledge the assistance they have received from a third authority. It must strike anyone with surprise that the authors should consider themselves competent to produce a book of this type, and yet feel it necessary to invite or to accept outside aid.

W. E. P.

The Sense of Touch in Mammals and Birds, with Special Reference to the Papillary Ridges. By Dr. Walter Kidd. Pp. viii+176; illustrated. (London: A. and C. Black, 1907.) Price 5s. net.

Having in a companion volume treated of the direction of the hair in animals, Dr. Kidd, in the one now before us, turns his attention to the kindred subject of the structure and function of the papillary ridges on the tactile surface of their hands and feet. Although the subject is by no means new, the author has studied it in a fuller manner than at least most of his predecessors, and has a new theory with regard to the function of the ridges in the Primates, in which alone these structures attain full development. In monkeys, at any rate, it has been generally considered that the main purpose of the rough surface produced by the papillary ridges is to ensure firm hold in grasping. Without denying that this may be a part of their function, Dr. Kidd is, however, of opinion that there are other important uses, which vary in different groups. In man, for instance, the papillary ridges in the hand alone exercise the function of discriminative sensibility, and those in the foot that of maintaining the equilibrium of the body, whereas in the lower Primates both functions are discharged by the ridges of the two pairs of limbs, although sensibility is less marked in the front pair than in the human hand. The most interesting part of the author's conclusion relates, however, to the papillary ridges of lemurs, which are much more complicated than those of apes and man, and are accordingly believed to be subservient to the necessity for special means of preserving the equilibrium in the case of nocturnal creatures.

R. L.

Zur Wirtschafts- und Siedlungs-Geographie von Ober-Burma und den Nördlichen Shan-Staaten. By Dr. H. J. Wehrli. Pp. 130. (Zurich: Lohbauer, n.d.)

Though in completeness and fulness of illustration this popular handbook of the British province of Burma bears, of course, no comparison with Sir J. G. Scott's recent monograph, it contains in a short space all that a merchant or a traveller intending to visit the country needs. The physical geography, climate, ethnology, natural productions, and industries are clearly described in a series of chapters illustrated by four maps and twelve photographic plates. The book is frankly a compilation from the best authorities, of which a full bibliography is appended. The maps, like all German work of the kind, are good, but the political map would be more useful if the boundaries were marked in colours. Except some of the handbooks for emigrants issued by our more important colonial Governments, we have no geographical series in English which corresponds with this. The organisation which has just been started to spread a knowledge of the Empire among British schoolboys might well provide a series of handbooks of this class.

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 intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

International Investigation of the Upper Air.

The International Commission for Scientific Aëronautics has for some years past arranged that observations in the upper air by means of kites and balloons should be made on certain pre-arranged days, generally the first Thursday in each month. At the conference held at Milan in October last, M. Teisserenc de Bort suggested that better results would be obtained if a series of observations could be made on several successive days instead of on isolated days as hitherto.

It has accordingly been arranged that while the observations on the first Thursday in each month should be continued, some further days should be arranged for a more extended series of observations. The first of these series is to take place in the fourth week in July, and it is hoped that, besides the ordinary observatories that take part in the monthly ascents, as many meteorologists as possible should assist in order that observations may be obtained from a number of widely extended stations

The three principal days of the series are July 23, 24, and 25, but where possible ascents will also be made on July 22, 26, and 27. All the observatories engaged in upper-air research will take part. In addition, the Prince of Monaco will make observations in a high northern latitude, and a German man-of-war will send up *ballons-sondes* between Iceland and Norway. Another German expedition, under Captain Hildebrandt, will go to the neighbourhood of the Hebrides, while a French man-of-war will be stationed near the Azores. Further south, M. Teisserenc de Bort and Mr. Rotch will send an expedition, in their yacht *Otaria*, to the region of the trade winds and doldrums. It is hoped, also, that the Italian Government will cooperate by sending a man-of-war to some point in the Mediterranean. With the addition of Blue Hill Observatory and other North American stations, there will thus be a net-work of observations over a large region of the northern hemisphere.

In this country Mr. W. H. Dines will send up *ballons-sondes* and pilot balloons at a station on the west coast of Scotland; *ballons-sondes* and pilot balloons will also be sent up at Manchester by Mr. Petavel, and at Ditcham Park, Petersfield. Conditions in this country at the end of July are not likely to be favourable for flying kites, but should there be sufficient wind kites will be flown at Glossop Moor, Pyrton Hill, Ditcham Park, and Brighton.

The Royal Meteorological Society is also making arrangements to cooperate in the investigations, and an allowance (in aid of the expenses) has been made to them from the Government grant for scientific investigations.

It may be possible to obtain the assistance of other observers to send up pilot balloons; by the use of two theodolites and a measured base, the velocity and direction of the wind and the heights of clouds may be determined. By using rubber balloons and filling them to a certain size corresponding to a known rate of ascent, useful observations may be made by a single observer using an ordinary theodolite.

The International Commission has also arranged for a series of observations on September 4, 5, and 6, and on November 6, 7, and 8.

Charles J. P. Cave.

Radium and Geology.

The temperature of 55° C. to which I referred in a former letter is the temperature of the *rock*. I find that Prof. C. Schmidt, of Basel, on his chart of isogeotherms, gives this temperature as attaining 56° C. This is in the dry part of the tunnel, towards the north end.

The difficulty attending the inflow of warm water mainly arose from the *rate* at which heat was thereby brought into the tunnel, necessitating large supplies of cold water to keep down the temperature. Prof. Schardt's paper, to which I have already referred, contains very strong evidence as to the *rôle* of the circulating water. The evidence is far too lengthy to quote here.

Mr. Fisher refers to the Hon. R. J. Strutt's estimates of radium in rocks as capable of accounting for a gradient of 1° F. in 42·4 feet. In point of fact, Mr. Strutt *assumes* this gradient (quoting from Prestwich) as a basis upon which to calculate the thickness of the radium-bearing crust. The gradient in question is, therefore, not derived from Mr. Strutt's observations (nor could it be), but is a gradient taken as a basis of calculation.

That special conditions affect the temperature gradients in mountain ranges appears from the results of observations on the Mont Cenis and the St. Gothard tunnels. Everett's estimate for the former, with correction for convexity of surface, is 1° F. in 79 feet. In the case of the latter there were remarkable variations observed, of which radium will very probably furnish the explanation. The central gradient is 1° F. in 85 feet. At the north end there is a gradient of 1° F. in 38 feet. This brings the general average for the whole tunnel up to 1° F. in 57·8 feet. Dr. Stapff, who conducted the temperature observations in the St. Gothard, subsequently predicted for the Simplon a maximum rock temperature of 47° C., as I have already pointed out.

J. Joly.

Trinity College, Dublin.

AËRIAL LOCOMOTION.

In December of last year Dr. Alexander Graham Bell delivered an address, under the above title, before the Washington Academy of Sciences. This address recently appeared in the March number of the Proceedings of that academy[1] (vol. viii., pp. 407–448), and the interesting nature of the contents is well worth the attention of the readers of this Journal who have not had the opportunity of perusing it.

In the opening paragraphs Dr. Bell refers to the earlier attempts made to travel in the air, and points out how the problem in the last decade or so has gradually been approached from a different point of view. The principle of the gas bag has taken second place, and the heavier-than-air type of machine is now in the forefront.

The researches of Lilienthal are next referred to, followed by those of Chanute, Herring, the Brothers Wright, and Hargrave. The magnificent work accomplished by Langley is here given its proper position. "To Prof. Langley," as Dr. Bell remarks, "is due the chief credit of placing this subject upon a proper basis, and of practically originating what he termed the art of 'Aerodromics.'"

Dr. Bell witnessed the experiments made by

Fig. 1.—Langley's Aërodrome No. 5 in Flight, May 6, 1896.

Langley on May 6, 1896, when a large model of an aërodrome, with a spread of wing of about 14 feet, was driven through the air by a steam engine under the action of its own propellers. With regard to the actual flight he saw, he wrote:—"No one who witnessed the extraordinary spectacle of a steam engine flying with wings in the air, like a great soaring bird, could doubt for one moment the practicability of mechanical flight." Dr. Bell was fortunate enough to secure a photograph of the apparatus while in the air, and this record, which is reproduced in his article, is here given (Fig. 1). In time it will undoubtedly be of exceptional historical interest.

The circumstances connected with the later experiments of Langley are next described, and Dr. Bell's knowledge and great faith in Langley's work allow him to state his unbiased opinion that the full-sized aërodrome, which the newspapers described as a failure, "would have flown had it been safely launched into the air."

It is with regret, however, that we find no mention made of either Hiram Maxim or Pilcher, for the

[1] See also *The National Geographic Magazine*, vol. xviii., No. 1, January.

former spent a great amount of money and time in valuable experiments, while the latter sacrificed his life in advancing the science of gliding.

Perhaps the most interesting portion of Dr. Bell's address is the account of his own initial experiments in the construction of an aërodrome. He has been at work on this subject for many years, and so far back as 1894 Langley visited him and witnessed some of his experiments.

The progress of his experiments is divided by him into three stages, namely, the kite stage, the motor-boat stage, and the free flying-machine rising from the water.

As the first of these is now complete, it is fully described in this address, and indicates that a distinct step in advance has been made. Dr. Bell's kite is quite different from any other form. It is built up of a great number of small structures or cells, all alike in form and size. Each cell has the form of a regular tetrahedron, and, as he says, "possesses in a remarkable degree the properties of strength and lightness." By connecting several of these figures by their corners a very rigid structure is built up, and the whole possesses the same properties of

FIG. 2.—A sixteen-celled kite.

strength and lightness inherent in the individual cells themselves.

The *unit* tetrahedral cell is bounded by four equal triangular faces; if two adjoining faces be covered with some kite material, the result is a "winged cell" resembling a pair of birds' wings with their points raised upwards. By coupling four of these unit cells together at their corners, a four-celled structure is formed having itself the form of a tetrahedron, but with an empty space in the middle octahedral in shape. If now four four-celled structures be connected at their corners, a sixteen-cell structure of tetrahedral form is formed (Fig. 2). Experience has shown that when these structures are flown as kites they exhibit remarkable automatic stability in the air under varying conditions of wind.

Up to the present time, the most stable form of kite is that of the "box" or Hargrave type. Dr. Bell is, however, of the opinion that his compound tetrahedral structure is more stable even than this. To make a comparison, he flew both kinds simultaneously in squally weather. Although the tetrahedral appeared to "shiver" when struck by a sudden squall, the box kite "seemed to be liable to a swaying or tipping motion that would be exceedingly dangerous in a structure of large size forming part of a flying machine."

The good behaviour of the former kite is due, as he suggests, to the porous nature of the structure, the squall passing right through between the covered triangles, and lifting the other side of the kite as well as the side first struck; the blow is thus counterbalanced before the kite has had time to upset.

Although the horizontal aëroplane has always an element of instability about it, it has, nevertheless, greater lifting power than similar surfaces arranged obliquely as in the tetrahedral construction. The structure of winged cells is, however, the reverse,

FIG. 3.—The *Frost King* in the air, flying in a ten-mile breeze, and supporting a man on the flying ropes.

being more stable when in the air, but deficient in lifting power. There seems, however, no difficulty in adding to the number of surfaces in the latter construction in order to secure the desired lifting power, while the condition of stability remains. Further experiments have shown that the blank spaces between the groups of winged cells can be filled up with more cells; in fact, the cells can be massed together "without marked injurious effects." Not only, therefore, is the structural strength improved by this increase of size, but the lifting power, which varies directly as the cube of the dimensions, is increased (Fig. 3).

The result of these kite experiments has been to show that it is possible to build a structure of moderate size, composed simply of these winged cells, that will support a man and an engine in a moderate breeze.

It will be interesting to watch the progress made in the next two stages of Dr. Bell's programme, which literally means the conversion of a kite into a flying machine. These stages consist in mounting his structure on a light catamaran form of boat and propelling it on a water surface by means of aërial propellers until it can be steered upwards into the air. Whether this form of starting is as good or as practical as running it on wheels remains to be seen, but at any rate it seems the safest way to commence with (Fig. 4).

It may be mentioned in conclusion that not only is this printed address accompanied by numerous well-reproduced illustrations and a useful bibliography relating to aërial locomotion, but all details concerning one of the large winged-cell structures and the interesting discussion which followed the reading of the address are inserted.

Among those who took a prominent part in this discussion was Mr. Charles M. Manly, who, as he stated, "had the pleasure and the honour of being associated for some seven years with the lamented Secretary Langley as his assistant in direct charge of the experiments which he conducted at the Smithsonian Institution." In his remarks it is good to read that the work initiated by Langley is not abandoned, but merely temporarily suspended. In fact, it seems quite probable that Langley's machine will again be seen flying through the air, for Mr. Manly proposes to re-equip and launch it again. To use his own words:—

"It is my purpose at the earliest moment that I can possibly spare the time for it, to re-equip the aërodrome with proper supporting surfaces, and, using the same launching apparatus, to give the aërodrome a fair trial, this time over land instead of over the water, when I feel very certain that it will fully demonstrate the correctness of its design and construction and crown Mr. Langley's researches with the success which they so richly deserve, and I trust that the day that this will be achieved is very near at hand. It was the launching apparatus, all will remember, which in both of the experiments caused the accidents that prevented any test of the aërodrome itself. These accidents were not due to defects in the design or fundamental construction of the launching apparatus, for the smaller apparatus of exactly the same design had been used more than thirty times for launching the smaller machines, and without a single failure. Certain minute defects in the releasing mechanism were the sole cause of the trouble."

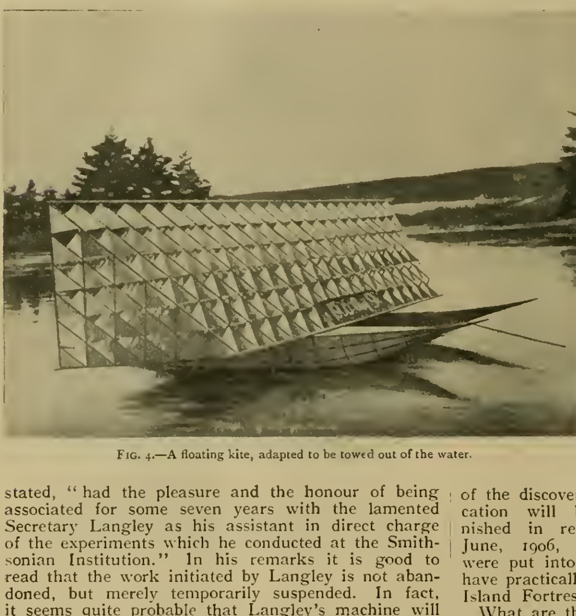


FIG. 4.—A floating kite, adapted to be towed out of the water.

MALTA FEVER.

A LESSON IN PREVENTIVE MEDICINE.

SITUATED in the midst of the Mediterranean, swept by all the winds of heaven, and enjoying brilliant sunshine for several months in the year, the island of Malta should be one of the healthiest of places. Its freedom from swamps or standing water of any kind protects the island from that scourge of warm climates—malaria. For many years past, however, Malta has suffered from the prevalence of a serious local fever, of a most persistent character, which has been the bane of the island, and particularly of the garrison; for a large fraction of the naval and military forces has been constantly incapacitated by this disease. Every year some 650 sailors and soldiers have fallen victims to it, and, as each patient stays on an average 120 days in hospital, this gives a total of about 80,000 days of illness per annum. Moreover, most of these men have to be sent to England to recover their health, and the consequent expense has involved a very considerable loss in money to the Government.

This fever appears to be widely distributed in the world, but is most familiar to us in its incidence around the coasts of the Mediterranean. On the island of Malta it has worked its worst ravages, and hence the name of Malta fever, by which it is best known.

Now, however, all this has been changed by a simple application of the discoveries of science, and widespread gratification will be given by the intelligence, furnished in recently published reports, that since June, 1906, when the new preventive measures were put into practice, Malta fever may be said to have practically disappeared from the garrison of the Island Fortress.

What are these preventive measures, and how has this result been achieved?

The serious ravages of Malta fever made it desirable that a searching investigation should be taken in hand. In 1904 the Royal Society, at the request of the Admiralty, the War Office, and the Colonial Office, undertook to investigate the causes of this fever, and sent out a small commission to Malta for that purpose. This commission, which consisted chiefly of Army and naval medical officers, has been at work for three years, under the supervision of a committee of the Royal Society, and has only lately completed its labours. It is unnecessary to describe the details of the three years' work; it is enough to say that every likely line of research was followed in order to discover how man becomes infected by this disease. So long ago as 1887 an Army medical officer discovered that Malta fever is caused by the entrance into the body of a minute bacterium, which was named the *Micrococcus melitensis*. This microbe was studied from many points of view, but with no success until a discovery was made which cleared up the mystery. This was the remarkable fact that the goats in Malta are susceptible to this disease, and act, as it were, as a reservoir of the virus. In truth, it is probable that Malta fever is primarily a disease of goats, and that man is infected from the goat, not the goat from man. The goat is very much in evidence in Malta, there being some 20,000 of them, which supply practically all the milk used in the island. It was discovered by the commission that half these animals are affected by Malta fever, and that one-tenth are constantly passing the *Micrococcus melitensis* in their milk. Notwithstanding that the goats show no outer signs of the disease, they continue, possibly for years, to secrete milk containing the poison.

It seemed evident, then, that to banish Malta fever from our sailors and soldiers on the station, all that was required was to eliminate goats' milk from their dietary. This step was taken in June, 1906, with the striking result that the cases of fever fell to one-tenth of what had been their normal number. There is, therefore, reasonable hope that this disease will now disappear from the garrison in Malta, and some 80,000 days of illness be blotted out from the yearly records of the Navy and Army.

If these good results are maintained, this investigation will stand out as one of the most notable examples of successful work in the prevention of disease, and will clearly show the economy of spending a few thousands on a thorough scientific investigation.

The research occupied some time, and from first to last employed some twelve men, but the outlay in time and money are as nothing to the result achieved.

INTERNATIONAL ASSOCIATION OF ACADEMIES.

Yesterday morning, May 29, there opened at Vienna the third triennial general assembly of the International Association of Academies, of which the Imperial Academy of Sciences, Vienna, has been the directing academy for the last three years.

Great Britain is represented in this association by the Royal Society of London in the section of natural science, and by the British Academy for Historical and Philological Studies in the section of letters.

The delegates appointed to attend the assembly on behalf of the Royal Society are Sir George Darwin, K.C.B., Sir Norman Lockyer, K.C.B., Lieut.-Colonel Prain, Prof. Schuster, Dr. W. N. Shaw, Prof. C. S. Sherrington, Prof. H. H. Turner, and Dr. A. D. Waller, Prof. Schuster being the delegate charged to deliver the vote of the society; while the British Academy is represented by Prof. Bywater and Prof. Israel Gollancz.

A number of subjects of general scientific importance will be discussed at the meeting, as well as certain questions of internal policy concerning the status of the association, and its mode of working under its statutes.

The Royal Society has put forward two proposals for the consideration of the assembly. One is for the establishment of a uniform lunar nomenclature, and a proposition will be submitted by the council of the association for the appointment of a committee to work out a scheme in furtherance of this object. In this connection the Royal Society propounds suggestions regarding the coordination of lunar nomenclature, which will no doubt form a basis for discussion.

Another proposal of the Royal Society for the cooperation of the International Association in the International Union for Solar Research will probably lead to considerable discussion, not on account of want of sympathy with the movement, but because of questions which have been raised as to the constitutional power of the association to join another organisation.

An important proposal of the Académie des Sciences to create an organisation of meteorological stations at different points on the earth's surface, at the expense of the Governments respectively concerned, will be put forward with the support of the council of the association.

The assembly will also be recommended to approve the resolutions of the committee which met at Frankfurt-am-Main in 1904, proposing changes in the statutes of the International Seismological Association, which have since been adopted. That committee recommends the associated academies to endeavour to induce their Governments to cooperate with the International Seismological Association in dealing with seismic problems of physical interest.

Other matters to be brought before the assembly in the science section are a report of the committee for investigating the anatomy of the brain; reports upon geodetic measurements; a report of the commission appointed in 1904 for the investigation of atmospheric electricity; the consideration of the further working of the committee appointed in 1904 for the magnetic measure of a circle of latitude.

In the section of letters there will be reports presented upon the edition of the works of Leibnitz, initiated by the association; upon the international loan of manuscripts; upon the edition of the Mahabharata; the publication of an Encyclopædia of Islam; the Corpus of Greek records and the Corpus medicorum antiquorum.

THE SMALL PLANETS.[1]

M. Mascart's summary of his own work is as follows:—

Nous avons voulu montrer l'ampleur de la question des petites planètes, qui ne fut jamais encore exposée dans son ensemble, et si nous avons suscité bien plus de points d'interrogation que nous n'en avons levés, nous serons du moins heureux, peut-être, d'appeler l'attention des astronomes sur quelque problèmes assez mystérieux.

Probably an author has seldom given in few words so excellent and accurate a description of his work. M. Mascart has collected on a large scale, and has thus performed a great service to this branch of astronomy. We may turn to his bibliography containing more than a hundred names with a reasonable confidence that nothing of importance has been omitted.

The subject of the small planets appears to bristle with striking statistical peculiarities. To exhibit their nature we note down a few, and may remark that perhaps in no case whatever has a completely satisfactory explanation been given.

(1) If the small planets be arranged in order of mean distance, or of mean motion, there are marked gaps in the series, first noticed by Kirkwood, corresponding to mean motions twice and three times that of Jupiter.

(2) When the inclination to the ecliptic is large, so also, in general, is the eccentricity, and *vice versâ*.

[1] "La Question des petites Planètes." By M. J. Mascart. Pp. 110.

(3) Occasionally there are striking similarities in the elements of two planets, *e.g.*

	a	e	i	☊	ω
(251) Sophie	3·10	0·09	10° 29′	157°	80° 16′
(318) Magdalena	3·19	0·07	10° 33′	163°	80° 5′

The resemblance of the elements in the case quoted is far closer than is reasonably probable, even for a selected pair out of several hundred planets. We, however, are much inclined to doubt whether it is more than an accident. A famous case of coincidence is that between the periods of rotation and revolution of the moon. Here there is a controlling cause tending to produce equality, and the equality is exact. Now in the case of the elements of Sophie and Magdalena, we suppose that there are only three possible hypotheses:—(i.) accidental resemblance; (ii.) a cause tending to produce similarity; (iii.) a common origin with no subsequent connection. We may take as analogies:—(i) two watches that have run down, but happen by accident to show nearly the same time; (ii.) two clocks synchronised with each other; (iii.) two clocks, each constructed with the same object of exhibiting mean time, but entirely independent of each other subsequently. Now, as regards (ii.), we may remark that in the present instance the supposed controlling force has done its work very imperfectly. The objection to (iii.) is that a common origin hypothesis can only be applied in a few isolated cases, of which the above is one, and therefore we ourselves feel inclined to fall back upon (i.), the hypothesis of accidental resemblance, although we fully admit its antecedent improbability.

In the early part of the book an estimate is given of the total mass of the asteroids. It would appear that the entire mass is very far short of a quarter of the mass of the earth, very far short indeed of the mass that would have been expected if a single planet had filled the gap in Bode's law between Mars and Jupiter.

In a few cases approximate linear dimensions are given, founded on measures by Barnard in 1894.

We must congratulate M. Mascart on a very interesting and exhaustive work. We regret, however, the absence of a complete list of all known asteroids with their elements. We should have been glad to have seen such a list in several different forms, with the small planets arranged in order of mean motion, eccentricity, longitude of perihelion, and in the various other ways mentioned in the book. It would have enabled us to follow the arguments from statistics with greater appreciation, and the value of the book as a work of reference would have been much increased. The work admirably fulfils the design of the author.

SIR BENJAMIN BAKER, K.C.B., F.R.S.

SIR BENJAMIN BAKER, whose sudden death in his sixty-seventh year we recorded last week, had a distinguished career as an engineer, and was concerned more or less directly with most of the great engineering schemes of recent years. By his death the profession of civil engineering is deprived of one of its leading members, and the scientific world of a man who combined scientific knowledge with practical training and experience. He was a constant contributor to early volumes of NATURE, and his writings and addresses cover a wide field of applied science.

Sir Benjamin Baker was born in 1840, and for the last thirty years or so was engaged in the design and construction of important engineering works at home and abroad. He carried out numerous investigations relating to the strength of materials and of engineering structures generally, and contributed papers thereon to various scientific societies. He was the author of "A Theoretical Investigation into the Most Advantageous System of Constructing Bridges of Great Span," upon which plan the Forth Bridge and six of the largest bridges in the world have been built.

His name will be remembered chiefly in connection with the Forth Bridge and the great dam across the Nile at Assouan. On the completion, in 1890, of the former engineering feat Sir Benjamin Baker was made K.C.M.G., and when the dam at Assouan was finished in 1902 he was made K.C.B., and received at the same time the first-class of the Order of the Medjidieh from the Khedive. Two years ago plans were submitted to him for the raising of the Assouan dam, and since then he had worked more or less continuously at the subject of stresses on dams. A note by him upon the project appeared in the Earl of Cromer's recent despatch respecting the water supply of Egypt; and in it he stated that a design had been evolved which satisfied all the theoretical and practical conditions, and rendered the storage of nearly two and a half times the present quantity of water in the reservoir a simple problem.

Though his name will always be associated first with the famous works mentioned, Sir Benjamin Baker took a very active part in other great engineering enterprises in many parts of the world. He had much to do with making the Metropolitan Railway, and was associated more recently with the construction of the various tubes for electric traffic under London.

Sir Benjamin Baker was elected a Fellow of the Royal Society in 1890, and in 1895 he became president of the Institution of Civil Engineers. Honorary degrees were conferred upon him by the Universities of Cambridge and Edinburgh, by the Irish Academy, and other learned bodies. He was closely associated with the various engineering societies, and was actively interested in the work of the British Association and the Royal Institution. He was a member of the council of the Institution of Mechanical Engineers, and an honorary member of the American and Canadian Societies of Civil Engineers, and the American Society of Mechanical Engineers. His unexpected death will be deplored wherever pure and applied science are studied, and his personal friends have suffered a loss that cannot easily be realised by those who did not know his broad interests and sympathetic nature.

NOTES.

THE Senate of the State of Pennsylvania has voted 70,000*l.* to the American Philosophical Society to provide a fitting memorial to Benjamin Franklin.

SIR WILLIAM RAMSAY, K.C.B., has received through the Foreign Office the Order of Commendatore della Corona d'Italia from the King of Italy, together with King Edward's permission to wear it.

AT the anniversary meeting of the Linnean Society on May 24, the Linnean medal, awarded by the council to Dr. Melchior Treub, director of the State Botanic Garden at Buitenzorg, Java, was formally handed to Mr. Van Royen, councillor of the Netherlands Legation, who undertook to transmit the medal to Dr. Treub.

MR. ANDREW WATT has been elected meteorological secretary of the Scottish Meteorological Society in succession to the late Dr. Buchan, F.R.S. Mr. Watt has since 1900 been closely associated with Dr. Buchan in the discussion of rainfall and other important meteorological problems.

The Maccabæans, a society of Jewish literary and scientific men, gave a dinner at the Hotel Great Central on May 22, at which some of the leading members of the medical profession were present. Before the dinner a telegram was dispatched to Lord Lister, sending him respectful salutations. Lord Lister replied, returning his warmest thanks to the Maccabæans for their message.

The Transvaal Government Gazette of April 20 announces the appointment of a commission, consisting of the following gentlemen, Dr. Kynaston (Geological Survey Department), Mr. T. N. Leslie (Vereeniging), Mr. J. P. Johnson (Johannesburg), and Prof. R. B. Young (Transvaal University College), "to report to the Government on the Bushmen paintings and stone etchings existing in the Transvaal, and as to what steps should be taken to preserve them from decay and mutilation."

Speaking at the forty-seventh annual dinner of King's College, London, on Monday, May 27, Dr. Headlam, the principal, referred to the loss which the college has sustained by the death of Dr. MacFadyean, and suggested that there should be a public recognition of one who died as a martyr in the cause of science, and for the sake of amelioration of disease and the benefit of the human race. Alluding to the incorporation of the college with the University of London, and to the appeal for funds made in connection therewith, he mentioned that the Goldsmiths' and the Clothworkers' Company have each contributed 5000*l*., and that other promises and donations bring the amount subscribed up to the present time to 15,000*l*.

Reuter's representative at Upsala records that the celebrations at the University of Upsala on the occasion of the 200th anniversary of the birth of Linnæus took place on May 23. The Crown Prince Regent, the Duke and Duchess of Vester-Gotland, and the Dukes of Nericia and Scania, were present. A speech was made by M. Schuck, the Rector of the University, after which the foreign guests read addresses. The speakers were afterwards presented to the Crown Prince. On May 24 the University held a solemn session in the cathedral for the purpose of conferring the doctorate on distinguished Swedes and foreigners on the occasion of the Linnæus celebrations. Among those upon whom honorary degrees were conferred were Mr. Francis Darwin, F.R.S., and Mr. W. Carruthers, F.R.S. The Crown Prince Regent, the Duke of Scania, and the Duke and Duchess of Vester-Gotland attended the ceremony. We hope to give later an account of the celebrations by one of the British delegates now in Upsala.

We learn from the *Lancet* that a movement for the institution of an Italian Association for the Advancement of Science, proposed at Milan last year, has now taken form and development under capable organisers, including Prof. Romiti, of Pisa. The first meeting will be held at Parma in September next, when it is hoped that the sister Powers of Europe, as well as those of the New World, will assist in an auspicious "send-off." Italy has many associations for the advancement of special sciences, but, as Prof. Romiti has put it, she has yet to form an association which shall "represent the synthesis" of them all. Attempts were made in 1839 and 1875 to start such an association on the British model, but they have had no successor. It is hoped and believed that the attempt which has now been renewed will result in the establishment of a permanent institution.

The Aëro Club of the United Kingdom is very active in promoting many aspects of aërial navigation. On Saturday last nine balloons started from the Ranelagh Club, Barnes, in a race for the Harbord Cup, the first balloon leaving at 4 p.m. and the last at 6 p.m. The point to which the balloons were piloted was Goring, in Oxfordshire, and the winner will be the competitor who landed nearest this point. The committee will meet and examine certificates of descents before issuing an official list of placings. On Saturday, June 29, there will be a race for the Hedges Butler Challenge Cup, which will be awarded for the longest voyage in any balloon, airship, or aëroplane on that day. The club offers a silver medal for the best set of photographs taken by a member from a balloon during this year, and a silver and bronze medal for the best set of meteorological observations. Arrangements have also been completed for carrying out a series of important practical experiments in connection with aërial navigation.

The report of the Departmental Committee appointed to inquire into the probable economic effect of an Act of Parliament limiting work in coal mines to eight hours per day has been issued. It is a document that has been prepared with great care, and forms a valuable addition to economic literature. While, on the whole, the committee is of opinion that its immediate effect would be a reduction in total output of about 26,000,000 tons per annum, it is concluded that because the pits would be worked with more energy, the total reduction would be only about one-half this, while the introduction of improved machinery might still further diminish the reduction. The scientific interests of mining were well represented on the committee by Prof. S. H. Cox, of the Royal School of Mines, and by Prof. R. A. S. Redmayne, of Birmingham.

Mr. Walter Wellman, who proposes to make another attempt to reach the North Pole by means of his airship *America*, has left for Norway, on the way to Spitsbergen, where the balloon will be inflated. In the first week of July there will be trials of the airship until it is demonstrated that it is ready for the voyage. The start for the Pole will be made on the first favourable opportunity afterwards, probably between July 20 and August 10, but, if necessary, Mr. Wellman is prepared to start as late as August 20. Mr. Wellman has given Reuter's representative the following particulars of his plans:—The airship has been made 18 feet longer and its lifting power increased by 3000 lb., giving a total lifting force of 19,500 lb. The balloon is 184 feet long and 52 feet in its greatest diameter, its cubic volume being 265,000 cubic feet. With the single exception of Count Zeppelin's airship, this is the largest ever built. The keel or backbone of the airship consists of a steel tank 18 inches in diameter and 115 feet in length, with a capacity for holding 1200 gallons of petrol. At the stern of the vessel is a rudder of some 900 square feet, in the form of a bicycle wheel, which, despite its great size, only weighs 30 lb. A little forward of the centre is placed a very heavy motor, built for endurance and safety, of 70 horse-power, and having a weight of 900 lb. In this new airship the propellers are placed in the centre on either side of the vessel. They consist of two blades of steel, 11 feet in diameter, and capable of 380 revolutions per minute. The living quarters of the airship are in triangular bunk-like spaces within the enclosed steel car. These are capable of accommodating ten or twelve men, twelve dogs, together with the provisions and equipment. The total weight of the steel car and tank is 2200 lb. The motors, screws, and machinery weigh 1350 lb. In the tank will be carried 6800 lb. of petrol, capable of running the motor for 150 hours at a normal speed of 14 knots. The total radius of action is believed to be 2500 miles, or double the distance from the base to the Pole and back again. The balloon will not ascend more than 300 feet to 500 feet, and a guide-rope will trail over the surface of the earth. Instead of employing a steel line a leather tube has been made, 15 inches in diameter and 130 feet long, and weighing about 1400 lb. This is filled with reserve food weighing 1200 lb., and is suspended from the airship by means of a steel rope. The airship will carry 3000 lb. of food, or enough to enable the crew to subsist on its own stores for a period of ten months.

To vol. iii., No. 11, of the zoological series of the Publications of the University of California, Messrs. E. C. Starks and E. L. Morris contribute a descriptive list of fishes taken off the coast of southern California.

We have to acknowledge the receipt of a copy of the first of a series of "guides" to the Peabody Museum of Natural History at Yale University. This deals with the evolution of the horse family, a subject which has been treated in a very satisfactory manner by Dr. R. S. Lull. The "guide" has previously appeared in the form of an article in the *American Journal of Science*.

A very satisfactory result has attended bird protection in a certain district of Norfolk, the black tern (*Hydrochelidon nigra*), which had ceased to breed in that county for a period of something like seventy years, having this season re-established itself in its old nesting haunts. Several nests are recorded, and it is sincerely to be hoped that the species will once more be entitled to a permanent place on the British breeding list.

A paper in the Annals of the Natal Government Museum (vol. i., part ii.), by Messrs. E. Hill and L. G. Haydon, on the characters of the larva in certain mosquitoes of the group Anophelina, is of importance in connection with the endeavour to stamp out malaria. All the fifteen species described are referred to genera other than the typical Anopheles. In a second article in the same issue Dr. R. Broom records, for the first time, the occurrence of remains of anomodont reptiles in the Karoo rocks of Natal. They are referred to the genera Dicynodon, Lystrosaurus, and Scymnosaurus, the representatives of the first and third being regarded as new species.

The evolution of the colour-pattern on the shells ot South African land tortoises, more especially those included in the genus Homopus, forms the subject of a paper by Dr. J. E. Duerden in the Records of the Albany Museum (vol. ii., part i.). Starting with species in which each shield of the shell is of the normal horn-colour, the author finds that the first stage is the development of a dark border, followed later by a dark centre. Next the whole shield becomes dark, excepting light lines radiating from the centre, after which the dark area may break up into spots or flecks. In a second paper the same author describes a giraffe head from British East Africa, provisionally identified with *Giraffa camelopardalis tippelskirchi*.

In a paper on the geographical distribution of closely related species, as exemplified by plants, Mr. R. G. Leavitt, in the April number of the *American Naturalist*, comes to the conclusion "that the study of specific distribution in the vegetable kingdom is not likely to be unfavourable to mutation, regarded as a method, but perhaps not the sole method, of evolution." After putting aside certain cases which may be ascribed, for want of a better name, to "geographical effect," the indications suggest that a good many instances favourable to mutation will be forthcoming, and that those who seek to discredit the mutation theory will find it difficult to procure weapons to support their attack from plant evidence.

We have received from the author, Mr. James Drummond, a copy of a paper on foreign birds acclimatised into New Zealand, published as a Bulletin of the Agricultural Department, and likewise copies of the *Lyttelton Times* of March 23 and 30 containing an account of the bird-sanctuary at Little Barrier Island, near Cape Rodney. As regards the introduction of small birds, which commenced, mainly for sentimental reasons, some sixty years ago, it appears that, on the whole, this has been a mistake, correspondents urging that no more kinds should on any account be admitted. Although sparrows are admitted to have done good in the early days of the colony, when insects were, literally, on the war-path, they are now unmitigated pests, while greenfinches, blackbirds, and even larks (which do enormous damage to young wheat) and thrushes are included in the same category. Little Barrier Island, we are told, comprises 10,000 acres, of which all but about fifty are hilly or mountainous, with abundant timber. It thus appears admirably suited for a bird-sanctuary, and efforts are being made to introduce from the mainland many species not naturally represented on the island.

Four parts have been received of the scientific results of the voyage of the *Belgica* (Expédition Antarctique Belge), now in course of publication at Antwerp, in which Mr. E. Hérouard describes the holothurians, Prof. G. W. Müller the ostracods, and Mr. O. Maas the medusas, while a number of writers deal with the comparatively small collection of insects. Out of nine holothurians obtained, no less than five are new, one being referable to a new generic type. All the Antarctic members of this group belong to the family Elpidiidæ, of which only a single representative (*Elpidia glacialis*) occurs in Arctic seas. The ostracods of the Antarctic plankton include four species of Conchœcia, of which one is new. Jelly-fish (medusas) are but poorly represented, although two out of the small number of species collected by the *Belgica* are regarded as new. As regards insects, the number of species recorded from the neighbourhood of the Antarctic circle is still infinitesimal as compared with those from the opposite pole, the list comprising merely certain colembolids taken near the Canal de Gerlache by the *Belgica* expedition, a podurid and a pediculid collected by the *Southern Cross*, and a dipterid (*Belgica antarctica*) and a larva described in the fasciculus before us. That fasciculus includes, however, descriptions and figures of a considerable number of insects from the lower part of South America and the Falklands, several of which have received new names.

The *Philippine Journal of Science* for March (ii., No. 1) contains a paper on filariasis in the Philippines, by Messrs. P. M. Ashburn and C. F. Craig. They consider that the filaria met with in these islands is a new species (named *F. philippinensis*), owing to its lack of periodicity and certain morphological characters. It develops in *Culex fatigans*. Dr. Musgrave contributes an exhaustive paper on paragonimiasis (infection with the fluke, *Paragonimus westermanii*) in the Philippines. The journal is illustrated with a number of plates.

In the Journal of the Royal Sanitary Institute for May (xxviii., No. 4), Prof. Ronald Ross, F.R.S., discusses some points of interest in connection with tropical sanitation, and Major Horrocks describes some interesting experiments made to determine the conditions under which "specific" bacteria derived from sewage may be present in the air of ventilating pipes, drains, sewers, &c. It would appear that the bursting of bubbles, the separation of dried particles from the walls, and the ejection of minute droplets from flowing sewage, may determine the ejection of specific bacteria from the sewage into the air.

Bulletin No. 4 of the division of pathology and physiology, issued from the experiment station of the Hawaiian Sugar Planters' Association, has been received. It contains the substance of a lecture, delivered by Dr. N. A. Cobb before the association, on some elements of plant pathology relating to disease in the sugar cane.

Mr. D. McAlpine communicates to *Annales Mycologici*, vol. iv., No. 6, an account of the hymenomycete fungus, formerly called *Isaria fuciformis*, as it exists in Australia. Growing on various native grasses and rye-grass, the fungus often forms a conspicuous pest in wet seasons. In general appearance it resembles a Clavaria, but the hymenium or spore-producing layer is borne mainly or entirely on the portion of the fungus attached to the host plant, so that the author refers it to the genus Hypochnus as *Hypochnus fuciformis*.

A short paper by Mr. R. Fitch appears in *Annales Mycologici* (vol. iv., No. 4) describing some experiments on the action of insoluble substances in modifying the effect of deleterious agents upon fungi. It is known that the action of certain toxic solutions on plants varies according to the degree of concentration and that a very weak solution often stimulates growth. Nägeli discovered that the addition of certain solid materials to solutions reduced the toxicity. Similarly it is found by Mr. Fitch that the introduction of sand or glass is equivalent to weakening the proportion of poison in a given solution.

Mr. E. R. Burdon contributes to the *Journal of Economic Biology* (vol. ii., No. 1) an article on the spruce-gall and larch-blight diseases caused by the genus Chermes of the Aphidæ. He points out that, according to investigations made in Germany and Russia, both diseases are induced by the same species, and draws up in a tabular form the sequence of generations. Starting from the gall-foundress generation on the spruce, some of the winged insects of the subsequent generation migrate to the larch, pine, or fir, upon which two generations are developed before there is a migration back to the spruce previous to the sexual generation. The galls are only produced on the spruce and by one of the generations. In order to prevent migration, it is recommended that spruce and larch should not be planted together, but should be separated by a belt of other trees. The author discusses various remedies, among them a paraffin emulsion, with which he washed the trees in winter.

An important addition to the literature on the Phycomycetes will be found in the fifth number of the botanical series of Memoirs of the Department of Agriculture in India, wherein Dr. E. J. Butler furnishes an account of the genus Pythium and some of the Chytridiaceæ. The memoir contains a phylogenetic review and systematic revision of the genus Pythium, for which eighteen species are distinguished, and of these *indigoferae, diacarpum, palmivorum*, and *rostratum* are new. The account of the life-history is based upon the examination of ten species collected in Europe and India. Full details are given of the development and liberation of the zoospores in *Pythium proliferum*. The observations on the Chytridiaceæ made on species of the genera Pleolpidium, Pseudolpidium, Olpidium, Olpidiopsis, and Nowakowskiella enable the author to describe the life-histories of these parasitic fungi.

On September 2, 1906, twenty years had elapsed since the opening of the Sonnblick Observatory, at an altitude of 10,190 feet above sea-level. From Dr. Hann's summary of the results, it appears that the monthly mean barometric pressure is lowest in March and highest in August. The mean yearly minimum temperature is $-22°{\cdot}2$, the mean maximum $49°{\cdot}3$; the absolute extremes were $-35°{\cdot}0$ in January, 1905, and $56°{\cdot}8$ in July of the same year. The relative humidity is the opposite to that which obtains in the plains—the winter is the driest and the spring and summer the dampest; the afternoon is the dampest period of the day. The mean yearly precipitation amounts to 70·71 inches, of which only about 4·77 inches fall as rain, the remainder being chiefly due to snow. The amount is fairly uniformly distributed throughout the year, the mean number of "rain-days" being 212. Fog occurs on 253 days on an average.

The report of the committee appointed by the Governor of Hong Kong to inquire whether earlier warning of the disastrous typhoon of September 18, 1906, could have been given to shipping has resulted in the exoneration of Dr. Doberck and the observatory staff from blame in the matter. The committee was composed of Sir H. S. Berkeley, K.C., Lieut. H. Butterworth, R.N. (King's Harbour Master), A. B. Skottowe (Eastern Extension Telegraph Co.), and Captain A. Sommerville. The evidence taken by the committee, and the documents referred to, are appended to the report. On the afternoon of September 17 the observatory received telegraphic reports from various stations, including Zi-ka-wei (Shanghai), Swatow, and Manila; the barometer readings at those places pointed to the conclusion that there was a gale in Formosa Channel, apparently travelling N.N.W., but in the opinion of the committee these observations did not call for the hoisting of any typhoon signal in Hong Kong on September 17. The evidence as to the appearance and state of the weather on the evening of September 17 and morning of September 18 is conflicting; the Consul for France thought that the appearance of the sky on September 17 indicated a typhoon not far off. But, reviewing the evidence as a whole, the committee found that prior to 7h. 44m. a.m. on September 18 there was no indication of a typhoon approaching Hong Kong, and that by hoisting the signal drum on the morning of September 18 warning was given as soon as was practicably possible.

An address on the "Education of the Professional Chemist," delivered by Prof. C. F. Mabery in his capacity of chairman of Section C of the American Association for the Advancement of Science, is printed in *Science* for May 3. It contains a number of points of educational interest. The methods of teaching chemistry in the elementary schools of the United States are severely criticised; they appear very similar to those which have been attacked in this country during the past fifteen years. "The pupil is taught a text-book rather than chemistry," and has inflicted on him a series of definitions and theoretical principles before he has learned correctly to observe a single fact. In spite of this, the students of technical chemistry appear to be able to overcome at the university such early disadvantages; and we learn that as a result "most manufacturers have a high respect for the advantages afforded by scientific education," and are "ready to receive the young graduate with open cordiality." The lot of the young chemist seems, indeed, to be a particularly happy one in the States in view of the "unprecedented demand for good men." Statistics show that the average salary of the graduates in chemistry of five years' standing from the Case School of Applied Science is about 3000 dollars per annum. At all colleges "there is a far greater demand for graduates than can be supplied." A powerful aid to research has recently arisen in the immense funds devoted by many individuals to this purpose; amongst these the Carnegie foundation for the retirement of teachers is mentioned, "as it relieves the teacher during his earlier years from the anxiety of later need and gives him courage to devote his residual energy in some efforts for the advancement of knowledge."

WE have received a copy (printed for private circulation) of the Friday evening discourse delivered by Prof. A. H. Church at the Royal Institution on April 12 on the "Conservation of Urban Stone-work and Wall-paintings." The most active among the agents tending to destroy the stone-work of buildings of historical interest in large towns is undoubtedly the sulphuric acid produced by the combustion of coal used as fuel. It has been estimated that at least half a million tons of sulphuric acid are formed annually in London in this way. Rain charged with the acid gradually converts the surface of the limestone of public buildings (such, for instance, as St. Paul's Cathedral) into gypsum, the increase of volume accompanying the change being responsible, moreover, for a greater or less degree of disintegration of the more delicate mouldings and tracery. An account is given by Prof. Church of the remedial treatment adopted in such cases, based on the use of a solution of baryta, which has the property of re-cementing together the particles of the decayed stone-work. The baryta acts by forming an insoluble sulphate with the gypsum and liberating lime, which, under the influence of carbonic acid from the air, regenerates the original binding cement of the stone. This treatment is applicable, not only to limestones, but also to sandstones which were originally compacted by a calcareous cement. The success attending its use is well illustrated by the experience obtained in the case of the Chapter House at Westminster. "Before treatment a touch of the finger sufficed to bring away the surface of the carving, afterwards the stone was as sound as that newly quarried and harder." To render the stone subsequently resistant to the action of acids it may be covered with a suitable waterproofing coating of paraffin wax. The conservation of mural paintings or frescoes needs in each special case, according to its character, a different process. A number of typical cases of treatment are described.

AN interesting article on the life and work of Linnæus, by Mr. G. W. Murdoch, appeared in the *Newcastle Daily Journal* of May 23. We congratulate that journal upon being one of the few daily papers to publish a special article upon Linnæus on the 200th anniversary of his birth.

THE *Brazilian Engineering and Mining Review*, which has now reached its fourth annual volume, is a high-class monthly technical journal published in English at Rio de Janeiro. Looking through some back numbers recently sent to us, we notice many articles of permanent value regarding the mineral resources of Brazil, and, continued from number to number, a very important bibliography of the geology and palæontology of Brazil compiled by Prof. John C. Branner.

SEVERAL plates of illustrations of the zoology of the Royal Indian Marine Survey ship *Investigator* have been received from the Indian Museum. The illustrations include Crustacea (Malacostraca and Entomostraca) and Mollusca, and have been prepared under the direction of Dr. A. Alcock, F.R.S., Dr. N. Annandale, and Mr. A. C. MacGilchrist.

A "HANDY Guide to Photographic Requisites," which is a conveniently arranged price list of photographic apparatus, materials, and pure chemicals, has been published by Messrs. Reynolds and Branson, Ltd., of Leeds.

THE much-discussed question of the structure of cyanic acid forms the subject of a communication by F. Carlo Palazzo and E. Carapelle in the *Gazzetta* (vol. xxxvii., ii., p. 184). It is pointed out that, while Nef's experiments have shown that esters of the structure OR.C N derived from normal cyanic acid do not exist, he still adheres illogically to the view that the free acid and its alkali salts are of the normal constitution. The argument that Nef advanced, that the free *iso*-acid, CO : NH, would be unstable in presence of water and undergo change into the normal acid, should, on his own showing, from the great power of addition possessed by the group .C N, be reversed. Cyanic acid when esterified at so low a temperature as $-5°$, by means of diazomethane or diazoethane, gives esters of the *iso*-type CO : NR alone. In view of the fact that the somewhat analogous α-pyridone gives only oxygen esters under similar conditions, and of the probability that isomeric change is excluded at so low a temperature, it is concluded that the free acid and its salts have the iso-structure. The same conclusion was also recently arrived at by Chattaway and Wadmore using a less direct argument.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE:—

June 1. Mars. Apparent Diameter = 17″·6.
9. 1h. Vesta in conjunction with Moon. Vesta 0° 11′ N.
10. 23h. 37m. Mercury in conjunction with ϵ Geminorum (mag. 3·2). Distance between centre of planet and star about 25″.
12. 14h. Mercury in conjunction with Neptune. Mercury 2° 51′ N.
15. 8h. Mercury in conjunction with Jupiter. Mercury 1° 41′ N.
18. 10h. 46m. Minimum of Algol (β Persei).
19. Uranus ½° S. of υ^2 Sagittarii (mag. 5·2).
22. 2h. Sun enters Cancer, Summer commences.
23. Uranus ½° S. of υ^1 Sagittarii (mag. 5·0).
24. 11h. 40m. to 12h. 48m. Moon occults ξ Ophiuchi (mag. 4·5).
26. Mercury at greatest elongation (25° 28′ E).

MAGNITUDES OF MIRA, DECEMBER 14, 1906, TO FEBRUARY 16, 1907.—The results of a number of naked-eye observations of Mira, made at the Radcliffe Observatory during the recent maximum brightness of this star, are published in the Monthly Notices (R.A.S.) for April (vol. lxvii., No. 6, p. 412), together with some notes on the star's colour.

The greatest magnitude, 2·06, during the period of observation was recorded on December 27, when Mr. Robinson found the colour of Mira to be similar to that of α Arietis, *i.e.* yellow. Examined with the Barclay equatorial on January 11, the image of Mira showed red spiculæ around the margin, but the margin was not so broad, nor so deep a red, as that seen by the same observers around Nova Persei in 1901. The image was, however, quite distinct in appearance from those of two other coloured stars, α Ceti and Aldebaran, when the same optical means were employed.

THE INTERNATIONAL EROS CAMPAIGN.—After suffering numerous delays, Circular No. 12 of the International Astrographic Conference of July, 1900, has just been published by the French Academy of Sciences. It contains the results of some thousands of visual and photographic observations of the position of Eros during the favourable opposition of 1900–1 at eleven different observatories. The plates taken at the Upsala Observatory, and part of those taken at Minneapolis, have been reduced at the Paris Observatory, and, in order not to delay the publication of the collected results any longer, the work of the Algiers Observatory is omitted from the present Circular, to be published when ready by the Algiers authorities themselves. A collection of all the important documents relating to the orbit of Eros is included in the present publication.

MARS.—At the coming opposition, which will take place on July 6, the planet's southern hemisphere will be presented, and the apparent diameter will be 22″·8, but, owing to the large southerly declination, the altitude of the planet as seen from Greenwich will be only 10°, therefore the observing conditions will be very poor.

CATALOGUE OF VARIABLE STARS.—The second Harvard catalogue of variable stars, compiled by Miss Cannon, appears as vol. lv., part i., of the Annals of the Astronomical Observatory of Harvard College. It contains all the known particulars of 1957 variable stars, and includes those found in globular clusters, but not those discovered in the Magellanic clouds. The latter number 1791, so that altogether there are now 3748 known variable stars, 2909 of which have been discovered at Harvard.

In addition to the tabulated data for each star, the present catalogue contains a valuable set of notes giving further particulars of numerous individual stars and a brief review of all previous catalogues which have appeared since Argelander published the first, including eighteen variables, in 1844.

ABBREVIATIONS FOR THE NAMES OF STAR CATALOGUES.—No. 4176 (May 14) of the *Astronomische Nachrichten* contains a useful list of abbreviations for star catalogues. The names of the numerous catalogues, to which frequent references are essential, are often lengthy, and different writers use different abbreviations. To obviate the consequent confusion, Dr. A. Auwers has compiled the present list, which includes all the important catalogues from Baily's Flamsteed catalogue (abbreviated to B.Fl.) of 1690 up to the Greenwich second nine-year catalogue ($9y_2$) of 1900.

THE NATAL OBSERVATORY.—The report of the Government astronomer of Natal, for the year 1906, is chiefly devoted to the publication of the meteorological results secured at various stations, as in previous years. Observations of the magnetic elements and the distribution of time signals were carried on as usual, and a number of observations of comet 1905*c* were made with the large equatorial telescope by Mr. Rendell, who, early this year, resigned the position of chief assistant to which he was appointed in March, 1903.

ANNIVERSARY MEETING OF THE LINNEAN SOCIETY.

THE Linnean Society of London, which may be said to have a preeminent position amongst the Linnean societies of the world as the faithful custodian of Linnæus's own library, manuscripts, herbarium, and other collections, along with many personal relics, holds annually its business meeting for the election of officers and the reception of the president's address on May 24, the reputed birthday of Linnæus.

In his presidential address at the meeting on Friday last, Prof. W. A. Herdman dealt with the special circumstances of this year, when the celebration of the 200th birthday of the illustrious Swede has been made the occasion of congratulatory meetings in Sweden and elsewhere throughout the civilised world wherever natural science is cultivated and the debt of the naturalist to Linnæus is gratefully acknowledged.

The Linnean Society has sent to Upsala and Stockholm as its representative on the occasion Mr. William Carruthers, F.R.S., a past-president who has made a special study of the work and the personal history and relics of Linnæus.

Mr. Carruthers, accompanied by the general secretary of the society, is now in Sweden, bearing to the ancient University of Upsala the society's Linnean gold medal, specially struck for the occasion, and conveying both to the University and to the Royal Academy of Sciences at Stockholm congratulatory documents, signed by the president and secretaries, and bearing the seal of the society.

At the conclusion of the section of his address dealing with the Linnean celebrations, the president moved that a telegram in the following terms be sent to the Rector Magnificus of the University of Upsala:—"Linnean Society of London assembled at anniversary meeting congratulates University of Upsala on historic Linnean celebration." The proposal was received with acclamation, and the telegram was dispatched forthwith from the meeting.

In further celebration of the occasion the Linnean Society proposes to hold a social gathering of the fellows and their friends, at the society's rooms in Burlington House, on the evening of June 7, when the society's Linnean relics will be on exhibition, and several short addresses on interesting recent discoveries in natural history will be given by fellows of the society.

THE JUBILEE OF THE SOCIÉTÉ CHIMIQUE DE FRANCE.

A NUMBER of scientific men from all parts of Europe met in Paris on May 16 and the two following days to celebrate the fiftieth anniversary of the Société chimique de France. Founded by a few students for mutual instruction, the society is better known as the Société chimique de Paris, the change in name having taken place a short time ago. British chemists were well represented; Sir W. Ramsay and Dr. H. Brown came on behalf of the Chemical Society; Drs. Markel and Lewkowitsch and Mr. Walter F. Reid for the Society of Chemical Industry. Sir W. Perkin, Prof. Armstrong, and Mr. C. E. Groves were also present.

The proceedings commenced on May 16 in the amphitheatre of the École supérieure de Pharmacie in the Avenue de l'Observatoire. The chair was occupied by M. Bouveault, president of the Société chimique de France, who was supported by M. Reynal, representing the French Government. The president welcomed the guests in a short speech, after which Dr. Graebe, who, with Dr. Liebermann and Dr. von Martius, represented the Deutsche Chemische Gesellschaft, read a somewhat lengthy address in German, and made a short speech in French which was well received. A second German address was presented by Dr. von Martius on behalf of the Verein Deutscher Chemiker, after which Prof. Piutti, of Naples, made a sympathetic speech in Italian which was much applauded. Senator Paternó, also a polished orator, was to have represented Italian chemists, but was detained in Russia on a tariff mission. Sir William Ramsay next read and presented the address of the Chemical Society, saying at the same time a few appropriate words in French. Mr. Walter F. Reid then made a short French speech, and presented the congratulatory address of the Society of Chemical Industry. Other speakers followed representing Russia, Norway, Switzerland, and other countries, after which M. Reynal, representing the French Government, welcomed the foreign delegates and referred to the numerous services rendered to the State by chemists, especially in connection with hygiene, agriculture, and the detection of adulteration and of crime generally.

In the afternoon a special boat conveyed the delegates and many members of the French society to Sèvres, where the porcelain works were visited under the guidance of several chiefs of departments. While not inferior to any other porcelain factory in its perfection of technical handling of the material and artistic treatment of form and colour, Sèvres undoubtedly surpasses all its rivals in the wide range of pigments which it possesses. Many of these are due to the scientific researches of the eminent chemists who have directed the operations of the factory, and research work is still continuously carried on, especially with the rarer elements which modern chemical progress has rendered available. A yellow titanium glaze was much admired, and a new method of decoration produced by the crystallisation of zinc oxalate in combination with various pigments promises to become a valuable adjunct to the decoration of vases and other decorative objects of porcelain. The dazzling white of the Sèvres material is said to be due, not only to the purity of the ingredients used, but also to the kind of wood used as fuel, namely, birch. No doubt there is some reason for this belief, because the heat in the furnaces is so intense that the greater part of the ash of the fuel is volatilised, and, although the ware is carefully packed in saggers and protected as much as possible from the furnace gases, the volatilised ash must to some extent permeate the whole mass. The waste during burning has been reduced of late years by the adoption of an electric pyrometer which enables those in charge of the firing operations to regulate the temperature within a few degrees. An interesting hour was spent in the museum, which contains a unique collection of porcelain from all parts of the world. Of special interest are the specimens of different pigments and glazes, and the ladies of the party regarded with curiosity the artificial rubies and sapphires made by Ebelmen. These were small, and cannot be compared with the beautiful specimens prepared by Hautefeuille which are preserved in the Museum d'Histoire naturelle; but they were the first of their kind, and the precursors of the gems now made in considerable quantities by Moissan's process. It may be remarked that even artificial emeralds are now being produced having the same chemical composition as the natural stones, from which they can only be distinguished by optical tests.

In the evening a banquet was given at the Palais d'Orsay which was attended by the foreign delegates and a number of French scientific men. Among the former were Sir W. Ramsay, Dr. H. Brown, Mr. C. E. Groves, Dr. Lewkowitsch, Dr. Markel, and Mr. W. F. Reid. From Germany came Graebe, Liebermann, and Dr. von Martius; from Italy, Prof. Piutti; from Switzerland, Werner, Guye, and Willstaetter; from Russia, Antonow and Jacovlew. Many distinguished French men of science had assembled to welcome their colleagues from other lands. M. Bouveault, president of the Société chimique de France, presided, ably seconded by M. A. Béhal, secretary of the society, well known for his researches in organic chemistry; M. Lindet, secretary of two international congresses of applied chemistry; MM. Poirrier and Lauth, representatives of the dye-stuffs and pigment industries; Prof. G. Bertrand, discoverer of oxydases; Le Bel, in whose fertile brain the idea of stereochemistry originated; Prof. Cazeneuve, whose researches on the derivatives of camphor are well known; M. Tanret, to whom we owe much of our knowledge of sugars; Le Chatelier, who is still investigating hydraulic cements; M. Haller, member of the institute; M. Armand Gautier, late president of the society; and a number of others no less distinguished.

M. Pichon, Minister of Foreign Affairs, represented the Government, and made an eloquent speech pointing out the advantage to the whole civilised world of such amicable meetings of scientific men of all nations, united in the common wish to promote science and thus advance the well-being of the human race. The British delegates present could not help thinking how unfavourably the action of our own Government contrasted with that of France. The latter had offered decorations of the Legion of Honour to three of the delegates, Sir W. Perkin, Sir W. Ramsay, and Mr. W. F. Reid, but the British Government raised objections, and at the time of the jubilee celebration these had not been withdrawn. The current explanation was that some mediæval rule exists that foreign orders are only to be received by British subjects connected with the Army or Navy. But the Legion of Honour is not a military order, and was specially founded for men of such eminence as Sir W. Ramsay and Sir W. Perkin, and Mr. W. F. Reid, who originated the modern industry of smokeless powder, may certainly claim to be placed on as high a level as Mr. Thomas Atkins, who uses it. It is high time that our Government paid more attention, if not to the claims of scientific men, at any rate to those of international courtesy. Their action in this matter has not given satisfaction in the French capital, and contrasts very unfavourably with that of Germany, which accepted gratefully what was, of course, intended as a graceful international compliment.

On Friday, May 17, proceedings commenced at the early hour of 8.30 a.m. with an exhibition of products and apparatus of the members of the Société chimique de France. Among many important exhibits, two especially aroused the interest of the visitors. Abbé J. B. Senderens showed a number of products obtained by a new method of catalysis. Amorphous phosphorus prepared at a low temperature is placed in a tube and heated to about 300° C. in a current of hydrogen gas. The vapour of the substance to be decomposed is then passed through, with the result that water is formed and condenses in the receiver with the product of the reaction. M. G. Bertrand exhibited about forty samples of products obtained by the action of a bacterium which he has isolated from sorbose. These contained a number of substances of extreme interest to the chemist, including several artificial sugars. At 10 o'clock a general meeting took place, at which M. Armand Gautier, a former president of the society, read an account of the work done by members of the society since its formation. Few societies can show such a record of discoveries of the first magnitude.

A distribution of prizes to the successful students of the École supérieure de Pharmacie then took place. At 1 p.m. a special train started for Chantilly, where the priceless art treasures presented to the nation by the Duc d'Aumale were inspected. In the evening a meeting of the Société chimique de France was held, at which country members only were entitled to read papers. Some communications of importance were read, and will be published in the Bulletin.

On Saturday a reception was held in the Hotel de Ville by the municipality. The president of the municipal council, Dr. Lefèvre, is himself a biological chemist, and made some humorous allusions to the important part played by chemists in modern municipal work. The beautiful paintings with which the building is decorated were shown and explained to the visitors, who also witnessed some of the preparations that were being made for the reception of the delegates of the University of London in the ensuing week.

During the evening a theatrical soirée was given at the Palais d'Orsay, which terminated the proceedings officially. There were, however, numerous private offers of hospitality extending into the following week, and the British delegates were loth to part from their hospitable colleagues of the Société chimique de France.

STUDIES FROM A NORTHERN UNIVERSITY.

THE two contributions to science referred to below[1] form part of the publications issued by the University of Aberdeen when the quatercentenary of its foundation was celebrated in September of last year. When men move northwards to occupy chairs in the most outlying university of the kingdom, it has been said that the isolation and absence of external incentives are apt to cause a premature cooling of their zeal for science. However that may be, these two volumes contain convincing evidence that in recent years Aberdeen University has been

1 "Studies in Pathology." Written by Alumni to celebrate the Quatercentenary of the University of Aberdeen and the Quatercentenary of the Chair of Pathology therein. Edited by William Bulloch, M.D. Pp. xxx+412. (Aberdeen, 1906.) Price 15s.

"Proceedings of the Anatomical and Anthropological Society of the University of Aberdeen, 1904–1906." Pp. viii+241; illustrated. (Aberdeen University Press, 1906.)

able to produce graduates who are both willing and able to widen the bounds of real knowledge.

The volume containing the studies in pathology is of such merit that the history of its origin deserves a brief mention. In reality, its preparation was commenced five-and-twenty years ago, when Sir Erasmus Wilson wisely presented the University with sufficient funds to establish a chair of pathology—the second created in this country. By a happy inspiration Prof. D. J. Hamilton was asked to occupy it. Out of the raw material provided by the surrounding country Hamilton has raised the school of pathologists which has produced the volume under review, and very fittingly dedicated it to him. The studies are seventeen in number, and illustrate the diverse directions in which pathology has branched in recent years. To the old pathology—the morbid anatomy of Rokitansky and Virchow—only three of the studies belong, those of Dr. A. Keith, on the malformations of the heart; Dr. A. Low, on epignathus; and Dr. G. Duncan, on exophthalmic goitre. Experimental pathology, a recent development, is represented by Prof. A. Cushny's excellent paper on paroxysmal irregularity of the heart, and by Dr. J. J. R. Macleod's study of the condition that follows a direct diversion of the portal blood into the systemic circulation.

All the other studies, with the exception of that by Prof. St. Clair Symmers on bilharziosis, are concerned with bacteriology—a subject which has expanded into its present gigantic proportions since Prof. Hamilton went to Aberdeen in 1882. Five of the researches deal with a matter of the very utmost importance—that of immunity. To this group belong the papers by Dr. G. Dean, on plague immunity; Dr. Wm. Bulloch, on *Bacillus pyocyaneus*; Dr. G. G. Macdonald, on pneumococcal infection; Dr. R. D. Keith, on the relationship between hæmolysis and phagocytosis of red blood corpuscles; Dr. J. G. G. Ledingham and Dr. Wm. Bulloch, on the relation of leucocytosis to the opsonic content of the blood serum. The question of infection of the body from the alimentary canal is discussed by Prof. Hamilton in connection with his investigations of the disease in sheep known as "louping-ill." The bacteria found with this disease are described by Drs. J. M. Adam and B. R. G. Russell. Dr. Wm. Hunter has employed the data he collected as bacteriologist in Hong Kong to demonstrate that there is a very direct relationship between the epidemics of plague amongst rats and men. The administrative means which may be employed for the prevention of human tuberculosis are discussed by Dr. W. L. Mackenzie; the results of experiments on the efficacy of certain disinfectants are given by Dr. A. R. Laing. The manner in which these studies have been edited and arranged reflects the greatest credit on Dr. Wm. Bulloch.

To the quatercentenary publications the Anatomical and Anthropological Society of the University contributed a special volume of its Proceedings. Prof. R. W. Reid, the president of the society, has organised a fully-equipped department of anthropology in the University, with the result that graduates bring back most valuable information regarding the people of the countries or colonies in which they have stayed, and contribute their observations to their old society. In this volume appear five papers which deal with native races. Mr. George Moir writes on the natives of the Malay Archipelago; Mr. F. S. Maxwell contributes notes on Hausaland; Mr. D. Horn deals with the people of the New Hebrides; Captain A. W. C. Young, with the Tibet mission force to Lhassa; and Dr. R. H. Spittal describes skulls of New Guinea. Important papers on ancient or prehistoric subjects are contributed by Dr. Alex. Low, by Mr. A. Macdonald, and by Dr. J. S. Milne. Dr. A. Keith writes on the results of an anthropological investigation of the external ear, and Dr. R. J. Gladstone on the variations in shape and size of the skull. The paper on the development of the lower jaw in man, by Dr. Alex. Low, deserves especial commendation, both for the importance of its facts and for the very exact and complete manner in which he has recorded his observations. There is also an excellent paper by Miss A. V. Baxter on 1500 finger-prints which are recorded in the archives of the anthropological laboratory of the University.

THE FLOWERING PLANTS OF THE MESOZOIC AGE, IN THE LIGHT OF RECENT DISCOVERIES.[1]

THE subject which I have chosen for my address relates to plants of Mesozoic or Secondary age, ranging from the Trias, through the Jurassic, to the Cretaceous, the great period which bridges the gulf between the antique vegetation of Palæozoic days and the essentially modern type of flora which characterises the Tertiary formations.

We have abundant evidence of the existence of seed-plants in very early days, in fact, practically as far back in the Palæozoic as our records of terrestrial plants extend. On this occasion, however, I am going to speak of flowering plants, by which I do not mean the same thing as seed-plants, though the two terms have often been used as synonymous. One of the results of recent discoveries in Palæozoic botany has been to show that the seed-bearing and flower-bearing characters by no means coincide, for the fern-like seed-plants of Palæozoic age were in no sense of the words flowering plants. The evidence shows that their seeds, like the fructification of ordinary ferns, were borne on leaves differing but little from the vegetative fronds, and not aggregated on any special axis as are the parts of a flower. The nearest and, indeed, the only analogy to be found among recent seed-plants is in the female plant of Cycas, to which we shall return presently. The Mesozoic plants, however, with which we are now concerned were not only seed-plants, but they bore their reproductive organs in a form which everyone would naturally describe as a flower. They were flowering plants in the full sense of the term, however different in other respects from the flowering plants of the present day.

The Mesozoic floras from the Upper Trias to the Lower Cretaceous maintain, on the whole, a very uniform character, widely different from that of the preceding Palæozoic vegetation. True ferns were abundant, more so, no doubt, than in the earlier period; true conifers, often much resembling recent genera, were a dominant group; the family now represented by the maidenhair tree (Ginkgo) was prevalent, but the most striking feature of the vegetation was the abundance, in all parts of the world, of plants belonging to the class of the cycads, now so limited a group.

We will concentrate our attention on the cycad-like plants, or Cycadophyta, to adopt the broader class-name, appropriately suggested by Prof. Nathorst. The living Cycadaceæ are, it will be remembered, quite a small family, embracing only nine genera, and, according to a recent estimate, about 100 species, inhabiting the tropical or subtropical regions of both the old and new worlds, but nowhere forming a dominant feature in the vegetation. Throughout the Mesozoic period, however, at least until the Upper Cretaceous is reached, plants with the habit and foliage of cycads are extraordinarily abundant in all regions from which secondary fossils have been obtained; they are as characteristic of Mesozoic vegetation as the dicotyledons of our recent flora.

The most important point in questions of affinity is the fructification. Throughout the recent cycads this is of a simple type; in all the genera the staminate fructification is a cone, consisting of an axis densely beset with scales or sporophylls, each sporophyll bearing on its lower surface a number—often a very large number—of pollen-sacs, grouped, like the sporangia of a fern, in small sori. In eight out of the nine genera the female fructification is also strobiloid, each sporophyll bearing two marginal ovules. In Cycas itself, however, so far as the female plant is concerned, we find a much more primitive arrangement; no cone at all is differentiated, but the carpels are borne directly on the main stem of the plant, in rosettes alternating with those of the vegetative leaves. The carpels themselves are lobed and extremely leaf-like, bearing as many as six ovules in many cases, though in one species the number is reduced to two. Thus in Cycas the seeds are borne on organs still obviously leaves, and

[1] Abridged from the presidential address delivered by Dr. D. H. Scott, F.R.S., before the Royal Microscopical Society on January 16, and published in the Journal of the Society for April.

nothing of the nature of a flower is differentiated. No other living seed-plant is so primitive as this, but the cycads as a whole are undoubtedly the most primitive family of present-day Spermophyta, as is most strikingly shown in their cryptogamic mode of fertilisation by means of spermatozoids, which they share with Ginkgo alone among seed-plants.

When we go back to the Mesozoic age we might, on what one may call the elementary view of evolution, expect to find the Cycadophytes, which were so abundant at that period, still simpler and still nearer the cryptogamic condition than the members of the class which have come down to our own day. But this is by no means the case; there were, no doubt, a certain number of cycads in Mesozoic times which were about on the same level of organisation as their living representatives, but the great majority, so far as the available evidence shows, attained a much higher organisation, at least in their reproductive arrangements, far surpassing any of the gymnosperms now known to us. This is one of the many facts in palæontology which show that evolution is by no means the obvious progression from the simple to the complex which many people have imagined. Just as the lycopods and the horsetails of the Coal-measures were not simpler, but far more complex than their successors, so the Cycadophyta of Mesozoic age were, on the whole, on a much higher level than the surviving family Cycadaceæ, which now represents them. The history of the vegetable kingdom, so far as its records are known, is the history of the ascendancy of a succession of dominant families, each of which attained at some definite period its maximum, both in extent and organisation, and then sank into comparative obscurity, or died out altogether, giving place to some other race, which, under changing conditions, was better able to assume the leading *rôle*. The cycadophytes of the Mesozoic were, in their day (and it was a long one), a dominant group, almost as much so as the dicotyledons are now, and they equipped themselves with a correspondingly high organisation, even rivalling the angiospermous flowering plants (perhaps cadets of the same stock), which ultimately displaced them.

Among the Mesozoic Cycadophyta there were some, as already mentioned, which seem to have been essentially similar to our recent cycads. I do not, however, propose to dwell on this line of descent, but will now pass on to those Mesozoic Cycadophyta which attained a higher level of organisation, giving them a better title to the name of "flowering plants" than any of their predecessors or contemporaries.

The genus Bennettites was founded by Carruthers in 1868[1] for certain cycadean stems, of Oolitic and Lower Cretaceous age, with fruits borne on secondary axes, not protruding beyond the bases of the petioles. The species on which, for many years, our knowledge of the group was principally based is *Bennettites Gibsonianus*, of which a magnificently preserved specimen was discovered, just fifty years ago, in the Lower Greensand of Luccombe Chine, in the Isle of Wight. Some years later a second specimen was found in the same locality, but no others have as yet come to light. In *B. Gibsonianus* and other species the external appearance of the stem was similar to that of many recent cycads, its surface being completely invested by an armour of persistent leaf-bases. Anatomically, there is also a marked agreement, the chief distinction consisting in the simpler course, in the case of the fossil, of the vascular strands which pass out from the stem into the leaves. A striking feature is the presence, in great numbers, on the leaf-bases and bracts, of flat, scaly hairs, of the same nature as the ramenta characteristic of ferns. Even in external appearance, however, a Bennettitean stem, if in the fruiting condition, differs conspicuously from that of any recent cycad in the presence of a number of short, lateral branches, like large buds, wedged in between the leaf-bases, and arising in their axils (see Fig. 1, from an American species). These bodies are the fructifications, the characteristic feature of the Bennettiteæ. In structure, as well as in position, they differ totally from any form of fructification met with in recent cycads or other gymnosperms.

The peduncle bears many spirally arranged bracts, which completely enclose the fructification. The end of this peduncle expands into a convex receptacle, on which organs of two kinds are borne, the one fertile, the other sterile. The fertile appendages consist each of a long, slender pedicel, terminating in a single orthotropous seed, with the micropyle directed outwards. The seed-bearing pedicels are present in large numbers; the sterile appendages, or interseminal scales, are still more numerous. They form a dense packing between the seed-pedicels, and somewhat overtop the seeds themselves, expanding at their apices to form an almost continuous envelope, leaving only small perforations, into which the micropylar ends of the seeds are fitted. They form collectively a kind of pericarp, differing, however, from that of an angiospermous fruit in the presence of openings for the micropyles of the seeds. The whole complex fruit is enclosed in the mantle of overlapping bracts. In *Bennettites Gibsonianus* the fruits discovered are practically ripe, for each seed contains a large dicotyledonous embryo, with somewhat fleshy cotyledons. The embryo almost fills the seed, which was thus nearly, if not quite, exalbuminous—an unprecedented condition in

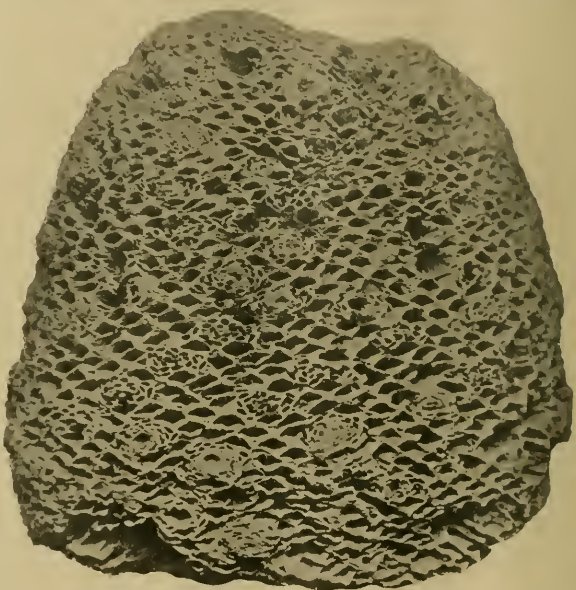


FIG. 1.—*Cycadeoidea marylandica.* The earliest described American fossil Cycad. From an original daguerreotype. Nearly thirty young fruits are marked in the present view by the groups of bract scars interpolated between the old leaf-bases. About one-fourth natural size. From Wieland's "American Fossil Cycads."

[1] "On Fossil Cycadean Stems from the Secondary Rocks of Britain." Trans. Linn. Soc. London, xxvi.

a gymnosperm. This plant, and a few of its immediate allies, afford the only instances, so far known, of the preservation of the embryo in a fossil seed.[1]

In the whole arrangement of the floral organs, the presence of a pericarp, and the character of the seed, the fructification differs entirely from anything known in gymnosperms, and the inclusion of Bennettites in Saporta's class "pro-angiosperms" appeared justified on grounds of analogy if not of affinity.

So far, however, nothing whatever was known of the staminate organs of these plants, and no one suspected that the fructifications already known were other than unisexual. The complete elucidation of the subject was reserved for the American palæontologists, who possess a wealth of material for the investigation of Mesozoic Cycadophyta far exceeding anything that Europe can show. No less than sixty species of silicified cycadean trunks have now been described from the Mesozoic of America, ranging from the Upper Triassic to the Lower Cretaceous.

The specimens are often extremely numerous; thus the twenty-nine species from the Black Hills of South Dakota are represented by nearly 1000 more or less complete trunks. In fact, the Cycadophyta of the American Mesozoic are as important to the botanist as the gigantic saurians (with which they are often associated) are to the zoologist.

FIG. 2.—*Cycadeoidea ingens.* Restoration of an expanded bisexual flower in longitudinal section, showing the central ovuliferous cone, the compound stamens bearing numerous synangia, and the surrounding bracts, hairy with ramenta. About half natural size. From Wieland's "American Fossil Cycads."

Fig. 1 represents the first American fossil cycad ever discovered; it was found about 1860 in Maryland, between Baltimore and Washington, by the geologist, Philip Tyson, and well illustrates the external features of the group. A third of a century elapsed before any further discoveries were made, so the present magnificent material has been accumulated within quite a short period. The systematic arrangement of the specimens has been principally the work of Prof. Lester Ward, while the morphological investigation has fallen to the share of Dr. Wieland, of Yale University, to whom the discoveries we have now to consider are due. In referring to Dr. Wieland's work, I shall follow him in using the name Cycadeoidea, but it must be understood that this is synonymous, so far as we can tell, with Bennettites.

In external features, as well as in anatomical structure, the American species so far investigated agree wonderfully closely with the European species of Bennettites, but it must be remembered that the vast extent of the material will necessitate many years of arduous research before its investigation can be completed. During the eight years or so that Dr. Wieland has been at work, a marvellous amount has been accomplished. His results are embodied in a magnificent volume issued last August by the Carnegie Institution of Washington.[1]

[1] Solms-Laubach, "On the Fructification of *Bennettites Gibsonianus*." English translation in Ann. of Bot., v. 1891.

The male organs of the Bennettiteæ were first found in 1899, in the species *Cycadeoidea ingens.*[2] Two years later the important fact was established that the organs of both sexes occurred in the same fructification, the whole thus constituting a "hermaphrodite," or bisexual flower.[3] Twenty-five trunks bearing bisexual flowers have now been investigated, belonging to seven American species. The conditions in *Cycadeoidea dacotensis*, one of the cases most fully investigated, are as follows. The whole fructification has a length of about 12 cm., and protrudes beyond the leaf-bases of the trunk. About half the length is occupied by the peduncle, the upper part of which bears 100 or more spirally arranged bracts, enclosing the essential organs. The centre is occupied by the ovuliferous cone, about 4 cm. in height, corresponding to the receptacle, with its seeds and other appendages, as found in *Bennettites Gibsonianus*. In *C. dacotensis*, however, the stage of development is far earlier, immature ovules taking the place of the ripe seeds of the more advanced European specimens. We have to do, then, in this case with an organ in the stage of a *flower*, as distinguished from the *fruit* previously described. The ovuliferous cone, or gynæcium, is completely surrounded by the hypogynous staminate disc, as Dr. Wieland calls it, springing from the rim of the receptacle at the base of the cone (see diagram, Fig. 2). The stamens are numerous (eighteen to twenty in *C. dacotensis*), and arranged in a whorl; their stalks are united to form a continuous sheath, which extends to about the level of the top of the gynæcium. Here they become free from each other; each stamen is a compound, pinnate sporophyll, about 10 cm. long altogether, and is folded inwards towards the gynæcium, the deflexed tip reaching down nearly to its base. The alternate pinnæ, of which there are about twenty pairs, are likewise bent inwards. The pinnæ, with the exception of those at the apex and base of the frond, which are sterile, bear the pollen-sacs in two rows, ten in each row on the longest pinnæ. Thus the stamens are highly complex organs, resembling the fertile fronds of a fern rather than the stamens to which we are accustomed in our modern flowering plants. The complexity, however, does not end here, for each pollen-sac is itself a compound structure containing two rows of loculi, ten or more in each row. It thus constitutes a *synangium*, comparable to that of the marattiaceous ferns, and especially the genus Marattia. The similarity to the fructification of such a species as *Marattia Kaulfussii* is, in fact, surprisingly close.

It appears that all the specimens actually investigated were in the bud condition, the stamens being still infolded, as described above. Presumably the stamens eventually opened out, and the diagrams introduced in Figs. 2 and 3 show them in the expanded condition. The ground-plan of the open flower, shown in Fig. 3, is based on *Cycadeoidea ingens*, a species in which the number of stamens is smaller than in *C. dacotensis*.

The leading features in the organisation of the Bennettitean flower may be briefly recapitulated as follows:—The centre is occupied by the gynæcium, seated on the convex receptacle, and consisting of numerous long-

[1] "American Fossil Cycads." By G. R. Wieland (1906).
[2] "A Study of some American Fossil Cycads." Part i. The Male Flower of Cycadeoidea. Amer. Journ. Science, vii., 1899.
[3] Op. cit., Part iv. On the Microsporangiate Fructification of *Cycadeoidea*, Amer. Journ. Science, xi., 1901.

stalked ovules, imbedded among the interseminal scales. Surrounding this central body is the hypogynous whorl of stamens, fused below to form a tube, and expanding above into the pinnate sporophylls, bearing very numerous compound pollen-sacs or synangia, filled with pollen. The whole is surrounded by an envelope of spirally arranged bracts springing from the upper part of the peduncle. The general arrangement of parts is manifestly just the same as in a typical angiospermous flower, with a central pistil, hypogynous stamens, and a perianth. The resemblance is further emphasised by the fact, long known, that the interseminal scales are confluent at their outer ends to form a kind of pericarp or ovary-wall. When to these general features we add the practically exalbuminous character of the seed, with its highly organised dicotyledonous embryo, the indications of affinity with the higher flowering plants become extremely significant. The comparison was drawn by Dr. Wieland in 1901, immediately on his discovery of the hermaphrodite flower. The angiosperm which he specially selected for comparison was the tulip-tree, Liriodendron. The elongated strobiloid fruit, with many carpels spirally arranged in the receptacle, no doubt suggests similarity, and, on general grounds, we should naturally look for analogies among the less specialised polypetalous dicotyledons, such as Magnoliaceæ, in some of which the leaves of the perianth are spirally arranged. Analogies may also be found in our familiar Ranunculaceæ, such as Anemone, or, still better, the globe-flower (Trollius), with its numerous sepals, or, again, in the water-lilies (Nymphæaceæ). In certain respects, indeed, the Bennettitean flower was in advance of these more primitive dicotyledons, as seen in the arrangement of the stamens, which have abandoned the spiral phyllotaxis of the other organs to range themselves in a definite whorl, while at the same time their stalks are fused into a tube, thus becoming "monadelphous," as in the mallows of our own flora.

The flower, with its great stamens, 10 cm. long in some species, must have been a striking object when it opened (Figs. 2 and 3). As, of course, we can know nothing of the coloration of the perianth and other parts, we cannot tell how brilliant its appearance may have been; the bright tints of the carpels and ovules in some recent cycads, such as species of Cycas and Encephalartos, suggest the probability that the attractions of colour were not wanting to the more elaborate flowers of the older Cycadophyta; the possibility of a relation to the insect life of the period cannot be ignored. It is not my intention to push further the comparison of the Bennettitean fructifications with the angiospermous flower; the deeply interesting questions which must suggest themselves to the mind of every botanist, as to how far these manifest analogies are likely to indicate an immediate affinity, will be fully discussed elsewhere by others. Enough has been said to show that the remarkable organs discovered by Dr. Wieland fully merit the name of "flower," in the same sense in which we apply it, in everyday language, to the flowers of our gardens and fields.

As stress has been laid so far on the points of agreement with the flower of the angiosperms, some reference must now be made to characters which indicate relations in other directions. The structure of the gynæcium renders it probable, if not certain, that the Bennettiteæ were still gymnosperms as regards their mode of pollination, for the openings between the scales of the pericarp leave the micropyles of the seeds exposed. One must therefore suppose that the pollen was received by the ovule directly, without the intervention of a stigma, so that functional angiospermy had not yet been attained. This is, no doubt, a primitive condition, but it by no means excludes an affinity with angiosperms. Just as in Lagenostoma, the seed of the pteridosperm Lyginodendron, the beak of the nucellus was still the receptive organ for the pollen, in spite of the presence of an integument,[1] so, in the Bennettitean flower, the micropyle of the seed was still the receptive organ in spite of the presence of a pericarp. The integument in the one case and the pericarp in the other might be termed a "prophetic organ" in the only sense in which such organs exist, *i.e.* an organ which has not yet assumed all the functions to which it is destined.

The stamens, while by their arrangement and position they suggest those of a typical angiosperm, carry us back by their structure and form to the sporophylls of a fern (see Figs. 2 and 3), so that the characters of the flower as a whole may almost be said to bridge the gulf between cryptogams and the higher flowering plants. The fern-like characters, however, have probably come to the Bennettiteæ, not directly from true ferns, but through the

FIG. 3.—*Cycadeoidea ingens.* Plan of bisexual flower consisting of a central ovuliferous cone, a hypogynous whorl of compound stamens, united at the base, and a series of spirally inserted enveloping bracts, all shown diagrammatically on about the same scale as Fig. 2, and as if pressed out flat. From Wieland's "American Fossil Cycads."

intermediate group of the Palæozoic pteridosperms. The fact that the pollen-grains are borne in compound pollen-sacs, or synangia, like those of the Marattiaceæ among ferns, is one of great significance.[2] It is impossible to emphasise too strongly the extraordinary combination of characters which the Bennettitean flower presents, uniting in itself features characteristic of the angiosperms, the gymnosperms, and the ferns, and suggesting that the passage from the Filicineæ to the higher flowering plants may have been (comparatively speaking) a short cut. The complexity of this earliest known type of a true flower indicates the probability, as Dr. Wieland points out,[3] that

[1] See Oliver and Scott, "On the Structure of the Palæozoic Seed *Lagenostoma Lomaxi*," Phil. Trans. Roy. Soc., Series B., 197 (1904), p. 231.

[2] The general question of the relation of the early seed-plants to ferns is discussed in my article, "On the Present Position of Palæozoic Botany," Progressus Rei Botanicæ, Heft 1. 1906.

[3] "American Fossil Cycads," p. 143.

the evolution of the angiospermous flower was a process of reduction. There is thus no longer any presumption that the simplest forms among the flowers of angiosperms are likely to be the most primitive. The tendency of the older morphologists to regard such flowers as reductions from a more perfect type appears fully justified by the discovery of the elaboration of floral structure attained by the Mesozoic Cycadophyta before the advent of the angiosperms themselves.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The special board for biology and geology has approved a grant of 150*l.* from the Balfour fund made by the Balfour managers to W. E. Agar, of King's College, in furtherance of his proposed expedition to the Paraguayan Chaco.

The board of agricultural studies reports that the fund for providing the department of agriculture with a permanent building of its own has received substantial additions during the year, the conditional contribution of 5000*l.* by the Drapers' Company having been secured. The fund now amounts to 13,030*l.* 10*s.*

Manchester.—Mr. F. T. Swanwick, Richardson lecturer in mathematics, has been appointed Fielden lecturer in mathematics in place of Mr. R. F. Gwyther, who is now devoting his whole time to the joint matriculation board of the northern universities. Mr. J. E. Littlewood (Cambridge) has been appointed Richardson lecturer in mathematics; he was bracketed senior wrangler in 1905, and was placed in the first division of the first class of part ii. of the mathematical tripos in 1906. Mr. H. M. Priestley (Cambridge) has been appointed assistant lecturer in mathematics; he was fifth wrangler in 1905, and was placed in the second division of the first class of part ii. of the mathematical tripos in 1906.

Plans have been prepared for new engineering laboratories, and building will shortly be commenced on a site on the north side of Coupland Street, near the present physical laboratories. For some time past need has been felt for this extension, and the new buildings will afford ample space for the whole work of the engineering department to be carried out under one roof. In addition to the main laboratory of 75 feet by 166 feet, lecture rooms, a large drawing room, and a boiler house are to be erected.

Sir Arthur Rücker, F.R.S., principal of the University of London, will distribute the prizes to the successful students at Guy's Hospital on Thursday, July 4.

Sir John Kennaway, Bart., M.P., will preside at the commemoration day proceedings of Livingstone College, Leyton, E., on Wednesday, June 5. Livingstone College exists for the purpose of solving one of the greatest problems connected with missionary effort, viz. the preservation of the health of missionaries and others in tropical climates.

It is stated in *Engineering* of May 24 that the Technikum at Ilmenau, in Thuringia, is one of the few technical schools that are conducted in direct connection with commercial works. The director is also head of a firm of engineering and electrical works, and the students are, at all times, when not occupied by their regular lectures and laboratory practice, admitted into the works, in which advanced pupils can receive further training. The combination seems to answer.

In the *Engineering Magazine* (vol. xxxiii., No. 2) Mr. H. Cole Estep discusses the attitude of technical students towards the engineering-apprenticeship courses which are offered by the leading manufacturers of the United States. He finds the attitude unsympathetic. The present low flat-rate system of wages is discouraging rather than encouraging to the average college student. The objections are also raised that the courses are too long, that there is no reward at the end, and that the invention clause existing in many apprenticeship contracts is unfair.

A course of instruction in natural history has been arranged at the Horticultural College, Swanley, for students who, having passed through the ordinary training in gardening, wish for additional training in natural-history subjects, in order to qualify as teachers of gardening and nature-study. Other students will be admitted to the course provided they can show they are able to take full advantage of the instruction. Students will be given an insight into field work in natural history based on laboratory instruction; the work will be practical, and students will be shown how to prepare their own material and to construct their own apparatus. The course will last a year, of which the first two terms will be devoted to general work in botany, zoology, and geology, and the third term to special subjects. Fuller particulars may be obtained from the principal at the college, Swanley, Kent.

In his presidential address to the Royal Geographical Society on Monday, May 27, Sir George Goldie again directed attention to the omission of geography in examinations for the Foreign Office and other branches of the Civil Service. For a good many years the Foreign Office stood in an exceptional position amongst the Civil Services of the Crown by including geography amongst the subjects for the entrance examinations of candidates and making a pass in this subject compulsory. After next month, however, geography will cease to be a subject which candidates for the Foreign Office may select even voluntarily. So many sons of the well-to-do classes of this country compete in examinations controlled by the Civil Service Commissioners that the standing in the whole educational sphere of any subject depends to some extent upon whether it is or is not a means of gaining marks in the civil and military examinations, and it may be asserted that if geography is included as one of the subjects of examination, it will very shortly take its place in Great Britain, as it has long since done in the United States, Germany, and other countries, as one of the fundamental and indispensable elements in the education of childhood and youth. That this has not been the case up to now is probably due to the unintelligent and unmethodical manner in which the subject was taught until a few years ago, with the result that the majority of those who are to-day in a position to speak with authority retain an entirely incorrect impression of its scope and objects. It is to the University of Oxford, supported, Sir George Goldie added, by the Universities of Cambridge, London, Edinburgh, and other great centres of education, that geographers must look for a satisfactory solution of this important question; for, so far as can be gathered from the correspondence on the subject which appeared some months ago, the Civil Service Commissioners are willing to consider the admission of geography as one of the voluntary subjects for examinations, provided the great universities will give a lead. In taking such a step, both the universities and the commissioners would have behind them the pressure of public opinion, owing to the sudden awakening both of interest in the Empire as a whole and of recognition of our widespread ignorance of its geographical conditions.

SOCIETIES AND ACADEMIES.

London.

Royal Society, January 31.—"On the Thermo-chemistry of Flame Spectra at High Temperatures." By Prof. W. N. **Hartley**, F.R.S.

(1) The oxides of calcium, strontium, and barium are not dissociated by heat alone, because they show no spectrum in a carbon monoxide flame; (2) they are reduced by the combined action of heat and hydrogen in the oxy-hydrogen flame and by the action of cyanogen in the cyanogen flame; (3) the flame coloration is due to the metal, because not only is the flame spectrum from lime essentially the same as that of the metal calcium, but also the heats of formation of CaO, SrO, and BaO have very nearly the same value, and that where calcium oxide can be reduced the other oxides could, on that account, undergo a similar reduction. Whether the compound of strontium or barium in the flame be a sulphide or an oxide, the same spectrum is emitted, but there is some

uncertainty as to whether the barium sulphide is not converted into oxide by water-vapour in the flame.

The explanation given by Lenard, of the flame coloration by the alkali salts, appears to be inapplicable to the coloration of the carbon monoxide flame by the haloid salts of the alkaline earth metals.

February 21.—"Longitudinal Symmetry in Phanerogamia." By Percy **Groom.** Communicated by Dr. D. H. Scott, F.R.S.

The paper describes a graphic method of recording the longitudinal distances apart of plant members, and gives results obtained by the method, which is as follows:—

On squared paper the successive internodes (or other segments) are recorded as successive ordinates, and the resultant curve is termed the internode curve (or other curve).

In a typical herb the internode curve of the main axis is a regular ascending-descending one, while those of the successive branches commencing at the base of the herb more or less completely and gradually change from this complete curve to a purely descending one. These internode curves are shown to be inherent, though liable to modification by external conditions.

In alternate-leaved Chenopodiaceæ the internode curve invariably shows a periodic zigzag form, and, by connecting the alternate ordinates, can be analysed into two "subcurves" which are frequently not synchronous in period. Both these subcurves of the main axis are of the ascending-descending type, while those of the successive branches traced from below more or less change into the purely descending form. Of the two subcurves, one is the "internode subcurve" and the other is the "displacement subcurve." Evidence is given in favour of the view that the original phyllotaxis of the Chenopodiaceæ was opposite, that the internode subcurve represents a modification of the original internode curve, and that the displacement subcurve represents a series of intercalated segments registering the distances up which single leaves have been displaced from the original opposite arrangement.

This view is confirmed by the fact that a similar displacement curve is formed by recording the heights of the successive branches above their subtending leaves in certain Boraginaceæ. It is shown, too, that the Boraginaceæ are probably opposite leaved in design, and that in *Solanum Dulcamara* the familiar leaf displacements high up the stem are foreshadowed by others lower down.

One point of significance in connection with these assumed hereditary displacements is that they follow the rule formulated by de Vries in reference to the dimensions and distribution of monstrosities.

The paper also discusses smaller or more fluctuating displacements of leaves; double-leaves; the correlation of alternate rather than successive internodes and nodes where phyllotaxis is cyclic; and the theory of stem structure.

Finally, the applicability of the method to other morphological problems is tested by observations on sympodes, with a positive result in the case of *Ampelopsis hederacea.*

March 14.—"Capillary Electrometer Records of the Electrical Changes during the Natural Beat of the Frog's Heart." By Prof. Francis **Gotch,** F.R.S.

The chief points brought forward in this communication are the following:—(1) The electrical changes during the natural rhythmic activity of the frog's heart, when kept *in situ* and supplied with blood, resemble in all essentials those observed by Waller, Starling, Bayliss, Einthoven, &c., in the mammalian heart, but do not correspond with those observed by Engelmann, Burdon-Sanderson, &c., in the excised frog's heart artificially excited. (2) The more prolonged character of the activity of the frog's heart, and the ease with which the locality of any change can be determined, render it clear that the special feature of the natural beat is the occurrence of two chief electrical changes of similar sign. (3) This is explicable as due to the first or base change being more prolonged and of greater magnitude than the apex change. (4) The increased duration and magnitude of the base change is mainly caused by the circumstance that, although the base change occurs first, the whole of the base is not involved, the portion around the spring of the aorta remaining quiescent until the activity has occurred at the apex; this aortic portion then becoming active produces the terminal effect. (5) Each contraction wave thus starting at the auriculo-ventricular junction is propagated to the apex, and returns from the apex to the part of the base around the start of the aorta; from this it spreads to the aortic bulb; at 15° C. the propagation rate is about 130 mm. in one second, *i.e.* 6/100″ after the first base change, an apex change is perceptible, and 6/100″ after the apex, a second aortic base change. (6) The return wave is brought into prominence when the heart is distended with blood, or has been so distended, and is associated with the persistence of the early tubular condition which prevails in the heart of the tadpole. (7) The return wave reveals itself in the records as a double reversal of the electromotive condition of the whole base contact; this is at first galvanometrically negative (base activity), then suddenly positive (apex activity), and then, again, suddenly negative (second aortic part of base activity). It is confirmed by records made under a variety of conditions, comprising local alterations of temperature, local injury, and altered position of electrometer contacts. All the records were those of the displacements of the capillary meniscus, photographed upon moving sensitised plates.

Entomological Society, May 1.—Mr. C. O. Waterhouse, president, in the chair.—*Exhibits.*—Coleoptera from Iceland: Mr. O. E. **Janson** exhibited a small collection of Coleoptera made by him in Iceland in July, 1906, comprising thirty-nine species, of which some were previously unrecorded as inhabiting that island. He also directed attention to the affinity between the beetle fauna of Iceland and of Scotland, only one of those taken, *Colymbetes groenlandicus*, Aubé, not occurring in both countries.—Larvæ of *Otiorrhynchus sulcatus*: Mr. J. A. **Clark** brought for exhibition living larvæ of *Otiorrhynchus sulcatus* feeding on the roots of ferns.—Coleoptera from the south of France: Commander J. J. **Walker** showed living specimens of *Oxythyrea stictica*, L., *Epicometis hirtella*, L., and *Anthaxia parallela*, taken by Dr. T. A. Chapman at St. Maxime, Var, S. France.—Mimetic relation of *Leuceronia argia*, ♀: Dr. F. A. **Dixey** exhibited specimens of seven different forms of the variable female of *Leuceronia argia*, Fabr., showing that each form stood in mimetic relation with a separate model. The models belonged to the genera Belenois, Phrissura, Pinacopteryx, and Mylothris, and the association was probably in every instance synaposematic.—Mimicry in Coleoptera: the **President** exhibited some Coleoptera collected in Pahang by Mr. H. C. Robinson, and recently received at the Natural History Museum.—Living luminous Coleoptera: Dr. G. B. **Longstaff** exhibited living specimens of the Elaterid *Pyrophorus noctilucus*, Linn., brought from Trinidad by Dr. F. L. J. M. de Verteuil, R.N.—*Quedius riparius* and *Trypodendron quercus*: Mr. H. St. J. **Donisthorpe** exhibited on behalf of Prof. T. Hudson Beare and himself specimens of *Quedius riparius*, Kell., and *Trypodendron quercus*, Eich., taken by them at Porlock, Somersetshire, on April 16 and 17. Also *Hydrovatus clypealis*, Shp., taken by them on April 14 at Worle, near Weston-super-Mare.—Dipteron associated with ants: Mr. **Donisthorpe** also showed the larva and pupa of a Dipteron of the genus Microdon, taken in a nest of *Formica fusca* at Porlock last month.—*Hemimerus talpoides*, Walk.: Mr. R. **Shelford** exhibited a specimen of the curious parasitic orthopterous insect *Hemimerus talpoides*, Walk., from Portuguese Guinea.—*Paper.*—A case of homœotic variation in a cockroach: R. **Shelford.**

Linnean Society, May 2.—Prof. W. A. Herdman, F.R.S., president, in the chair.—The respiratory mechanism in certain elasmobranchs: A. D. **Darbishire.** The author exhibited living examples of the dog-fish, ray, and angel-fish, and explained that the primary object of the investigation was to determine the question whether water went in, or was expelled, from the spiracle of the dog-fish. The method employed to elucidate this point consisted in liberating from a pipette some powdered carmine suspended in sea-water in the immediate vicinity of the spiracle. The cloud of carmine was seen to be vigorously drawn in at each inspiring phase. A remarkable difference was discovered to exist between the respiratory mechanism in the dog-fish and the ray on the one hand, and the angel-fish, *Rhina squatina*, on the other, for whilst in the case of the former two fish the gill-covers are purely passive agents in determining the respiratory current, in the case of Rhina the undulation of the gill-covers seemed to be solely responsible for the flow of water into the spiracle and mouth.—The common elements of the fauna and flora of Abyssinia and West Africa: Prof. E. B. **Poulton.** The author based his remarks on his observations of a group of African butterflies. The paper was illustrated by a series of lantern-slides and a large orographical map.—The fauna of the Sudanese Red Sea: Prof. W. A. **Herdman.** Four papers of a proposed series on this subject were laid before the society; they consisted of (1) an introduction, by the president; (2) a narrative of Mr. Cyril Crossland's explorations; (3) Mr. Crossland's account of the formation of certain shore-cliffs in Egypt; and (4) of the Red Sea coral reefs; with (5) Mr. E. R. Sykes's enumeration of the Polyplacophora collected.—Pseudo-scorpions: C. J. **With.** The specimens described all belong to the British Museum. They comprise in the Australasian group, under the family Cheliferidæ, Hagen, four new species of the genus Chelifer, Geoffroy. In the Asiatic group three species of the same genus are re-described, one of them, which Pocock in 1900 referred to *C. javanus*, Thorell, being now named as a distinct species, *C. pococki*. A single species of Chelifer from Africa is the subject of comment, but notice is taken of the large additions to our knowledge of the Chelifer fauna in that continent recently made by Ellingsen. Under the family Garypidæ, Hansen, a new species of Garypus, Koch, is described from the island of Grenada; a new species of Olpium, Koch, from St. Vincent; and another from Stewart Island, New Zealand. Further, a species from Funafuti, which Pocock in 1898 referred to *Olpium longiventer*, Keyserling, is here transferred to the genus Garypinus, Daday, as an independent species, *G. oceanicus*; and another species, from Kauai in the Sandwich Archipelago, assigned by Eugène Simon in 1900 to *Olpium longiventer*, now becomes *Garypinus mirabilis*, n.sp. An appendix reviews the species *Chiridium ferum*, Simon, fam. Cheliferidæ, and *Ideoroncus cambridgei*, Koch, fam. Obisiidæ, chiefly with regard to peculiarities in the structure of the antennæ. The paper is accompanied by numerous illustrations, and contains many notes on distribution.

Zoological Society, May 7.—Mr. G. A. Boulenger, F.R.S., vice-president, in the chair.—Original drawings of *Spirochaeta anodontae* from the crystalline style and intestine of *Anodonta cygnea*: H. B. **Fantham.** This was the first record of the occurrence of this parasite in the British pond-mussel, though Keysselitz recorded probably the same organism from *Anodonta mutabilis* about a year ago, without giving its dimensions. The organism was found to be about 40 μ long and about 0·7 μ broad, with pointed ends and an undulating membrane. Its motion was most rapid, but seemed to be both spiral and vibratory.—The Cephalopoda of Zanzibar and East Africa collected by Mr. Cyril Crossland in 1901–2: Dr. W. E. **Hoyle.** The collection was not extensive either in point of individuals or species, and a large proportion were young individuals to which it was impossible to affix definite names in the present state of our knowledge. Five were identical with forms contained in a collection recently made by Prof. Herdman near Ceylon, whilst others occurred also in the Red Sea, thus showing a marked similarity in the cephalopod fauna of the whole of this region. Advantage had been taken by the presence of several specimens of *Sepioteuthis loliginiformis* to give a full description of that species. Some octopod embryos showed epidermal structures very similar to, if not identical with, those described by Chun as constituting a bristle coat in young octopods, and an account of these, as full as the material allowed, was given.—The mammals collected by Mr. M. P. Anderson during the Duke of Bedford's exploration of eastern Asia: O. **Thomas.** The present paper (the fifth of the series) gave an account of a collection from central Korea, just north and south of Seoul, the capital. Seventy-three specimens were dealt with, belonging to thirteen species, of which several were new, additional to those already discovered by Mr. Anderson during a previous visit to the southern part of the peninsula.—Some new buildings in Continental zoological gardens, based upon recent visits to those of Stellingen, Hamburg, Berlin, Dresden, Breslau, Vienna, Budapest, Frankfort-am-Main, Amsterdam, Düsseldorf, Rotterdam, and Antwerp: A. **Trevor-Battye.**

Physical Society, May 10.—Prof. J. Perry, F.R.S., president, in the chair.—Stereoscopy with long base-line illustrated on the screen: Dr. T. C. **Porter.** The use of a long base-line for telestereoscopy occurred to M. Selb, of Brussels, and in 1903 he obtained stereoscopic mountain photographs. The applications of the method for military, geographical, and meteorological purposes, although obvious, do not seem to have been used before, and the author discusses the possibilities of these applications.

PARIS.

Academy of Sciences, May 21.—M. A. Chauveau in the chair.—New determination of the metre in terms of lengths of luminous waves: R. **Benoit,** Ch. **Fabry,** and A. **Perot.** The length of the standard metre in terms of wave-lengths of the red ray of the spectrum of cadmium at 760 mm. pressure and 15° C. on the hydrogen scale was found as a mean of four series of experiments to be equal to 1,553,164·13 λ, whence $\lambda = 0{\cdot}64384696\ \mu$. These four series were selected from seven series which together gave a mean of 1 metre $= 1{,}553{,}163{\cdot}99\ \lambda$ and $\lambda = 0{\cdot}64384702\ \mu$, but three of these seven series are to be omitted in calculating the absolute value. The authors point out, however, that the mean of the seven series agree in a remarkable manner with the value obtained at the International Bureau of Weights and Measures by Michelson, the originator of the idea, and M. Benoit in 1894, namely (after due correction), $\lambda = 0{\cdot}64384700\ \mu$. From the authors' results it is easy to see that if all standard metres were destroyed, a determination to within one ten-millionth of the actual value could easily be made.—The reduction of diketones by hydrogen in presence of reduced nickel: Paul **Sabatier** and A. **Mailhe.** Typical α-, β-, and γ-ketones were studied. Diacetyl, $CH_3.CO.CO.CH_3$, gives

$$CH_3.CH(OH).CO.CH_3 \text{ and } CH_3.CH(OH).CH(OH).CH_3$$

on reduction. Three-fourths or more of the acetyl-acetone tested split up according to the equation

$$CH_3.CO.CH_2.CO.CH_3 + H_2 = CH_3.CHO + CH_3.CO.CH_3,$$

while acetonyl-acetone, $CH_3.CO.CH_2.CH_2.CO.CH_3$, gave chiefly oxyhexane 2·5, $CH_3.\underbrace{CH.CH_2.CH_2.CH}_{O}.CH_3$. The authors are to continue similar work with the quinones.—Observations of the sun made at the Observatory of Lyons during the first quarter of 1907: J. **Guillaume.** Tables are given of the distribution of spots and faculæ as regards latitude.—The variation of double integrals: M. **Hadamard.**—Continuous, infinite, and simple groups of transformations (mathematical analysis): E. **Cartan.**—The surfaces produced by a circular helix: M. **Barré.**—The absolute sensibility of the ear: Henri **Abraham.** The sensibility of the ear was determined in absolute value by producing in it variations of pressure of known amplitude. The variations of pressure were produced in a cylinder of known volume by the vibrations of the membrane of a telephone, which formed one of the bases of the cylindrical cavity. The other base of the cylinder was also closed, except in the centre, where an opening connected with a bell-shaped orifice, which could be applied against the ear, was arranged. The results obtained seem to show that the limit of the sensations of the normal ear corresponds to variations of pressure having a magnitude of four ten-millionths of a millimetre of mercury. The author points out that his results agree approximately with those of Max Wien, who measured variations of pressure in Helmholtz resonators, but that they do not agree—being much smaller—with the values of different authors, who have used methods analogous to that indicated some time ago by Lord Rayleigh.—The ultimate lines of metals in dissociation spectra: A. **de Gramont.** A summary of the lines which may be regarded as specially characteristic for a number of common metals is given, and it is indicated that the lines termed ultimate by the author are the same in the condenser-spark, in the ordinary spark discharge without condenser, in the electric arc, and in very hot flames.—Application of Trouton's law to the determination of molecular rise of boiling point of solutions: D. E. **Tsakalotos.**—Explosive mixtures of air and ether: J. **Meunier.** The lower limit of inflammability is about 58 to 60 milligrams of ether per litre of air, and the upper limit is about 200 milligrams. From 100 to 175 milligrams per litre it is more or less explosive.—The removal of water from alcohol by the catalytic action of red phosphorus and the phosphates: J. B. **Senderens.**—The action of magnesium amalgam on the aldehydes: André **Kling** and Paul **Roy.** Certain compounds such as polymerised formaldehyde (trioxymethylene) and chloral do not react, but others, *e.g.* acetic and benzoic aldehydes, react readily.—The double compounds of aluminium sulphide with the protosulphides of chromium, nickel, cobalt, and magnesium: Marcel **Houdard.** Al_2S_3MnS, Al_2S_3FeS, and Al_2S_3CrS were isolated and analysed. They are considered to be similar to spinels in crystalline form and structure.—The dissociation of silicates of lithium: Edgard **Derome.**—Study of the calcium salt of paraoxybenzoic acid: Œchsner **de Coninck.**—The products formed by the condensation of ethyl oxalate with dimethylaniline in presence of aluminium chloride: A. **Guyot.**—Synthesis of ketones of the hexahydroaromatic series: G. **Darzens** (*cf. Comptes rendus*, vol. cxlii., p. 714).—Metallic thiosulphocarbamates: preparation of sulphocarbimides of the fatty series: Marcel **Delépine.**—The respiration of the vegetative aërial organs of vascular plants: G. **Nicolas.** The author summarises his results as follows:—(1) the different aërial organs of vascular plants have each their own intensity and special respiratory quotient; (2) the stalk and the petiole have generally intensities and respiratory quotients similar to each other; (3) of all aërial organs, those which are essentially charged with the assimilatory function are those which have the greatest respiratory intensity and the lowest respiratory quotient.—Properties of the pigments of batrachians: A. **Magnan.** The properties, including solubility, of green, yellow, brownish-yellow, red, and black pigments are described.—The reaction of the tissue of the iris to light: A. **Nepveu.** The iris is irritable to light in cephalopods, fish, and birds, but not in mammals.

DIARY OF SOCIETIES

THURSDAY, MAY 30.

ROYAL SOCIETY, at 4.30.—The Solubility of Air in Fats, and its Relation to Caisson Disease: Dr. H. M. Vernon.—Mitosis in Proliferating Epithelium: Dr. J. O. Wakelin Barratt.—An Experimental Inquiry into the Nature of the Substances in Serum which Influence Phagocytosis: Dr. G. Dean.—The Correlation of Ovarian and Uterine Functions: E. S. Carmichael and Dr. F. H. A. Marshall.—Report of Private Expedition to Philippeville, Algeria, to view the Total Solar Eclipse, August 30, 1905: Dr. T. C. Porter and W. P. Colfox.

ROYAL INSTITUTION, at 3.—Chemical Progress—Work of Berthelot, Mendeléeff, and Moissan: Sir James Dewar, F.R.S.

SOCIETY OF ARTS, at 4.30.—Irrigation Colonies in India: Laurence Robertson.

FRIDAY, MAY 31.

ROYAL INSTITUTION, at 9.—Recent Journey Across Africa: A. Henry Savage Landor.

SATURDAY, JUNE 1.

ROYAL INSTITUTION, at 3.—The Contest between Guns and Armour: Sir William H. White, K.C.B., F.R.S.

MONDAY, JUNE 3.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Nature of, and Changes involved in the Production and Setting of Plaster of Paris: W. A. Davis.—The Analysis of White Lead: W. A. Davis and C. A. Klein.—A Calorimeter for Volatile Liquid Fuels, specially adapted for Petrol: W. Hansen Rawles.—Influence of Temperature of Dyeing on Resolution: W. P. Dreaper and A. Wilson.—The Loss of Nitre in the Chamber Process, Part iii.: J. K. H. Inglis.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

TUESDAY, JUNE 4.

ROYAL INSTITUTION, at 3.—Malaria, Sleeping Sickness, Tick Fever, and Allied Diseases: Prof. G. F. Nuttall, F.R.S.

WEDNESDAY, JUNE 5.

ENTOMOLOGICAL SOCIETY, at 8.—Bionomic Notes on some South African Insects: Dr. G. B. Longstaff and Dr. F. A. Dixey.

GEOLOGICAL SOCIETY, at 8.—Brachiopod Morphology: Cincta, Eudesia, and the Development of Ribs: S. S. Buckman.—A Marine Fauna in the Basement-beds of the Bristol Coalfield: Herbert Bolton.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Note on Horse Fat and "Animal" Oil: H. Dunlop.—A Method for Determining Caustic Lime in Fertilisers: J. Hendrick.—The Rapid Estimation of Total Solids in Milk: C. Revis.—The Reducing Action of Hydrogen, iii., The Reduction of Molybdic and Vanadic Acids: A. C. Chapman and H. D. Law.

THURSDAY, JUNE 6.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Two Modes of Condensation of Water Vapour on Glass Surfaces, and their Analogy with James Thomson's Curve of Transition from Gas to Liquid: Prof. F. T. Trouton, F.R.S.—The Mechanical Effect of Canal Rays: A. A. Campbell Swinton.—The Distribution of the Blue and Violet Light in the Corona on August 30, 1905, as derived from Photographs taken at Kalaa-es-Senam, Tunis: Prof. L. Becker.—On the Velocity of Rotation of the Electric Discharge in Gases at Low Pressures in a Radial Magnetic Field: Prof. H. A. Wilson, F.R.S., and G. H. Martyn.—The Osmotic Pressure of Compressible Solutions of any Degree of Concentration: A. W. Porter.

LINNEAN SOCIETY, at 8.—Contributions to our Knowledge of the New Zealand Holothurians: Prof. A. Dendy and E. Hindle.—Observations on Australasian Polyclads: Prof. W. A. Haswell.—Report on the Marine Fishes collected by Mr. J. Stanley Gardiner in the Indian Ocean: C. Tate Regan.—The Lithothamnia of the *Sealark* Expedition: M. Foslie. Notes sur les Ixodidæ recueillis dans les îles de l'Océan Indien, par M. J. Stanley Gardiner: Prof. L. G. Neumann.—*Exhibitions: Orobanche Ritro*, and some New Varieties of Plants from the Channel Islands: G. Claridge Druce.

ROYAL INSTITUTION, at 3.—Chemical Progress—Works of Berthelot, Mendeléeff, and Moissan: Sir James Dewar, F.R.S.

CHEMICAL SOCIETY, at 8.30.—The Relation between Absorption Spectra and Chemical Constitution, Part vii., Pyridine and some of its Derivatives: F. Baker and E. C. C. Baly.—The Interaction of Methylene Chloride and the Sodium Derivative of Ethyl Malonate: F. Tutin.—Molecular Weight of β-Naphthol in Solution in Solid Naphthalene: E. P. Perman and J. H. Davies.—Synthesis of Hexatriene Derivatives, Preliminary Notice: I. Smedley.—The Constitution of the Diazo-Compounds: J. C. Cain.—p-Cresol Sulphoxide and Sulphide: S. Smiles and T. P. Hilditch.—p-Dioxypbenylsulphoxide: S. Smiles and A. W. Bain.—Coloured Azo-derivatives of 1:3-Diphenylbarbituric Acid. Dynamic Isomerism among the Hydrazones of 1:3-Diphenylalloxan: M. A. Whiteley.—Dibromoaminoazobenzene: J. T. Hewitt and N. Walker.

FRIDAY, JUNE 7.

ROYAL INSTITUTION, at 9.—Studies in High Vacua and Helium at Low Temperatures: Sir James Dewar, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Chalk of Surrey, Part ii., The Western Area: G. W. Young.

SATURDAY, JUNE 8.

ROYAL INSTITUTION, at 3.—The Contest between Guns and Armour: Sir William H. White, K.C.B., F.R.S.

CONTENTS.

THURSDAY, JUNE 6, 1907.

PREHISTORIC ITALY.

Introduction à l'Histoire romaine. By Basile Modestov. Translated from the Russian by Michel Delines. Pp. viii+473. (Paris: Félix Alcan, 1907.) Price 15 francs.

PROF. MODESTOV'S work, which appeared originally in Russian, with an analysis in French, in the years 1902 and 1904, is a learned if somewhat conjectural attempt to reconstruct by the aid of archæological evidence the history of prehistoric Italy, with the view of elucidating the antecedents of Rome. In his own words (p. 341):—"abordant l'histoire de Rome, il se donne la tâche de discerner toutes les influences qui ont entouré la ville de Romulus dans la première phase de son existence." Basing himself on the work of Italian archæologists, which for the most part lies buried in the pages of periodicals, he begins with the Palæolithic age, and ends with the arrival of the Etruscans, which he dates somewhere about 1000 B.C. His learning is incontestable. It ranges from Rome to Berlin, and from St. Petersburg to London; it includes at once the work of Prof. Conway on Italic dialects and the researches of Mr. Arthur Evans and Mr. J. L. Myres on prehistoric Greece. Every scholar must be grateful for this laborious and exhaustive synthesis of the knowledge accumulated, during the last forty or fifty years, with regard to the history of primitive Italy.

Yet the critic may be pardoned if, in some respects, he ventures to criticise Prof. Modestov's work. For one thing, the author seems to exaggerate unduly the value of archæological research and archæological results. Etruscan pot-sherds and the débris of *terramari* are valuable in their way, but our sense of their value must not allow us to pooh-pooh, as Prof. Modestov too readily does, the work of a great constructive historian like Mommsen. The spade of the archæologist is, after all, a meaner tool than the pen of the historian, and the failing of the Pharisee is one to which the archæologist is so readily liable that it behoves him to be on his guard. It must be admitted, however, that the polemics of Prof. Modestov are directed against brother archæologists still more vehemently than against Mommsen. He wastes not a few pages, and exhausts not a little the patience of the reader, by continual diatribes and disproofs, which may cause a flutter in the dovecots of Italian archæology, but end by annoying the uninitiated scholar. There is something of a barbarous zest in such a sentence as:—

> "Only the reasoning of M. Helbig, which M. Marthe has elected to follow, can vie, in its inconsistency and lack of scientific profundity, with that of its imitator."

And this suggests, what the reviewer has again and again noticed, that the author lets us too much into the workshop, and shows us too much rude workmanship and too little finished work. These argumentations represent the scaffolding of a book, which ought to be taken down when the building is finished, instead of remaining to spoil the view. Prof. Modestov has been so much interested in his matter that he has forgotten its form. He repeats himself, for instance, again and again, and one comes to notice, as a running refrain, the information (some four times repeated) that Pliny narrates the capture of 300 towns from the Umbrians by the Etrurians (though, by the way, at the fourth time of mentioning, p. 448, the captors are the Proto-Pelasgians).

The author is somewhat too prone to *risqué* conclusions, which he is not averse to supporting by dubious arguments. Though he is ready, upon occasion, to controvert Sergi, he accepts without reluctance the most hazardous of his conclusions, and believes in a "Mediterranean race" originating from Northern Africa. This is, he thinks, the earliest Italian race, and its representatives are the so-called Ligurians and Sicels, who came into Italy by way of the Straits of Gibraltar, and formed the basis of Italian population during the Stone age. To attain this conclusion, Prof. Modestov follows Sergi in exalting the evidence of skulls far above the testimony of language; to support it he is willing to accept the most dubious of linguistic evidence, and to connect the language of the Basques with that of the Berbers, or, indeed, with that of the hieroglyphics of Egypt. Is it for this, one asks, that Mommsen and Ihne are rejected in scorn? But the conclusions of Prof. Modestov on which he would himself wish most stress to be laid are not those which relate to the Stone age or to the Mediterranean race, but those which are concerned with the age of Bronze and the age of Iron (the *civiltá Villanovana*); and with the races by which these ages were introduced; while still more important, perhaps, in the eyes of the author is the part of his book in which he attempts to solve the problem of the origin of the Etruscans (pp. 341–468).

We may conclude by a brief indication of the conclusions which the author reaches on these important points. The age of Bronze came in two ways. Partly it came by way of commerce, from Cyprus—more especially in southern Italy; partly it came through immigration of an Aryan stock from the valley of the Danube. The first entry of this Aryan stock is represented by the *terramari* of the lower valley of the Po, as is proved more particularly by the Aryan custom of incineration (instead of burial), which can be shown to have been practised in the *terramari*. The first Aryan stock left the lower valley of the Po owing to the pressure of a second Aryan immigration, and, forced gradually southward, it settled in Latium, and became the parent of the *populus Romanus*. The second Aryan immigration is that of the Umbro-Sabellians, who came about 1000 B.C., and introduced the age of Iron, the so-called civilisation of Villanova, which they had derived from the Greeks by way of the Adriatic. The first Aryan stock, which had settled in Latium, borrowed from these new-comers something of their civilisation (their use of iron, their methods of decorating in bronze, and their rudimentary writing), while it also absorbed certain elements from the primitive Neolithic civilisation of the original "Ligurians" of the Tiber valley. Finally (*tantae molis erat Romanam condere gentem*), there came the Etruscans, at about the same date as the Umbro-Sabellians. The Etruscans, according to Prof. Modestov, who accepts, and fortifies by archæological evidence, the testimony of Herodotus, were a people from Asia Minor, who came by sea to Tuscany, bringing, *inter alia*, Eastern methods of divination which they had borrowed through the Hittites from Chaldæa. To corroborate this view, Prof. Modestov alleges the conclusions of a Danish scholar, who seeks to connect the mysterious Etruscan language with the dialects of the southern Caucasus. Here Prof. Modestov seems somewhat inconsistent, for while he compares the archæological relics of the Etruscans with those of south-western Asia Minor, he compares their language with the dialects of the north-east.

We should be ungrateful if we did not mention the many illustrations, for the most part original, with which the author has ornamented his book and sought to aid his readers. The Etruscan illustrations are particularly interesting.

ERNEST BARKER.

THE FUNCTIONS OF THE BRAIN AND SPINAL CORD.

The Integrative Action of the Nervous System. By Dr. C. S. Sherrington, F.R.S. Pp. xvi+411. (London: Archibald Constable and Co., Ltd., 1906.) Price 16*s*. net.

THE unravelling of the arrangement and complications of the nervous system has always been of great interest, not only to physiologists, but also to mankind in general. The specially human attributes which distinguish our species from the rest of the Mammalia have at least an intimate connection with the superior development of the central nervous system, and we have therefore a peculiar interest in tracing the methods by which this complexity is of advantage to the individual.

The central idea of the book under review is the action of the nervous system in connecting the various cells composing the body into one individual, as distinguished from a mere collection of separate items. While there are other agencies that work to this end, mechanical as well as chemical, still the nervous system is preeminently effective in this respect from the delicacy and speed with which the intercommunication is effected. The unit reaction, to which all the complex phenomena of nervous activity are referable, is recognised to be the "simple reflex action."

The recognition of this definite unit, in place of the vague generalities too often quoted, marks the first important step in the study of the subject.

Prof. Sherrington then goes on to show that the anatomical basis underlying this simple reflex consists of three parts:—(1) the *receptor*, the sensitive organ which receives the impression; (2) the *conductor*; (3) the *effector*, the organ which effects the reflex act.

The various details of the apparatus are then considered. By an arrangement of this kind the threshold is lowered for one kind of stimulus and heightened for others, so that the reflex becomes selective. The phenomena called out by these stimuli are then considered, namely, the irreversibility of the direction of the impulse, the long latent period, and the rhythm of the action. By the method of "successive degeneration" it is possible to examine the conductor apparatus, and the conclusion is arrived at that the simple reflex arc is at least *disynaptic*, that is, composed of three separate neurones as a minimum, that the "effector" part of the arc is a "final common path" for all the reflexes using the particular end organ attached to it, and that somewhere in the "conductor" (the part of the arc connecting receptor and effector) there is some mechanism which gives a refractory phase. The importance of this is seen when such a phenomenon as the scratch reflex is examined, as this consists of a rhythmic series of movements the rate of which is governed by the purpose for which the reflex acts, and not by the rapidity of the successive stimuli. Further, as such a reflex is a coordinated action, there must be rhythmic *inhibition* of a series of muscles as well as rhythmic *contraction* of the opposing set, and by a series of well-devised experiments and careful consideration of the results the author again makes an important advance. This becomes more evident when the next chapter of the story is considered, namely, the compounding of reflexes, and the method by which one reflex becomes prepotent over another which would use antagonistic muscles.

The limited space at a reviewer's disposal will not permit the further description of Prof. Sherrington's account of the functions of the cerebral cortex and the very ingenious experiments on sensual fusion, but it will be found that the later chapters of the book possess the same wealth of information and lucid reasoning as the earlier. The only criticism that might be gently urged is that occasionally the language in which the reasoning is conveyed becomes nearly as complicated and abstruse as the subject-matter of the discourse. Sometimes, however, this recondite phrasing hides gems of humour as well as knowledge, as in the sentence on p. 317:—

> "Into that sequestered nook the organism by appropriate reactions gathers morsels of environmental material whence by chemical action and by absorption it draws nutriment,"

which by careful examination of the context appears to mean "Tommy ate a piece of cake!!!"

But, jesting apart, we have in this book the most valuable contribution to the comprehension of the functions of the nervous system that has appeared up to the present time, not only from the records of the experiments quoted, but also from the logical and orderly way in which the due inferences from the experiments are put forward, and the volume stands out as a landmark in our knowledge of the subject.

PHYSIOLOGICAL CHEMISTRY.

Practical Physiological Chemistry; Junior Course; Senior Course. By R. H. Aders Plimmer. Pp. 55 and 83. Privately printed. n.d.

"THIS book has been compiled as a handbook for practical work in Physiological Chemistry at University College. Much use has been made of the books by Milroy, Cole, Halliburton, Hofmeister and others, from which some pages have been adapted almost in their entirety."

The foregoing quotation from the preface shows that the work makes no attempt at originality. It is mainly a compilation from various sources of what a teacher considers most suitable in his own classes. Every teacher has his own ideas as to what a student in physiological chemistry should perform for himself; if any other teacher were to adopt Dr. Aders Plimmer's book as a guide in his practical classes, one anticipates that he would modify the arrangement, adding here, omitting there, and in still other places transposing parts from the junior to the senior course, and *vice versâ*. The line between a junior and senior class is always difficult to draw, and every teacher has his own ideas as to what should be placed on either side of the line.

The book, from another point of view, is, however, different from all others hitherto published, for it includes the pure organic chemistry necessary for the understanding of the chemical problems of the physiologist and medical man. One of the difficulties of medical education to-day is the ever-increasing scope of the preliminary sciences, and the deciding as to how much of each is to be crowded within the few years of the curriculum. Science grows, but the years devoted to its study still have only 365 days each. The question is becoming an acute one as to which parts of each science the pruning knife must be applied. In the University of London, chemistry always has been, and still is, specially insistent on its claims; it has, moreover, been successful in obtaining an additional six months in the time devoted to it over and above the year that physics and biology are satisfied with. It is for this reason that so many teachers are anxious to see chemistry as a preliminary science cut down to the single year's work which suffices for the other subjects. Unfortunately, in many instances lecturers on chemistry, not having themselves had a medical training, know but little of what the students of medicine really need, and teach the subject as though their pupils hoped to be expert chemists. Such teachers point out the importance of chemistry as a groundwork of much that follows later in the course, but lose sight of the fact that a student has not done with chemistry when he passes his preliminary examination in science; he has later on in his studies to consider chemistry in its applications to both physiology and pathology.

In these circumstances it is not to be wondered at that the teachers of other subjects which have a more direct bearing on the study of medicine are urging that if the work of the pure chemist is limited to the one year, which they regard as ample for the learning of the groundwork, the superstructure will later on have to include more physiological chemistry diluted to a suitable degree with those parts of organic chemistry which are absolutely necessary for its comprehension. As an earnest of what can be done with this object in view, Dr. Plimmer's book should meet with a hearty welcome.

W. D. H.

CEMENT AND CONCRETE.

(1) *Portland Cement: its Composition, Raw Materials, Manufacture, Testing, and Analysis.* By Richard K. Meade. Pp. viii+385. (Easton, Pa.: The Chemical Publishing Co., 1906.) Price 14*s*. 6*d*. net.

(2) *Reinforced Concrete.* By C. F. Marsh and W. Dunn. Third edition, revised and enlarged. Pp. vii+654. (London: Archibald Constable and Co., Ltd., 1906.) Price 31*s*. 6*d*. net.

(1) THE author is chemist to the Dexter Portland Cement Co., and the analytical methods described have all been used to some extent in his laboratory. The treatise is a second edition of a small manual, published some four years ago, on the chemical and physical examination of Portland cement. In preparing this new edition, a considerable amount of fresh matter dealing with the manufacture of Portland cement has been added. The first two chapters, which form an introduction to the book, are devoted to the history of the development of the Portland cement industry in America; the growth in the total consumption, and the growth in the consumption per head of population, have both increased in a remarkable degree during the last sixteen years—in 1890 the total production in the United States was 335,000 barrels, and by 1904 this had increased to more than 26½ million barrels; but even in that year the consumption was in excess of the domestic production, and more than two million barrels had to be imported.

In the next section of the book, chapters iii. to viii., a comprehensive and complete account is given of the processes of manufacture; the raw materials are described in detail, and much information is given as to the localities in the States in which they are found, and one of the chapters is devoted entirely to the subject of quarrying and excavating the raw materials. In dealing with kilns and the burning of the raw materials, modern rotary kilns are described; this chapter will be found a very valuable one for reference purposes; the thermochemistry of the calcining is discussed in a very exhaustive manner. In connection with the description of the process of grinding, Mr. Meade not only explains the construction and working of the various ball and tube mills, which are now generally employed, but he gives plans and sections of the complete equipment of a modern Portland cement plant on the wet process plan and also on the dry process plan, with notes as to the cost of plant and manufacture.

The next section treats of the analytical methods which are, or should be, employed in determining the quality both of the raw materials and of the finished product. This portion of the book will be very useful to chemists engaged in Portland cement factories, and to every analyst who may have to deal with the problem of determining whether or not a given sample of cement is up to the standard of some particular specification. The different methods employed are explained with great clearness, and the apparatus necessary is shown in well-drawn illustrations; so explicit are the instructions that an engineer who has had a fair training in the elements of chemical analysis could, should necessity arise, make many of these determinations for himself after procuring the necessary apparatus.

The last section of the book is devoted to the physical testing of Portland cement, and this section will be invaluable for reference purposes to the civil engineer and to other users of Portland cement. The author describes in turn all the ordinary physical tests, and his comments upon the various tests and their value in enabling a conclusion to be drawn as to the quality of any given sample are of much practical value.

(2) The first edition of this work appeared in the autumn of 1904, and since that date there has been such great progress in the employment, and in our knowledge, of reinforced concrete that a new edition was rendered imperatively necessary; much new matter has been added in addition to a general revision of all the portions of the book dealing with calculations. Reinforced concrete is still not used in this country to anything like the extent to which it has been employed both in America and on the continent of Europe, but much of the opposition to its use is now steadily declining.

The first three parts of the book are devoted to a general description, with excellent illustrations, of the various systems which have been employed up to the present date, and give a brief account of the materials, including both concrete and the reinforcing metal. Great stress is laid on the absolute necessity of employing only the best material in connection with the concrete, and of ensuring that the materials shall be of uniform quality and the concrete well and carefully made.

Part iv. deals with the practical construction of reinforced concrete for various purposes, and the construction of the necessary moulds for beams, floors, arched ribs, chimney shafts, pipes, sewers, and reservoirs. The next two sections are devoted to a very full and complete account of the experimental researches, and the data deduced therefrom, which form the basis of all calculations necessary in designing reinforced concrete; the authors are to be congratulated on the admirable way in which they have brought together, in a most convenient form for reference, information scattered through a very large number of publications, and on the complete way in which they have brought up to date all the data obtained in experimental investigations. The chapter devoted to calculations necessary in design work has been almost entirely re-written and very considerably simplified, with great advantage to the designer who may desire to consult this work, the method of treatment adopted for the case of singly reinforced rectangular and T-beams being entirely new.

The last section of the book, as in the earlier editions, is devoted to a descriptive account of various buildings and structures which have been erected up to the present time in reinforced concrete; this chapter contains a series of most admirably reproduced photographs of many large buildings and handsome arched bridges built entirely on this system.

The regulations which have been laid down by the Prussian Government for the employment of reinforced concrete in buildings are printed *in extenso* in appendix ii., and another appendix contains the report of the experiments carried out by the United States Geological Survey Department on the permeability of reinforced concrete pipes.

The present edition is a great improvement on previous issues, and every engineer and architect who utilises reinforced concrete on anything like a large scale in his constructional work will find this book an indispensable addition to his reference library.

T. H. B.

BOOKS ON ELEMENTARY BOTANY.

(1) *Principles of Botany.* By J. M. Bergen and B. M. Davis. Pp. ix+555. (Boston, U.S.A., and London: Ginn and Co., n.d.) Price 6s. 6d.

(2) *Introduction to Plant Ecology for the Use of Teachers and Students.* By Rev. G. Henslow. Pp. x+130. (London: E. Stanford, 1907.) Price 2s. 6d.

(3) *An Introduction to Practical Botany.* By E. H. Davies. Pp. x+127. (London: J. M. Dent and Co., 1906.) Price 2s.

(4) *The School Garden. A Handbook of Practical Horticulture for Schools.* By J. E. Hennesey. Pp. 155. (London: Blackie and Son, Ltd., 1906.) Price 1s.

(5) *Flowers Shown to the Children.* By J. E. Kelman and C. E. Smith. Pp. xii+154. (London and Edinburgh: T. C. and E. Jack, n.d.) Price 2s. 6d. net.

(1) IN the "Principles of Botany" the authors have introduced an innovation that offers definite advantages, and promises to be as suitable for practical work as for lecturing. The book is apportioned into three sections; the first comprises the morphology and physiology of the seed-plant taken in combination; classification and comparative morphology of cryptogams and phanerogams are treated in the second portion; and ecology, with a short reference to economic botany, forms the final section. As a result, only those morphological facts are noted in the first section that are required to explain the construction of the plant as a living entity, and much detail is appropriately transferred to ecology. Whilst most favourably impressed with the book in its entirety, the taxonomic portion, that more particularly demands judicious selection and

compilation, has been ably presented by Dr. Davis. He keeps the evolutionary sequence constantly before the student, and directs special attention to the significance of alternation of generations, heterospory, and the evolution of the sporophyte. Under ecology, chapters are devoted to recent work on the origin of species and plant breeding.

The book can be confidently recommended to students and teachers, and the latter will find the arrangement well worthy of consideration.

(2) Having devoted special attention to the ecological aspect of botany, Prof. G. Henslow has prepared an introduction to the subject. The earlier pages contain a discussion of methods of teaching botany, and in subsequent chapters the nature of plant associations, modifying factors, and plant surveying are considered. The information is mainly suggestive, and will therefore be found too diffuse for the ordinary student. On the value of ecology as an educational study the author advances arguments with which one is in accord, but with regard to certain criticisms on anatomy and physiology it can only be inferred that he has not had the opportunity of observing what an excellent training is provided by a judicious laboratory course.

(3) The main object of the course planned by Mr. E. H. Davies is to enable the learner to obtain his information by his own observation, so that the lessons, except in so far as they give instructions, consist of a series of questions. The assistance required to furnish the answers is contained in a glossary at the end of the book. The detail is well thought out, and if the exercises selected are a trifle too elementary, more difficult ones can be easily substituted. The author very rightly insists on the necessity of making outline drawings of all objects examined.

(4) The advantages of a school garden where children may acquire practical knowledge are sufficiently obvious, and in country schools there should be no difficulty in securing the necessary ground. For teachers who have not the requisite horticultural experience, Mr. Hennesey provides in "The School Garden" just the information required for directing their operations. The laying out of the garden, trenching, propagation, and the cultivation of fruit trees, vegetables, and flowers are rationally and practically expounded; to these are appended suggested courses of work and general hints as to ways and means.

The book provides a concise manual of elementary horticultural instruction that may be profitably consulted, not only by teachers, but generally by those who grow their own fruit and vegetables.

(5) A coloured picture-book of flowers arranged for children, so that they can distinguish them and find out their names, describes the nature of the last book under notice. Arranged according to colour, the illustrations furnish the means of determination. The type and general form of the book are pleasing, and the short descriptions, referring mainly to the flower, are expressed in simple language.

OUR BOOK SHELF.

Ballooning as a Sport. By Major B. Baden-Powell. Pp. xx+135. (Edinburgh and London: William Blackwood and Sons, 1907.) Price 3s. 6d. net.

Flying Machines: Past, Present, and Future. By Alfred W. Marshall and Henry Greenly. Pp. 128. (London: Percival Marshall and Co., n.d.) Price 1s. net.

MAJOR BADEN-POWELL himself, in a chatty introduction, describes his book as a *réchauffé* of a few magazine articles mostly written some years ago. The essays deal with the past of ballooning pure and simple, but their bright conversational style will commend them to a wide circle of readers.

The second little volume provides a popular account of flying-machines, dirigible balloons, and aëroplanes. Mathematical formulæ and calculations for designs have not been included, though the authors say they intend their information to "assist the reader with serious intention of making an attempt to produce a flying-machine, or air-ship." The book is fully illustrated, and should prove of interest to the general reader.

Principes de Géologie stratigraphique, avec Développements sur le Tertiaire parisien. By G. Courty. Pp. xiv+78. (Paris: A. Hermann, 1907.)

THOSE who look on Lyell's "Principles of Geology" with a filial regard, and those who keep by them Dr. Marr's scientific introduction to stratigraphy, will be disappointed with the title of this little book, which deals with elements rather than with what we know in this country as principles. Prof. Stanislas Meunier contributes a preface, in which he dwells on the constantly changing character of the earth's crust; and the author also holds that his work contributes towards the realisation by the reader of this "vitalité tellurique." But we are given little else than a summary of what is to be found in an ordinary text-book, and no attempt is made at generalisation. For a French work this is remarkably void of inspiration.

Outlines of Practical Sanitation. By Dr. H. B. Bashore. Pp. vi+208. (New York: J. Wiley and Sons; London: Chapman and Hall, 1906.) Price 5s. 6d. net.

THE scientific principles of public health and personal hygiene are explained in a simple and attractive style in this volume. Though the author refers particularly to conditions in rural and urban districts of the United States, his descriptions are concerned in the main with considerations of causes affecting health in general, both of the community and the individual. Familiarity with the principles described ought to be regarded as an essential qualification of every member of a sanitary committee of a public body. The book should be found useful as a means of imparting sound ideas of the laws of healthy living to teachers and citizens.

Essay on the Creative Imagination. By Th. Ribot Translated from the French by Albert H. N. Baron. Pp. xix+370. (Chicago: The Open Court Publishing Co.; London: Kegan Paul, Trench, Trübner and Co., Ltd., 1906.)

THE translator, enumerating some of his reasons for translating M. Ribot's essay, summarises the results at which it arrives by stating the author has shown clearly that "imagination is a function of mind common to all men in some degree," and that it is as highly developed in "practical inventors as in the most bizarre of romantic idealists." The chapter on the scientific imagination will appeal especially to the student of science.

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 intended for this or any other part of* Nature *No notice is taken of anonymous communications.*]

The Origin of Radium.

In a previous letter to Nature (January 17) I gave an account of some experiments which I had made upon the growth of radium in preparations of actinium. The results obtained were in substantial agreement with the earlier observations of Boltwood in this Journal (November 15, 1906), but it was pointed out that there was no definite evidence that actinium itself was the true parent of radium. The experimental results could be equally well explained by supposing that the parent substance of radium was ordinarily separated from radio-active ores with the actinium, but had no direct radio-active connection with the latter.

Observations have been continued upon the growth of radium in the actinium solution prepared in the manner indicated in my first letter. The rate of growth was found to be uniform over a period of 120 days, and to agree closely with the rate of growth observed in the solid preparation of actinium which had been set aside for a period of two and a half years. Another sample of actinium was then taken and successively precipitated with ammonium sulphide in order to remove the radium from the solution. In this way a solution of actinium was obtained initially almost entirely free from radium. By examination of the α-ray activity, it was found that the actinium after this chemical treatment contained an excess of radio-actinium. This was shown by the rise of the activity to twice its initial value in about twenty days, and then a gradual decay to a steady value. Special care was taken to measure accurately the rate of growth of radium in the solution at short intervals in order to see whether it depended in any way upon the variation of the activity. No such connection was observed, for the radium was produced at a constant rate over the whole period of examination, viz. 111 days.

For equal quantities of actinium, the rate of growth of radium observed in this solution was 1·5 times greater than the normal. This indicated that only a portion of the actinium had been precipitated, while the radium-producing substance had been precipitated with the actinium in excess of the normal amount. This conclusion was confirmed by an examination of the filtrates, which were found to contain more than half the actinium. After suitable chemical treatment, a small precipitate of actinium was again obtained which was about one hundred times as active, weight for weight, as the original preparation. This actinium precipitate was dissolved in hydrochloric acid, and observations of the amount of radium in it were made at regular intervals. *No appreciable growth of radium was observed over a period of eighty days.* If there were any growth at all, it was certainly less than one two-hundredth part of that normally to be expected. In order to make certain that the absence of apparent growth of radium in this solution could not be ascribed to the precipitation of the radium in some non-emanating form, the solution was again chemically treated. The actinium was precipitated with ammonia and re-dissolved in hydrochloric acid. Again no growth was observed over the period of examination, viz. twenty days. The solution in its present state contains a just measurable quantity of radium, viz. about 2×10^{-12} gram.

From these observations I think we may safely conclude that, in the ordinary commercial preparations of actinium, there exists a new substance which is slowly transformed into radium. This immediate parent of radium is chemically quite distinct from actinium and radium and their known products, and is capable of complete separation from them.

It is not possible at present to decide definitely whether this parent substance is a final product of the transformation of actinium or not. It is not improbable that it may prove to be the long-looked-for intermediate product of slow transformation between uranium X and radium, but with no direct radio-active connection with actinium. If this be the case, the position of actinium in the radio-active series still remains unsettled.

It is intended to continue observations on the growth of radium in the solutions described above. Experiments are also in progress to isolate this new substance in order to examine its chemical and radio-active properties.

Manchester, May 30. E. Rutherford.

The Structure of the Ether.

I welcome the interesting and helpful letter from Dr. O. W. Richardson, of Princeton, in Nature of May 23, in which he adduces arguments against an ether flow along magnetic lines of force, and in favour of a flow in the direction of the Poynting vector EH. The result comes out much the same, but it is probably a better way of regarding the matter. Prof. Hicks also has given a simple geometrical proof that a magnetic field cannot consist solely of ether flow; and I am referring to this in a note, already printed, in the *Phil. Mag.* for June.

We shall doubtless hear in due course from the mathematical physicists to whom the first idea of a magnetic ether flow is due, whether they are satisfied with the modification of their original conception now introduced. Meanwhile, I doubt if integration of momentum, without regard to direction, can be sound. Oliver Lodge.

Birmingham, May 28.

Root Action and Bacteria.

The remarkable and all but fatal effect of growing grass over the roots of freshly planted apple trees has been studied at the Woburn Experimental Fruit Farm since 1894, and formed the subject-matter of the third report of that station (1903). No satisfactory explanation of the action was obtained. Experiment showed that it could not be attributed to the abstraction of food or moisture from the soil by the grass, nor to the influence of the grass on the soil temperature or on the gaseous contents of the soil, and subsequent experiments have excluded the formation of acid or alkali from the possible causes. The conclusion drawn was that the action was probably that of a poison produced either directly by the grass or indirectly through the agency of bacteria. Since the publication of this report, further work has been done on the subject, and the view that bacterial agency is concerned has become much strengthened. The action is not confined to any particular grasses, nor to apple trees, but different grasses and different kinds of trees act and suffer, respectively, to different extents. The difference in the results, however, produced by different soils are much more conspicuous, especially in cases where trees are not grassed over until a few years after they have been planted. Though the deleterious action of grass may generally be noticed throughout the country, many notable exceptions have been met with, and these cannot be explained by any of the patent characteristics of the soils in question. Various pot experiments have been made which emphasise these observations. Trees grown in earth in pots are affected by grass in just the same way as they generally are in the field, the grass reducing the growth and vigour of the tree by at least 50 per cent.; but if the trees are grown in sand instead of earth (suitable nourishment being supplied), the grass has very little effect on them, reducing their vigour by about 5 per cent. to 10 per cent. only.

Following up this and other observations, twenty-six similar trees were planted in pots last February under various conditions; seventeen of them were in soil or sand which had not been heated, and nine of them in soil which had been sterilised, or partially sterilised, by heating to about 200° C. and to 82° C. respectively, the water lost in the process being made good. Of the seventeen in unsterilised material, all started into growth uniformly at the same time, whereas of the nine in sterilised soil two started about two days later, six did not start until at least fourteen days later, and one has not started yet.

The heating of the earth, especially to the low temperature of 82°, cannot have appreciably affected its chemical composition, and, indeed, the starting of a tree into growth is independent of nourishment supplied to it, as is shown by the behaviour of trees in sand; the only alteration produced in the soil by the heating must have been an alteration in the living organisms present in it. That bacteria are connected with root action has, of course, been established in certain special cases, but in these the connection consists of the bacteria being the means of augmenting the food supply of the plant; the present case is altogether different, for it appears as if the mere functioning of the roots was dependent on bacterial action. Such a conclusion would be one of far-reaching significance. Of course, the facts require much more examination and confirmation, but, even in their present state, they are sufficiently evident to warrant notification.

That two out of the nine trees in sterilised soil showed very little retardation in activity is not surprising, as there were many opportunities for the re-inoculation of the soil, the pots containing the trees having been exposed in the open since February 4, and no attempt having been made to sterilise the trees themselves before planting, though the roots were washed free from soil. The two exceptional trees were in earth which had been heated to the higher temperature; they were two out of six planted under these conditions. It may also be mentioned that heating to the lower temperature does not destroy all soil bacteria, indeed, it may increase the total bacterial contents; it is probably, therefore, a question of killing some particular bacteria which are connected with root activity.

SPENCER PICKERING.

The Astronomical and Archæological Value of the Welsh Gorsedd.

FROM the very interesting communication of the Rev. John Griffith (May 2, p. 9) it would at first sight appear that the modern "Druids" had indeed preserved a tradition of the May year as well as of the solstitial year in connection with the circles set up by them for the performance of their ceremonies. I should be glad to think that this was the case, but I find considerable difficulty in connecting the modern circles with the ancient ones; there is no ancient circle which shows any sign of ever having possessed such an array of outlying stones as appears in the plan given by Mr. Griffith, and the outlying stones that remain do not always conform to it either; nor is there any ancient circle, except those in which a sepulchral cist forms the central point, and Stonehenge, which has a flat stone in the centre. The late "Myfyr Morganwg, Archdruid of Wales," set up a circle round the rocking stone at Pontypridd in the middle of the last century, but in place of the eight outlying stones figured by Mr. Griffith it has curved avenues forming the head and tail ends of a serpent, so it does not appear that modern "Druidic" authorities are agreed upon this important subject. "Myfyr Morganwg" also published a book in Welsh, the principal illustration to which represents a Druid standing on a flat stone (sometimes it is a three-legged dolmen), surrounded by a circle of twelve others, on which converge three rays of light coming from the north-east, east, and south-east, and forming, no doubt, the original model of the "broad arrow" and of the "Y cross," but without any outlying stones, though three smaller stones are represented in those lines inside the circle; three stones which may represent these, or may, with others there, be intended for an inner circle, also exist in his Pontypridd circle. The central stone for sitting or standing on seems to be a *sine quâ non* with the modern "Druids," but it is not found in ancient circles. There are upright stones in the middle of the circles at Callernish, Boscawen-un, the Stripple Stones, and the Marshpool or Hoar-stone circle (Shropshire), and there was one in the middle of the southern inner circles at Avebury, where also the middle of the northern inner circles was occupied by a "cove," or open shrine of three stones, as again was the case at Arborlow, but at none of these places, except perhaps in the Shropshire circle, could any man stand or sit on these stones, though he might stand in front of them. In the other great British circles (Stonehenge, which occupies a place by itself amongst them, excepted) there is nothing in the centre nor any appearance of there ever having been anything, although there is reason to believe that whatever was done in them was done at or about the centre.

I am therefore inclined to think that the type of circle represented by Mr. Griffith, and probably much of the ritual connected with it, were evolved during the process of "re-codifying or otherwise dealing with the bardic traditions," which, as he says, took place between the twelfth and nineteenth centuries, when, as he also says, a "voluminous body of traditions grew up," and that whatever old ideas may be preserved amongst those traditions have got there rather in an accidental sort of way than by continuous use or direct descent. The traditions, however, though of no real authority in matters of detail, are not without value as indications of an opinion of very great antiquity as to the use of the ancient circles.

The number nineteen occurs at Stonehenge, Dawns Maen, Boscawen-un, the Cosdon circle (Dartmoor), and in the proportionate measurements of Stanton Drew. It probably refers to the cycle of nineteen years in which the sun and moon were thought to return to the same relative place in the heavens, and which was known in the fourth century B.C., if not, indeed, much earlier, in the island described by Hecatæus, usually identified with Great Britain.

A. L. LEWIS.

35 Beddington Gardens, Wallington, Surrey.

I AM glad that a brief summary of the evidence for the antiquity of the Welsh Gorsedd has interested Mr. A. L. Lewis.

(1) The name "Druids" for the Welsh bards should be dropped. It is retained at the Gorsedd as the name of one of the three classes of members. There is very little authority for calling the presiding bard archdruid. The proper name is Priv-vardd, Chief Bard. Let "Druids" and "Druidism" remain as general terms for the use of the "pre-historian." The Welsh bards insist on a grander name, *Gorsedd Beirdd Ynys Prydain*, the high court of the bards of the Isle of Britain.

(2) As to the May year, it has not become obsolete in Wales. There is practically no other in our ancient literature. Its omission from the conventional Gorsedd instructions, while it is everywhere present in the bardic traditions with that exception, is, I think, due to monastic influence. The Church year became solstitial. The bards fraternised with the monks, and Gorsedds were held in chapter-houses and churches. One result was that the bards adopted the festival year as fixed by the Church, so that the favourite time for a Gorsedd was neither solstitial nor agricultural, but such a time as Whitsuntide. This, the only serious meddling with the traditions that I can find, was done, say, about the twelfth century, when the Cistercian monks of Margam, Glam., where the Gorsedd traditions were chiefly preserved, found a new use for the Gorsedd, as a model for the round or polygonal chapter-house.

(3) It is not likely that a stone circle can be found exactly like a Welsh Gorsedd. In the earliest traditions, like those of the oldest Mabinogion, we seem to find the temple observatory in actual use, say, by the Druids; but, speaking generally, in the Gorsedd traditions themselves it is only a matter of minor importance, preserved as well as such a comparatively useless thing could be for the sake of some sacred associations. Modern bards do not understand the plans they have preserved. When a new Gorsedd is set up, no account is taken of the height of the horizon in the direction of the sunrise stones, a matter of much importance to the builders of the megalithic monuments. The bards have religiously preserved the general plan. At some point of time, when it was deemed necessary to preserve such a thing after it had ceased to be of practical use, the bards did better than copying any individual monument, which, as a rule, gives only one decisive sight-line to sunrise or sunset. They set up a complete almanac in stone. The perfect plan I have directed attention to (NATURE, May 2) presents sight-lines to the quarter days of both the solstitial and May years. As the individual monument is usually oriented to some one festival day, uniformity in detail is not to be looked for. The Gorsedd presents in one plan the combined sunrise sight-lines of all the circles in fair preservation that have been astronomically surveyed.

(4) The form of the central stone is immaterial in discussing the plan. At a temple observatory, what was chiefly necessary was to mark the exact centre of the circle. Where no "cove" was erected, an upright stone would suit well. Where neither was present, the priest-astronomer would simply stand on the spot to make his observations. The present fashion of placing a large boulder on the flat in the centre of the Gorsedd seems reminiscent of both the "cove" and the later kist.

(5) "Myfyr Morganwg" is only to be followed so far as he can produce some earlier authority. He tried to mix the contents of the "Asiatic Researches" with those of Welsh tradition. I have before me a plan of the Pontypridd circle, published in the second quarter of the last century, in which the three station stones, or sunrise stones, form alignments to the equinox, May, and November.

(6) The bards were not allowed to sit in a Gorsedd; they were to stand uncovered, head and feet.

(7) I did not mean that the process of "re-codifying or otherwise dealing with the bardic traditions" was in operation only from the twelfth to the nineteenth century. It seems very likely that there was a larger body of Gorsedd traditions known in the twelfth century than we find at any subsequent period. Again, I applied the epithet "voluminous" to the whole stock of printed and manuscript materials on the subject still extant. They have "grown," not to any large extent by addition or accretion, but by the multiplication of versions or recensions of what was recited at the Gorsedd meetings, as was the fixed rule. There is much work to be done by way of collating these recensions. I have an impression that the recital of the Gorsedd traditions proper would not have occupied a longer time than an old-time sermon. The only considerable additions concern the rules of poetry. There is no evidence, except the indirect evidence respecting the solstitial year, that the conventional instructions about the Gorsedd circle itself have been subjected to any revision. This is distinctly stated to be a matter of minor importance—the circle with its ceremonies. The following words, translated from a Welsh extract from an old book at Raglan Castle, before that place was destroyed by Cromwell's forces, shows the attitude of the bards towards the subject here under discussion:—

"Now follows an account of things that appertain to institutional ceremonies, and that accord with the reason and inherence observable in the reminiscence and customs of the bards of the Island of Britain; but which, nevertheless, are not considered as indispensably requisite parts of the system; because every truth and knowledge—every recollection and intention—as well as every art and science, may be acquired without them:—still they corroborate and illustrate reminiscences and primary regulations; for which reason, it is deemed laudable to perpetuate them in memory and usage; especially as they comprise the ancient forms transmitted, by the retentive memory of Gorsedd" ("Iolo MSS.," p. 445).

Then the scribe begins the list of non-essentials as follows:—"It is an institutional usage to form a conventional circle of stones, on the summit of some conspicuous ground," and he gives complete details. This is not the tone of a scribe who was conscious of any weakness in the traditional account.

I take no serious exception to anything that Mr. Lewis says. He has himself furnished very valuable data for this inquiry. But a better theory than an "accidental sort of way" must be found to explain highly finished and polished statements which, like pebbles in glacial drift, speak of the remotest origin.

JOHN GRIFFITH.

Llangynwyd, Glam.

MARINE ZOOLOGY AT THE CAPE.[1]

THE third volume of reports on the Cape marine fauna contains ten papers published between 1904 and 1905. Of these memoirs, two, dealing with eighteen new species of fish and the development of South African fishes, are by Dr. Gilchrist, to whose enterprise and ability these sustained and extended investigations of the resources of the Cape seas are largely due. In this work he has been ably seconded by European colleagues. Prof. McIntosh contributes two papers on the polychæt annelids; Prof. Hickson a second report on the Alcyonaria; Prof. Jeffrey Bell three contributions, dealing respectively with the echinoid, asteroid, and ophiuroid echinoderms; Mr. Stanley Gardiner publishes a careful study of the turbinolid corals; and Prof. Cleve submits a first instalment of a study of the South African marine plankton.

Dr. Gilchrist's second contribution to a knowledge of the life-histories of the Cape fish contains several matters of interest, although he has only succeeded in referring nine of the eighteen stages or eggs he describes to known species. The development of the saury-pike (*Scombresox saurus*) is worth noticing for two reasons. In the first place, the young fish before hatching keeps up a rapid and almost constant movement of one pectoral fin, and when hatched, keeping its tail well submerged, it skims the surface with its mouth as if in search of food. The second peculiarity of the saury, if well founded, is of greater interest, and consists in the presence of blue pigment arranged in chromatophores, massively developed on the dorsal surface and sparsely below. The presence of an indubitable blue pigment concentrated in cellular elements is probably a new fact in animal coloration, and one that suggests how wide a field of investigation is afforded by the phenomena of pigmentation in fish. Another noteworthy feature of this article is the account of cannibalism prevalent among the unborn young of *Cataetyx messieri*. It appears that this deep-sea fish is viviparous. In the one case described, the right ovary consisted of a mass of undeveloped bright red eggs with a single larva coiled up in a dense mucous substance, whilst the left ovary contained seven larvæ also strongly flexed and embedded in mucus. When these were detached it

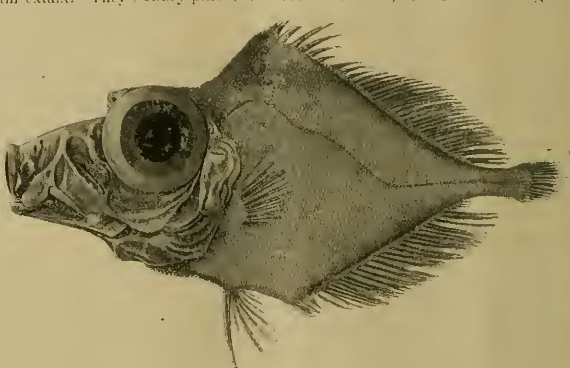


FIG. 1.—*Cyttosoma Boops*, ng. et sp. From "Marine Investigations in South Africa."

[1] Cape of Good Hope, Department of Agriculture. "Marine Investigations in South Africa." Vol. iii. Pp. 269+45 plates. (Cape Town: The *Cape Times*, Ltd., 1905.)

was found that in one case the larva had swallowed a smaller one, and that the others had partially digested their younger fellows. Further details of this habit are promised.

The papers on Polychæts are of interest, chiefly as affording further confirmation of the prevalence of European forms, and even of their parasites, in South African waters. The luminous Chætopterus, for example, that occurs on the Devonshire coast and among the Channel Islands, is found between tide-marks in False Bay and Simon's Bay at the Cape. Many of our commonest littoral annelids are found under similar conditions on the shores of these bays. Fifteen out of the thirty-eight species here described are British, and the majority of the remainder are closely allied replacing forms. Where the agreement is so close it is rather curious to note that no mention is made of the presence of the common lugworm or of its allies.

Prof. Hickson's paper on the Alcyonaria is a continuation of his previous work on this branch of the Cape fauna. It contains, amongst other matter, descriptions of a new family, two new genera, and four new species. The new family, Malacogorgiidæ, is remarkable as comprising Gorgonians, or sea-fans, without any calcareous structures. Of more general interest is the combination of local and of widely diffused corals that occur in the Cape waters. At least six peculiar Cape species, belonging to four genera, are now known, one of which, *Alcyonium purpureum*, is impregnated by a soluble purple pigment which deserves fuller investigation. On the other hand, the affinities of the members of the group in this region with Atlantic, Indian, and even Antarctic Alcyonaria are clearly indicated. We may expect a further investigation of these difficult problems of distribution from the distinguished author of this work.

FIG. 2.—*Platophrys dimorphus*, n. sp. Upper figure, male; lower, female. From "Marine Investigations in South Africa."

The remaining papers can only be briefly summarised. Mr. Stanley Gardiner's work on corals is of that high standard to which his previous papers have accustomed us. It is based on a large series of comparisons, and is executed in the most careful and thoughtful manner, both as regards the skeletal and malacological characters. Prof. Jeffrey Bell reports the discovery of the echinid Palæolampas in a living state.

The plankton investigations by Cleve is a most useful summary of the distribution of the Copepoda found in South African seas, and also gives the percentage of this fauna that extends northwards, the result showing that in Mediterranean waters the percentage reaches more than 70, thus supporting the view enunciated by Cleve that the waters of the north temperate Atlantic "originate not from the Gulf Stream, but from the Benguela current, which is supposed to pass as an under-current below the waters of the Tropical Atlantic." Finally, a word of praise must be added for the forty-five excellent plates that adorn this work.

REFORM IN RURAL EDUCATION.

THE Gloucester conference on rural education in 1904 directed public attention to the need for adapting rural education to rural requirements. Several county education authorities have since instituted inquiries into the subject, chambers of agriculture have passed resolutions, and now the County Councils Association, through its Rural Education Sub-committee, has published a "Memorandum as to certain subjects suitable for the upper standards of elementary schools, and for evening schools in rural districts." This memorandum is worthy of careful examination. The case for reform may first be briefly stated.

It is a disturbing thought that during the past half-century scientific method has largely disappeared from rural elementary education. The child, whose education chiefly consisted in learning from what he saw and did in the field, sheepfold and farmstead, grew into a man who, though his range of view was limited, possessed a remarkable store of accurate first-hand knowledge upon those things which concerned his work in life. With the introduction of a system of compulsory schooling, in which knowledge was principally gained from the lips of the teacher, the scientific method of basing knowledge on individual experience largely disappeared. Now faculties, while easily developed in children, as easily become atrophied through disuse, and, under the present system, it is too often the case that lads as they leave school have neither the power of intelligent observation which is essential to success in rural industry, nor have they acquired an interest in country things. In the absence of such interests, the amusements of a town prove an irresistible attraction, and this, it is believed, has been one of the factors in bringing about rural depopulation and the scarcity of skilled men on the farms, while at the same time we meet in every London street with able-bodied out-of-works.

In the memorandum of the County Councils Association, nothing is said about less schooling, but the guiding principle in all the subjects of the curriculum is to be to *let surroundings teach*, and thus to put back scientific method into rural education. Geography and history are to be based on the physical features of, or the events associated with, the neighbourhood. In arithmetic, out-of-door measurement of land, crops, stacks, and cisterns is to be introduced. School-gardening is to be regarded not merely as instruction in the operations of gardening, but as a study of the growth of crops in relation to the soil.

Thus, although no teaching of agriculture is to be introduced, partly perhaps because the teachers are not qualified to teach it, partly because it would be waste of time to those boys who do not afterwards follow agricultural pursuits, still knowledge of surroundings is being acquired, habits of intelligent observation are being cultivated, and every subject of the school curriculum is acquiring a reality which no oral teaching could ever give it, and which must render the education a better training for life, whatever the after careers of the lads may be.

But while agriculture is not taught, it is noticeable that in the study of surroundings such subjects are suggested as will yield knowledge that is useful to the farmer or farm-hand. For example, the boys are to collect the field and garden weeds, and study their root systems and time of seeding with the view of learning the reasons for their abundance and the best means of dealing with them. From the point of view of cultivating intelligent observation, such an exercise is as good as one that has no utilitarian bearing, and it has this additional value, that the boys learn to apply their knowledge to the practical purposes of rural life.

This idea of *purpose* is kept prominently in view in all the subjects named in the memorandum. Manual work naturally takes an important place, for it is as necessary to cultivate the habit of manual work in childhood as it is the habit of intelligent observation, and its neglect has been another factor in the preference shown by lads after leaving school for non-rural employment, and therefore in rural depopulation. But, again, the manual work is to have purpose. The woodwork is to be directed to making useful things, the gardening to growing useful vegetables, and thus the boys' hearts, as well as their heads and hands, become impressed into their education.

One omission is noticeable—that the teaching of science finds no place in the suggestions. But to acquire a scientific habit of mind, the study of a science is certainly not necessary, nor even perhaps desirable, for children of twelve and thirteen. It is nature-study rather than the study of a natural science that is advocated, for while the correlation of a number of facts or phenomena of the same kind is likely to weary children, the coordination of one fact or phenomenon with others of a different order stimulates their interest and widens their outlook, and permits more readily of application to the purposes of daily life.

The memorandum is followed by a series of "suggestions for the encouragement of rural education." These include the establishment of junior naturalist societies and boys' agricultural clubs, nature-study exhibitions, and school museums of local natural history, together with a suggestion that facilities should be provided for the training of teachers in rural subjects.

LANDSCAPE PROTECTION IN GERMANY.

An abstract of a lecture delivered on October 1, 1906, at Munich, at the annual meeting of the "Heimatschutz" League, by Prof. H. Conwentz, was recently published in pamphlet form. It deals with what has been done in Germany, and more especially in Bavaria, for the preservation of the forests, of bird and plant life, and of the beauty of the landscape in general.

Even so far back as 1803 a private property near the town of Bamberg, in Bavaria, was bought up by the State, and turned into a people's park. At one time the banks of the Danube were gradually becoming disfigured by large quantities of stone being taken away; it was then determined that the stone for public buildings should be obtained from those quarries which did not interfere with the landscape.

In 1841 an order was issued which dealt more especially with the trees. By it it was made almost impossible to remove or alter the existing avenues in the streets; further, oaks, elms, and beeches were specially to be looked after, and also any trees connected with history or legends. By the Bavarian forest-law of 1852, private as well as public forests came under State superintendence.

About 1902 an order was circulated that for the welfare and the increase of birds, hedges and bushes should be planted, or existing ones looked after. Moreover, uncommon birds were to be particularly safeguarded and spared, as complaints had been forthcoming that their number was decreasing.

Similarly, orders were issued for the preservation of certain local plants which were threatened with extinction in the neighbourhood of Garmisch.

In several cases, telephone wires have been laid underground, and in Saxony a certain proposed mountain-railway was not built in order not to spoil the view.

More recently, we find that in Prussia similar regulations have come into existence. There in 1903 a law was passed forbidding the disfigurement of provincial neighbourhoods by advertisements. The author directs attention to the fact that other countries might profit by obtaining such a law. How beneficial such a one would be to this country!

Further, we find that Saxony, Baden, Hesse, and Weimar have all adopted, in one respect or another, the same precautions.

Before concluding, the author points out how London has led the way in the matter of commons and of retaining woods in its more distant environs, referring more especially to Epping Forest.

SIR JOSEPH FAYRER, BART., K.C.S.I., F.R.S.

On Tuesday, May 21, Sir Joseph Fayrer died. He was born on December 6, 1824, and he died full of years and full of honours, for he was honorary physician (military) and physician extraordinary to the King, honorary physician to her late Majesty Queen Victoria, M.D. and LL.D. of various universities, and fellow of many learned societies. Yet all his honours were richly deserved, and he bore them with the most unassuming modesty. Many men are acquainted with parts of his work, but very few know the whole. When Huxley died, a wail of grief went up from the scientific world, but many people are unaware that but for Fayrer the course of Huxley's life might have been completely different, and a great part of his scientific work might never have been done. They were fellow students together, Huxley being senior by a year, though Fayrer was actually older by a few months. When Huxley had finished his medical studies he was, as he himself says in the autobiographical sketch prefixed to his essays, wondering what he should do to meet the imperative necessity of earning his own bread, when Fayrer suggested that he should enter the naval medical service. He did so, and after a few months at Haslar he went on his famous voyage on the *Rattlesnake*, and thus began his scientific career. The attraction which drew Fayrer and Huxley together and led to their close friendship was the great likeness between them in many respects. It has been said that in every human face a resemblance may be traced to some animal, and this was markedly so both in Huxley and Fayrer. Especially in his later years Huxley's face and head suggested that of a lion, while Fayrer's large, open forehead and calm expression reminded me of an elephant, and one could hardly look at him without thinking how rightly the Hindoos have chosen an elephant's head for their god of wisdom. Both men were alike in the stern uprightness of their characters, in the extent of their knowledge and the wideness of their interests, in the clearness of their views, the correctness of their decisions, their absolute fearlessness, their prompt and energetic action, their firm determination to carry out what they thought right, in their tenacity of purpose, in a certain impatience of opposition, and in their great success in overcoming it. Associated with these qualities which compelled admiration were an extraordinary kindness and tenderness of heart which gained the affection of all who knew them.

It is not so easy to draw a comparison between their intellectual powers, because their spheres of activity were so very different. Huxley's life was passed in the pursuit and teaching of science and philosophy; Fayrer's scientific work was done in the short intervals of time that he could snatch from the pressure of other occupations. While Huxley was on board the *Rattlesnake*, Fayrer was engaged in amputating limbs and treating gunshot wounds in the insurrection at Palermo, and narrowly escaped death at the siege of Rome by the French. Between such occupations, however, he managed to learn sufficient Italian to pass the examinations and obtain the degree of M.D. in the University of Rome, perhaps the only doctor not a Roman Catholic who ever did so.

Before his friend Huxley had come back from his voyage, Fayrer went out to India, and again saw active service in the Burmese war. During this war he distinguished himself so highly that the Governor-General appointed him residency surgeon at Lucknow, the best appointment at his disposal, as a reward for his services.

In order to carry on his work he had to learn Hindostani and Persian, and in addition to all his medical work he had to conduct a great deal of the correspondence between the British Government and the King of Oude. When the Indian Mutiny broke out, Fayrer's house in Lucknow was one of the most exposed to the enemy's attack, and he himself took an active part in the defence of the town as well as attending to all the medical and surgical work which disease from insanitary conditions, unsuitable food and the wounds by shot and shell caused amongst the besieged.

Broken in health, Fayrer returned to England after the Mutiny, but instead of remaining idle he went to Edinburgh, worked at the university, passed his examinations, and received the degree of M.D. He then returned to India, where he became professor of surgery in Calcutta.

In 1870 he went with the Duke of Edinburgh on his travels in India, and in 1875 accompanied the King, who was then Prince of Wales, to India. He was a keen sportsman, and was fond of zoology, and in 1867, when president of the Asiatic Society of Bengal, he proposed to found a Zoological Gardens in Calcutta, a proposition which, after some years, was carried into effect. He also proposed an ethnological investigation of the races of India, but this was never fully carried out.

Much of his time was taken up by pathological investigation and sanitary work, but the research in which he took the greatest interest was his zoological work on the snakes of India and his physiological investigation into the action of their venom. It was during this investigation that he first tried the effect of various antidotes, one of which, permanganate of potash, is now beginning to be used in such a way as to preserve life in cases of snake bite which would otherwise have been fatal. The difficulties under which his scientific work was carried out are shown by the fact that he had often to leave an experiment of this kind in order to attend to his hospital work, and that while there amputating a limb or performing some other operation his mind would be disturbed by anxiety regarding the condition of his private patients, who were anxiously waiting for him. But for Fayrer's extensive knowledge and firm dedecision in difficult circumstances, the Prince of Wales, with whom he was travelling, might possibly have been induced by the earnest entreaties of various personages to visit infected places, with the probable result that cholera might have spread over large districts of India, and that our King might never have returned from his visit to that part of his Empire. Not only do scientific men owe a great debt to Fayrer for his own contributions to science and for the bias he gave to Huxley's life, but also for the care which he took of our King's life and the benefits which its preservation has conferred upon the Empire.

At Fayrer's funeral one of the wreaths bore the gracious inscription,

"For Auld Lang Syne from Edward VII."

Lauder Brunton.

SIR DIETRICH BRANDIS, K.C.I.E., F.R.S.

By the death of Sir Dietrich Brandis, which occurred at Bonn on May 28, a man of world-wide renown has been removed. Brandis was born on April 1, 1824, at Bonn, being the son of Dr. Christian Brandis, professor of philosophy in Bonn University. As a boy he followed his father to Greece, where he spent several years. On his return to Germany he was educated at the Universities of Copenhagen, Göttingen, and Bonn. He became, in 1849, lecturer (*Privat-docent*) on botany at Bonn. In 1854 he married a daughter of Dr. Marshman, of Bengal. This happened to be the turning-point in his career.

After the occupation of the province of Pegu in Burma, Lord Dalhousie was looking for a man to take charge of the important teak forests of that province, when his attention was directed to Brandis by the latter's brother-in-law, General Sir Henry Havelock. Lord Dalhousie wrote to Brandis that if he would come to India he would be appointed superintendent of the Pegu teak forests. The offer was accepted, and Brandis landed at Calcutta in 1856. He explained his views to Lord Dalhousie, who, in taking leave of him, said, "Dr. Brandis, if you carry out the scheme which you have explained to me, you will confer a great benefit upon this country." Brandis never saw Lord Dalhousie again, but his parting words remained with him throughout his service. Brandis set to work to save the Burma teak forests, in which endeavour he had the full support of Major (afterwards Sir Arthur) Phayre. After a long-continued struggle the forests were placed under systematic management, and they, with the forests of Upper Burma, are now the chief supply of teak timber to the world.

In 1862, Brandis was called to Simla, at the suggestion, it is believed, of Dr. Cleghorn, one of the principal pioneers of forest conservancy in India, to advise the Government of India on forest matters in other provinces, and in 1864 he was appointed the first Inspector-General of Forests to the Government of India. He then set to work to introduce systematic forest management throughout India. A regular department was established and a forest law passed. Brandis travelled from one end of the Bengal Presidency to the other, advising and organising the department. He also visited Bombay twice, and spent two years (1881–3) in Madras. The department thus created has grown until it has now an area of 239,000 square miles, equal to twice the area of Great Britain and Ireland, under its management.

When Brandis first started operations he had to do with what staff he could lay his hands on; but he determined to obtain one fit to deal with the requirements of the case. In 1866, while on sick leave in England, he obtained the sanction of the late Lord Salisbury, then Secretary of State for India, to train young Englishmen in Continental forest schools, and under this scheme a number of highly qualified foresters have been sent to India. The training at Continental forest schools was subsequently supplanted by that at Coopers Hill College, and now at the University of Oxford.

But Brandis went a step further. In 1878 he started a forest school at Dehra Dun for the training of natives of India, which has now been raised to the rank of "The Imperial Indian Forest College," and sends annually from forty to fifty trained executive officers into the service.

By these means a trained staff of 200 Englishmen have been obtained, who control the operations of the forest department, assisted by about 11,000 native officials of various grades. The results are most gratifying. The supply of timber, firewood, grass, and other produce for the teeming millions of India has been placed on a satisfactory footing, while the net revenue from the forests has risen from 40,000*l.* in 1864 to 660,000*l.* in 1904, although produce valued at a similar sum is given free to the people of the country.

During his career in India Brandis wrote an endless number of reports, and in 1874 he brought out the "Forest Flora of North-west and Central India," a work which was so highly thought of by Sir Joseph Hooker and others that he was made a Fellow of the Royal Society in 1875. It may not be generally known that Brandis was the first who compiled a rainfall map of India; it has been improved since, but as regards the main points it holds good to this day.

Brandis retired from the Indian service in 1883, at the age of fifty-nine years; but he continued to devote himself to the advancement of forest conservancy in India, by articles and letters of advice to his friends in India. From 1888 to 1896 he superintended the practical instruction in Germany of the Coopers Hill forest students.

The last eight years of his life he devoted to the writing of a general Indian forest flora, which he published in 1906 under the title of "Indian Trees," a monumental work, which is likely to be the standing book of reference on the subject for another generation. Scarcely had he completed this when he fell ill, and he never rose from his sick bed. He was made a C.I.E. in 1876, and a K.C.I.E. in 1887.

It should not be omitted to mention that Brandis had a great share in the development of forest conservancy in the United States. He guided the studies of quite a number of young Americans, who have since established a great department in the United States. His influence in this respect has been so great that President Roosevelt presented him with his picture and the following dedication:—"To Sir Dietrich Brandis in high appreciation of his services to forestry in the United States, from Theodore Roosevelt."

Apart from India and the United States, Brandis's action has been felt in almost all parts of the British Empire, including these islands. He has left his mark upon every continent of the earth; at any rate, his name will go to posterity as the father of systematic forest management in the British Empire.

W. SCHLICH.

NOTES.

WE regret to learn that Dr. Maxwell T. Masters, F.R.S., whose writings on botanical and horticultural subjects are familiar to many readers of NATURE, died on May 30 at seventy-four years of age.

THE annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, Cromwell Road, on Tuesday evening, June 18.

DR. W. S. BRUCE and the remainder of his staff, who are starting on an expedition to the Arctic, have left Edinburgh for Spitsbergen. The expedition will finally be relieved and brought back to Europe by the Prince of Monaco on board his yacht the *Princess Alice*.

PROF. PAUL EHRLICH will deliver the second and third of his series of Harben lectures of the Royal Institute of Public Health on Friday, June 7, and Tuesday, June 11. The subject of the lectures is "Experimental Researches on Specific Therapeutics," and they will be delivered at the Royal Medico-Chirurgical Society, 20 Hanover Square, at 5 p.m. on each day.

GILBERT WHITE'S autograph manuscript of his "Natural History and Antiquities of Selborne," in the form of letters to Thomas Pennant and Daines Barrington, and arranged in a folio volume, will be sold by Messrs. Sotheby on July 1. The MS. remained in the possession of the author's descendants until 1895, when it was sold at Sotheby's and acquired by the present owner, Mr. Stuart M. Samuel, M.P.

THE council of the Society of Arts, with the approval of His Royal Highness the Prince of Wales, its president, has awarded the Albert medal of the society for the current year to the Earl of Cromer "In recognition of his pre-eminent public services in Egypt, where he has imparted security to the relations of this country with the East, has established justice, restored order and prosperity, and, by the initiation of great works, has opened up new fields for enterprise."

AT a meeting of the Corporation of the City of London on May 30, the Lord Mayor presiding, it was decided unanimously to present the freedom of the City to Lord Lister and the Earl of Cromer. Mr. Alderman Alliston, in moving that the honorary freedom of the City be presented to Lord Lister in a gold box, in recognition of his eminence as a surgeon and the invaluable services he has rendered to humanity by the discovery of the antiseptic system, remarked that more than one hundred years have elapsed since the Court bestowed the freedom of the City on a member of the medical or surgical profession. The last was that given to Edward Jenner, the discoverer of vaccination, in 1803. Since then the Corporation has welcomed Royal personages, great warriors, eminent statesmen, and others, but the still small voice of the personal ills that flesh is heir to—their amelioration and remedy—have, Mr. Alliston pointed out, somewhat escaped the City's notice. The deficiency is now to be rectified, and the City Lands Committee has been empowered to make the necessary arrangements for the presentation of the freedom to Lord Lister at an early date.

ON August 15, weather permitting, the international laboratory for Alpine investigations, at the Col d'Olen, on Monte Rosa, will be formally opened. In two articles contributed by the late Sir Michael Foster to NATURE (vol. lxv., p. 568, and vol. lxxi., p. 443), he described the laboratory established on the Gnifetti peak of Monte Rosa, at an altitude of 4560 metres, and referred to the valuable researches at high altitudes carried on in connection with it. The supplementary laboratory shortly to be opened is at an altitude of 3000 metres, and will therefore permit work to be carried on for longer periods and under less difficult conditions than at the higher Gnifetti laboratory. The new building provides accommodation for work in botany, bacteriology, zoology, physiology, terrestrial physics, and meteorology, including material and instruments usually required for investigations at high altitudes. Eighteen investigators can find places in the laboratory, and two of these places are for British men of science. Prof. A. Mosso, Turin, to whose zeal and activity the laboratories largely owe their existence, will give further particulars concerning the conditions under which places in them can be secured by investigators desiring to study physiological and other problems in the High Alps.

PLANS have been perfected recently, we learn from *Science*, for a detailed and systematic investigation of the Atlantic and Gulf Coastal Plain stratigraphy and palæontology. Several State surveys, including those of North Carolina, Georgia, Alabama, and Mississippi, will act in cooperation with the United States Geological Survey. The aim of the work is to determine the extent of the subdivisions recognised in New Jersey and Maryland on the north and Alabama on the south, to determine their relations to one another, and in general to establish satisfactory correlations throughout the district between the Potomac and the Mississippi River. Economic studies, especially on the phosphates, will also be made. The supervision of the work rests with a board of geologists, consisting of the State geologists in the Coastal Plain districts and the chief geologist and chief hydrographer of the national survey, Dr. W. B. Clark being chairman. The field work is in charge of Mr. M. L. Fuller, who will put seven parties into the field during the summer. It is hoped to complete the investigation in Virginia, North Carolina, South Carolina, and Florida within a year, while the work in the remaining States will be finished in 1908 and 1909.

THE closing sitting of the International Association of Academies was held on June 2. An article upon this third general assembly appeared in last week's NATURE (p. 105); and the Vienna correspondent of the *Times* gives, in Tuesday's issue, a short account of the proceedings, from which the following report of progress has been derived:—The next meeting will be held in Rome three years hence, and the management of the association during the interval will devolve upon the Accademia dei Lincei. The association has agreed to the issue of a complete and authentic edition of the works of Leibnitz, both the mathematical and the philosophical departments of the association recognising its desirability. Notable progress was reported in the preparation of the great Encyclopædia of Islam, of which Prof. de Goeje, of Leyden, laid before the meeting the first section in three languages—English, French, and German. The ideas of forming a Corpus of Greek documents and a Corpus Medicorum Antiquorum are taking practical shape. The Belgian Government has announced its intention of subsidising the scheme for an international bibliography of historical and philosophical subjects, and it is hoped that support will also be forthcoming from England and America. The proposal that the association should choose an international auxiliary language, such as Esperanto, for use in the communications between members was negatived by twelve votes to eight. The members of the association are gratified by the reception accorded to each of them personally by the Emperor Francis Joseph, and express warm gratitude for the hospitality extended to them by the Vienna Academy and by the Austrian authorities.

THE accounts which have been published in the Press, through Reuter's Agency, of the expedition of Dr. A. F. R. Wollaston to the Ruwenzori region give a terrible picture of the ravages of sleeping sickness. In the Manyuema country the sights are described as being fearful, with people dead and dying on the roadside, as it is the custom of those people to turn out stricken natives to die. A similar custom prevails in Uganda, and is inspired by the belief, firmly held by the natives, that persons affected with sleeping sickness are infectious to others living with them. Scientific investigations into the mode of transmission have so far demonstrated, however, only one means of conveying the infection, namely, by the intermediary of tsetse-flies (*Glossina palpalis*, also *G. fusca*, *fide* Koch). But since the fly has only been shown to transmit the disease by the direct method, that is to say, by taking up into its proboscis from sick persons the parasites which cause the disease, and inoculating them directly into healthy subjects, it seems at least within the bounds of possibility that other biting parasites, such as fleas or lice, might be able to do the same thing. Moreover, in a paper read before the Royal Society last November, Prof. E. A. Minchin suggested the possible occurrence of a mode of infection which he has termed *contaminative*, to contrast it with the ordinary *inoculative* method (see NATURE, December 27, 1906, vol. lxxv., p. 214). These suggestions, if confirmed, would account for the native theory of infection. On the other hand, no patient has ever yet been found to be infectious when removed to a healthy region from one where sleeping sickness is rife. It is evident, however, that the etiology of sleeping sickness is a subject which has not been exhausted, since there are several possibilities which require definite proof or disproof.

THE first part of vol. xxix. of Notes from the Leyden Museum is entirely devoted to descriptive zoology, and therefore mainly interesting to specialists. Reference may, however, be made to the description, by Dr. Jentink, of a new bat of the genus Taphozous from Batavia, which, in the possession of a wing-pouch and a gular sac, approximates to the rare *T. longimanus* of India.

IN the course of an editorial note in reference to the photograph of the skull of a hippopotamus which forms the frontispiece to the April number of the (*Haslemere*) *Museum Gazette*, it is stated that "the hippopotamus has its nearest British alliance in the pig, but unlike the latter, it has four toes." We are led to wonder how many digits the editor considers a pig to possess. We are also surprised to learn (p. 564) that Proechidna takes the place in New Guinea of Echidna in Australia, seeing that zoologists recognise a local race of the latter from Port Moresby. As to the list of mammalian names on p. 569, perhaps the less said the better.

THE structure and physiology of the male generative organs of the dibranchiates forms the first part of a critical study of cephalopod molluscs in general, by Mr. W. Marchand, of Leipzig, now in course of issue in the *Zeitschrift fur wissenschaftliche Zoologie*, this instalment appearing in vol. lxxxvi., part iii. As the result of his investigations, the author concludes that modern pelagic dibranchiates, in which the sexes are distinct, are the descendants of non-pelagic hermaphrodite forms, with longer bodies and "shells." The question as to whether these hypothetical ancestral types are represented by the belemnites is discussed towards the close of the paper.

JUDGING from the annual report for 1905–6, affairs have not been working quite smoothly at the Indian Museum. A proposal has been made that the museum should be divided into several sections (including one devoted to art), and that the whole establishment should be presided over by a director, who should not be a zoologist. Exception is taken to this proposal by the superintendent of the natural history section, who also expresses himself somewhat strongly with regard to the uses to which some of the galleries under his charge have recently been put. "I feel it my duty," he writes, "to record that this section has of late been seriously embarrassed and discouraged by a series of sudden evictions from its galleries and by constant schemes of Museum reorganisation in which its well-established claims, and the interests of zoology in general, have not received sufficient consideration." The zoological collections, with the exception of the insects (which suffer from the climate), are in the main in satisfactory condition, and have largely increased during the period under review.

THE annual return of experiments performed under the Vivisection Act has just been issued. In all, 46,073 experiments were performed by 279 licensees, of which 43,287 were of the nature of simple inoculations, hypodermic injections, &c. Nearly 6000 experiments were performed for Government departments, county councils, municipal corporations, and other public health authorities; 2144 experiments were performed for the Royal Commission on Tuberculosis, 8659 for the Imperial Cancer Research Fund, 4732 for the preparation and testing of therapeutic sera and vaccines, and 1079 for the testing and standardising of drugs. Irregularities occurred in the case of four licensees, the result of inadvertence or misunderstanding. The inspectors report that they have made the usual visits of inspection of registered places, and found the animals suitably lodged and well cared for, and the licensees attentive to the requirements of the Act.

A NUMBER of excellent illustrations of Maoris and others at the New Zealand International Exhibition are given in the *Weekly Press* (Christchurch, N.Z.) for December 12, 1906. One series shows the "Canoe dance," in which an elaborate story is told in pantomime by means of the *poi*, a small ball of *raupo*, at the end of a string of flax. Another series deals with the Fijian fire-walkers, whose performances were discussed in NATURE some years ago, and were the subject of a paper in the Proceedings of the Victorian Branch of the Royal Geographical Society of Australasia in 1892. There is also an excellent full-page plate of a Fijian dancing party.

THE Journal of the Anthropological Institute, vol. xxxvi., part ii., contains Prof. Petrie's Huxley lecture, illustrated by twenty-eight maps, mainly of Central Europe, with an appendix on the interpretation of curves. Mr. Torday continues his excellent series of papers on the tribes of the Congo, and, in collaboration with Mr. Joyce, deals with the Bahuana. Dr. C. S. Myers publishes two parts of his anthropometric survey of modern Egypt, treating of the Mohammedans and comparing them with the Copts and the "mixed" group. Mr. G. U. Yule attacks the validity of Dr. Karl Pearson's statistical methods in cases where ill-defined qualities, such as shades of colour, are in question. MM. Frič and Radin deal with the Bororo of central Brazil; a great part of their paper is devoted to ornaments, weapons, and music. Other papers in this part are by Miss Layard on the Ipswich Palæolithic site, and by Mr. Parkinson on the Ibos; Major Sykes publishes a second vocabulary of the Gipsies of Persia, giving words from three districts for comparison with Prof. de Goeje's Armenian and Egyptian lists. The number contains twenty plates, which, as usual, are of a high standard, both as regards interest and workmanship.

THOSE mysterious prehistoric excavations—the dene-holes—are found in great numbers in the neighbourhood of Bexley, some five miles from Woolwich, and in smaller numbers near Grays, in Essex, and numerous other localities in east, south-east, south, and south-west of England. Some recent explorations have unearthed a few more interesting evidences of their antiquity, and thrown a little more light on the problem of their origin. In sinking a shaft at Gravesend lately, the workmen discovered the nether cavity of a dene-hole, which had been almost entirely filled in by subsidences. The shaft was quite filled up, but the bee-hive chamber at the bottom is now being cleared of rubbish, and in the sand and earth a number of partially worked axe-heads of flint have been found, together with the bones and skull of an animal, probably a wolf, which are now being identified. The walls are covered with pick-marks, which seem to have been made with an instrument of either wood or bone, possibly a pick made of an antler.

IN the *Biologisches Centralblatt* (May 1) Prof. Haberlandt returns to his theory that the leaves of certain plants are enabled to perceive the stimulus of light because their epidermal cells are domed and function as lenses, whence he calls them "ocelli," since they resemble a primitive eye. He has somewhat modified his previous explanation, as follows:—If the light falls obliquely on the leaf, the rays act as a "tropic" or directive stimulus on the plasma-lining of the cell, causing the leaf to turn until it lies at right angles to the incident rays. In support of his theory, Prof. Haberlandt demonstrated that the cells can be prevented from functioning as lenses if the leaves are immersed in water, because the convexity is nullified by the water having a refractive index almost equal to that of the cell sap; to meet the arguments of critics he now shows that a continuous film of water on the surface is sufficient to prevent the leaf from turning.

AN article on the hybridisation of wild plants was contributed by Prof. D. T. MacDougal to the *Botanical Gazette* (January). The principal subject of examination was the oak tree, *Quercus heterophylla*, characterised by the veining and indentation of its leaves, that has generally been accepted as a hybrid. The author adduces evidence from the cultivation of seedlings in favour of regarding the species as a hybrid between *Quercus Phellos* and *Quercus rubra*. The article is, however, more important on account of the general remarks as to the methods of tracing supposed hybrids. Occasionally a hybrid may be synthetised from its supposed parents; sometimes evidence may be obtained from anatomical examination of the hybrid and parents, or, as in the present case, from cultures of the seedlings. These methods are, however, fraught with pitfalls that are better understood since the elaboration of the Mendelian principles.

IN connection with the silting up of Karachi harbour, Mr. G. K. Betham advances the opinion, in the *Indian Forester* (March), that much advantage might be derived from calling in the services of the forestry department.

The source of the enormous deposits of sand is traced partly to the sediment brought down by the Indus and partly to the drift from the littoral of Mirpur Sakro lying to the south-east of Karachi. While the control of the waters of the Indus is primarily the work of the irrigation department, it is urged that it would be possible to reduce materially the sediment if the banks and certain deposits, "kachas" in the upper waters were protected by planting with such grasses as *Typha elephantina*, *Eragrostis cynosuroides*, and *Eleusine aegyptiaca*. The problem of checking the sand drift from Mirpur Sakro is essentially one for the forester, and Mr. Betham maintains that, despite the want of water, it would be possible to develop plantations of Casuarina, tamarisks, and Agave.

DR. N. M. STEVENS, in Publication No. 36 of the Carnegie Institute of Washington, has given an interesting account of his investigations on the so-called heterochromosomes in a number of insects, especially the beetles. These chromosomes commonly form a pair differing in size from the rest of these nuclear bodies. One of the pair is smaller than the other, and this may go so far as to culminate in its entire suppression. The special point of interest attaching to these heterochromosomes lies in their different behaviour in the male and female animal respectively. The female always possesses an *equal* pair, and in those forms in which the small one has entirely disappeared from the cells of the male its surviving counterpart is still preserved in the female. A comparison of the eggs and sperms brings out the remarkable fact that half the eggs contain, and half quite lack, the large chromosome, whilst similarly the sperms, four of which are produced from each mother cell, divide the big and little ones between them when both are present, or they lack them altogether when they are absent from the somatic cells of the species. Thus it comes about that on fertilisation, on the average, half the offspring possesses, and half are destitute of, the large chromosome. Stevens correlates these remarkable nuclear characters with the differentiation of sex, but exercises a judicious restraint in forcing his conclusions. The paper contains full details, and should be consulted by those interested in these matters.

AT the annual meeting of the American Antiquarian Society on October 24, 1906, Dr. A. Lawrence Rotch read a paper entitled "Did Benjamin Franklin Fly his Electrical Kite before he Invented the Lightning Rod?" It is generally supposed that the kite experiment led to the invention of the rod, but Dr. Rotch's researches seem to show that the experiment was probably performed later than has been supposed (June, 1752), and that before then certain buildings in Philadelphia were provided with "points," probably as lightning conductors, and, further, that prior to Franklin's first account of the kite experiment he had drawn up precise directions for the erection of lightning rods. These directions were printed in "Poor Richard's (Improved) Almanac" for 1753, which was advertised in the *Pennsylvania Gazette* of October 19, 1752, as being then in the press. It is admitted that Franklin suggested the possibility of the lightning rod as early as 1750, but the directions referred to by Dr. Rotch and reprinted in his paper show that it was probably invented about a year earlier than has been supposed.

THE twenty-ninth report of the work of the Deutsche Seewarte, Hamburg, for the year 1906, shows that, in common with other national meteorological organisations, the scope of its operations is constantly increasing, with the result that some important investigations necessarily fall into arrear, *e.g.* the publication of the valuable "Daily Synoptic Weather Charts for the North Atlantic Ocean," undertaken in conjunction with the Danish Meteorological Office, which had commenced its twentieth year at the time of the issue of the Hamburg report for 1906. With regard to the necessary collection of trustworthy observations at sea, we observe that the Deutsche Seewarte received in 1906 some 1592 logs of different kinds from Imperial and mercantile vessels, containing 3627 months' observations. The observers are encouraged by the award of medals and diplomas, as well as by liberal presentation of publications. The department dealing with agricultural meteorology has greatly enlarged the area of its work, and issues special weather forecasts and charts in connection with that service. The important investigation of the upper air by means of kites and balloons is continued whenever practicable; 206 kite ascents were made in the year.

IN the *Geological Magazine* for April, Mr. G. J. Williams discusses the geological age of the Parys Mountain, Anglesey, and records a number of fossils recently discovered in shale beds opened up by the boring of a tunnel in the Mona Mine.

PROF. CHARLOTTE A. SCOTT contributes to the *Annals of Mathematics*, viii., 3, an interesting note showing how the regular polygons of five, seven, or nine sides can be constructed by determining four of their vertices as the points of intersection of a circle and a rectangular hyperbola.

IN the *Journal de Physique* for May, M. Ch. Maurain discusses the influence of torsion on magnetisation, and refers to the methods adopted in order to separate the effects of torsion from those of hysteresis. This paper may with advantage be taken in conjunction with one by K. Honda and T. Terada on the change of elastic constants of ferromagnetics, published in the Journal of the College of Science (Tokyo), vol. xxi., art. 4.

AN interesting paper on the genesis of mathematics is contributed by M. Jules Sageret to the *Revue scientifique* (vii., 19). The author gives a detailed account of Rouse Ball's observations on the Rhind papyrus, and refers to Tannery's conclusions regarding the work of the geometrical schools of Thales and Pythagoras. He considers that mathematics originated out of an empiricism which might have attained a high stage of development before any science came into existence, and that the fertile germ came from certain metaphysical ideas of imagination (shall we say intuition?) in the early ages of human thought. The genesis of mathematics differed from that of other sciences owing to the important part played in the latter by experience and observation. We can only wish that papers on the lines of M. Sageret's appeared more frequently in popular journals in Britain. They would do much to remove that unpopularity of mathematical study which arises from a too exclusive consideration of the mere examination ideal.

IN the *Psychological Bulletin* (iv., 4), Mr. David Coyle contributes a note on the inversion of the image in vision, and points out that the eye-movement theory of upright vision does not necessitate the inversion of the retinal images. In other words, an organism fitted with an eye capable of giving an upright image would execute the same eye-movements in turning its eye towards any definite object. In connection with this simple result, it might be interesting to direct attention also to the ease with which a microscopist can pick out diatoms under a non-erecting microscope, where the eye-movements are opposite in direction to the movements of the hand, showing how readily even the eye-movement sense of direction can be reversed by habit.

An interesting contribution to the study of the so-called "addition-compounds" is contained in a paper by L. Mascarelli and U. Ascoli in the *Gazzetta* (vol. xxxvii., I, 125). Many aromatic nitro-compounds combine with mercuric chloride or bromide to form "salts" analogous to those obtained from the corresponding iodoxy derivatives. Most of the substances formed in this way are, however, comparatively unstable, undergoing dissociation into their constituents in presence of the ordinary solvents; none of them has a true melting point. Their formation, however, is clearly demonstrated by the manner in which the melting point of the nitro-compounds varies as the mercuric haloid is added. The salts formed with mercuric chloride are more easily obtained than those derived from mercuric bromide, whilst mercuric iodide fails to give additive compounds at all.

MESSRS. A. GALLENKAMP AND Co. have sent us a copy of their catalogue of bacteriological and hygienic apparatus. It forms a volume of 260 pages, is profusely illustrated, and every piece of apparatus likely to be of use in laboratories of bacteriology and hygiene seems to be included.

MR. EDWARD STANFORD has published a second edition of his Geological Atlas of Great Britain and Ireland, based on Reynolds's Geological Atlas, which was reviewed in NATURE on February 2, 1905 (vol. lxxi., p. 315). The new edition is, like its predecessor, preceded by descriptions of the geological structure of Great Britain and its counties and of the features observable along the principal lines of railway. Mr. H. B. Woodward, F.R.S., the editor of the atlas, has added to the new edition, however, a sketch of the geological features of Ireland, its counties, and main lines of railway, and this subject is illustrated by geological maps of the country. A full list has been appended of the figured fossils, with indications of their zoological position and range in time.

MR. ROBERT SUTTON has published a third edition of Mr. T. Charters White's handbook for beginners on "The Microscope and How to Use it." Mr. Maurice Amsler has contributed to the new edition a chapter on staining bacteria, and the author has added a chapter on the marine aquarium as a field for microscopical research. The price of the new issue is 3*s*. net.

A CLASSIFIED list of publications of the Smithsonian Institution available for distribution as an aid to research or study has just been published by the institution. The list contains the titles of about one thousand papers, memoirs, and reports upon scientific subjects, grouped, so far as possible, according to the system of the International Catalogue of Scientific Literature, and arranged in each group alphabetically according to names of authors. Many of the papers can be obtained upon application by investigators interested in the subjects with which they deal, and others can be purchased at a nominal price from the Smithsonian Institution, Washington, D.C., U.S.A.

ANOTHER new edition—the fifth—of Mr. R. Kearton's "Wild Life at Home" has been published by Messrs. Cassell and Co., Ltd. The increasing popularity of what Mr. Kearton aptly calls "this new and bloodless form of sport" is a hopeful sign, as likely to lead to an increase of knowledge of the natural surroundings of living animals and their characteristics in the wild state. Mr. Cherry Kearton's photographs are both remarkable and artistic, and some of them provide abundant evidence that the peaceful sportsman need not lack the excitement which comes from danger to life and limb. The hints given how to study and photograph wild life should prove invaluable to naturalists beginning work in this direction.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—A telegram from Kiel announces the discovery of a thirteenth-magnitude comet by Prof. Giacobini, at Nice, on June 1.

The comet's position at 10h. 54·7m. (Nice M.T.) was

R.A. = 10h. 14m. 19·7s., dec. = +24° 4′ 41″,

very near to ζ Leonis.

The daily movement is given as +1° 10′ in R.A. and −36′ in declination.

SEARCH-EPHEMERIS FOR COMET 1900 III. (GIACOBINI).—A continuation of Herr Scharbe's ephemerides for comet 1900 III., during the apparition of 1907, is given in No. 4177 (p. 11, May 18) of the *Astronomische Nachrichten*.

These ephemerides give the positions, for every eighth day, from May 24 to July 27, for ten different values of the comet's daily movement, the normal argument being that perihelion will be passed on June 8.

COMET 1905 IV.—A further instalment of the ephemeris for comet 1905 IV. is given by Prof. Weiss in No. 4177 (p. 12, May 18) of the *Astronomische Nachrichten*.

This comet has been under observation for nearly 2½ years, and is now so faint (mag. = 14·0 approx.) that it will only be observed with the largest instruments. The present ephemeris gives the position of the comet at 12h. (M.T. Berlin) for 1907·0, and extends from June 1 to August 12.

DISCOVERY OF A SECOND ASTEROID NEAR JUPITER.—An investigation of the orbit of the minor planet 1907 XM, which was discovered by Dr. Kopff at Heidelberg on February 10, has been carried out by Dr. E. Strömgren, and has led to the interesting result that this asteroid is similar to (588) [1906 T.G.] in that its abnormally great aphelion distance lies in the immediate neighbourhood of Jupiter's orbit. The elements, derived from observations made on February 10, March 11 and 21, and April 12 and 16, are as follows:—

Epoch 1907 *February* 10·0 (*M.T. Berlin*).

$$\begin{array}{ll} M = 335^\circ\ 47'\ 12''\cdot3 & \phi = 2^\circ\ 8'\ 23''\cdot6 \\ \left.\begin{array}{l} \varpi = 183\ 51\ 51\cdot9 \\ \Omega = 341\ 58\ 21\cdot9 \\ i = 18\ 7\ 16\cdot9 \end{array}\right\} 1907\cdot0 & \begin{array}{l} \mu = 292''\ 584 \\ \log a = 0\cdot722504 \end{array} \end{array}$$

From the above it is seen that the length of the semi-major axis of this planet's orbit is roughly 5·28 astronomical units, that of Jupiter being 5·20.

This discovery of a second asteroid near Jupiter raises the question as to whether we are just discovering a hitherto unknown group of minor planets which for ages has been retained by the major planet in the neighbourhood of his orbit, or are dealing with the harbingers of an extension of the system of minor planets. The importance of answering this question is a further justification for vigorously prosecuting the apparently endless business of asteroid discovery (*Astronomische Nachrichten*, No. 4177, p. 13, May 18).

THE ECLIPSE OF JANUARY 14, 1907.—The official report of M. Milan Stefánik's expedition to Ura-Tjnbe (Russian Turkestan) to observe the total eclipse of the sun which took place on January 14 is published in the *Comptes rendus* for May 13. His intended observations—like those of MM. Belopolsky, Hansky, and Wittram, who occupied the same station—were prevented by a snowstorm, which commenced on the eve of the eclipse and continued without interruption until the evening of January 15. The crescent sun was glimpsed but once, at twelve minutes before third contact. At the time of totality the darkness was not profound, the earth and sky being of a purplish-blue tint. The passage of the moon's shadow on the lower layer of cloud was plainly visible.

PROGRESS IN REGIONAL GEOLOGY.

AMONG recent publications in the *Verhandlungen der k.k. geologischen Reichsanstalt* for 1906, it is fair to note that Prof. Hörnes and Dr. Franz Heritsch have replied to Vice-director Vacek's onslaught, the tone of which we regretted in a previous article. The stratigraphy of the picturesque basin of Graz thus receives further explanation (p. 305). Herr Gejza v. Bukowski (*ibid.*, pp. 337, 369, and 397) reports his work in the far south of Dalmatia. Among other points, he notes that the Eocene Flysch changes its lithological character according to that of the rocks on which it lies. Dr. E. Römer's discussion of what he styles "fossil dunes" (*ibid.*, 1907, p. 48) has a wide interest for students of the great European lowlands. The author urges that the post-Glacial valleys, which are cut in the deposits left on the withdrawal of the ice, have exercised a controlling action on the formation and origin of the dunes. Evidences of formerly prevailing east winds, and, later, of our present westerly winds, are clear to him, as to previous observers; but he connects the direction of the dunes with that of the river-valleys, into which the winds blew at right angles to the valley-sides. His studies in Galicia, round the head-waters of the Vistula and the Bug, assure him that the typical barchan, the dune with concave front and outstretched wings, is a phenomenon of deserts, and is constantly in a state of change. The European dune, now often surrounded with peat and itself grown over, is a stable product connected with a climate of steppes, not deserts. Dr. Römer (p. 53) observes how Neolithic settlements were established in the shelter of the dunes, indicating a wetter climate, following on that of the east winds and the steppes. Then a return of the steppe-climate led to the formation of sandbanks over the hearths and dwelling-places; and, finally, our present moister climate has restored the boglands and promoted the growth of trees. Anyone who has seen the winds in Poland laying bare the roots on the outskirts of a clump of pines will realise how easily the present balance may be disturbed, and how a slight meteorological change may allow the dunes again to grow.

In a paper on the Gosau beds of the lower valley of the Enns (*ibid.*, 1907, p. 55), Herr G. Geyer incidentally refers to the occurrence of red pisolitic bauxite in the base of the Cretaceous strata, at the unconformable junction with Triassic dolomite below. Two analyses are given, both with 25 per cent. of ferric oxide and about 50 per cent. of alumina.

The *Tenth Annual Report of the Geological Commission* (for 1905, published in 1906) reaches us from the Cape of Good Hope. Through Prof. Schwarz's appointment to a chair at Grahamstown, the staff of the survey has been reduced to two; but the director, Mr. A. W. Rogers, feels that the grant for travelling is not large enough for the requirements of three officers in the field. A pleasant reference is made to the geological tour of members of the British Association, which Mr. Rogers organised with such conspicuous energy and tact. The director contributes an account of a survey of parts of Uitenhage and Alexandria, with preliminary lists of fossils from the Cretaceous strata. Prof. Schwarz describes the coastal plateau south of the Outeniqua and Long Kloof Mountains, the latter rising to some 5000 feet, and the plateau or large shelf lying at 700 feet, bounded by a bold cliff towards the sea. Prof. Schwarz (p. 82) now regards this shelf as a continental ledge cut by the sea, and subsequently elevated. Mr. du Toit gives, in a paper on the Indwe coal area, a striking plan and section of a dolerite sheet undulating among horizontal beds of sandstone over about 2000 square miles of country. The part played by these intrusive basic rocks in the structure of hill-masses in South Africa is well seen in his other sections. Mr. Rogers revises some of Stow's conclusions in a paper on Hay and Prieska, north of the Orange River. Mineralogists will appreciate his description of crocidolite and its alteration-products (pp. 157–161). An ancient glacial conglomerate is well displayed at the top of the Griqua Town series in this area, while the Permian Dwyka boulder-beds are also represented in places. As an example of the work which a pioneer survey has to undertake, it may be mentioned that the structure of 4000 square miles of country, in parts impassable through drought, had to be realised in some three months.

More familiar ground is dealt with by Prof. Schwarz (p. 261) in the Ceres and Worcester area, which is known to most dwellers in Cape Town on account of the fine rock-scenery of the coast-ranges along the railway. We wish that the Hex River Valley (pp. 277–9) and some of the adjacent splendid examples of folded strata could have been illustrated by photographs, instead of by the rough sketches employed throughout this paper and the others in the report. Certainly, sunlight and opportunity are not lacking for geological photography in South Africa, and Mr. Rogers's well-known "Geology of Cape Colony" shows how the structure of so bare and open a country lends itself to the intervention of the camera. The report, with its envelope of maps, is a record of unflagging energy; and we have since received sheets 4 (1906) and 2 and 45 (1907) of the colour-printed geological map of the Colony of the Cape of Good Hope, on the scale of 3·8 miles to the inch. The topography is, of course, broadly set down, without representation of the surface-relief; but descriptions of the type of country are written across each distinctive area on sheet 45, and probably this practice will be continued. Sheet 4 includes the Great Berg River from Wellington to its alluvial area in St. Helena Bay, and the Breede River and Hex River on the east side of the watershed, where they cross the strike of the coast ranges in ravines of sandstone that remind one oddly of the limestone *cluses* among the Juras. The synclinal infolds of the Devonian strata are well indicated in the south-east of the map.

In the *Records of the Geological Survey of India*, vol. xxxiv., part iii. (1906), it is pleasant to note a paper by Mr. R. D. Oldham on explosion craters in the Lower Chindwin district, Burma (p. 137). These crater-pits are often occupied by lakes, since they have been excavated by explosive action to a lower level than that of the permanent saturation of the country. They show no sign of heat or of normal eruptions of ash, although they occur in a region of volcanic action. In accepting Mr. Oldham's explanation, we are reminded of the hydrothermal theory of the South African diamond-pipes, and of the trifling amount of contact-alteration on their margins.

In the same part (p. 172), Mr. Vredenburg discusses the "Tertiary system" in Sind, with references to his previous paper on the Foraminifera as zonal guides in this group of strata. In the field, he finds that the group, previously regarded as a continuous one, "includes five totally independent series," the unconformities between them being fortunately clear in Baluchistan. The basal series is thrown back to the Senonian, the supposed passage-beds into the Eocene disappear, and there are evidences of disturbance at the top of the Eocene and in Middle Miocene and Pliocene times. In Sind, layers of laterite, formed on low-lying continental surfaces (p. 179), represent the stratigraphical breaks. The amended classification leads to a re-examination of the Echinoidea described by Duncan and Sladen in 1882–6, and Mr. Vredenburg is able to separate faunas formerly, and somewhat naturally, confused. The stratigraphical breaks become all the more emphasised by this revision of the genera and species. The paper has thus a considerable additional interest for students of fossil Echinodermata.

Going further east, Herr Georg Boehm adds considerably to his previous exploration of Jurassic strata from Celebes to New Guinea ("Neues aus dem Indo-Australischen Archipel," *Neues Jahrbuch für Min.*, &c., Beilageband xxii., 1906, p. 385). In Buru, contemporaneous volcanic ashes are found containing ammonites and belemnites (p. 399). The occurrence of European species in the Far East is regarded as surprising, but is paralleled, as the author points out, by facts in animal distribution at the present day. *Argonauta argo* and *Octopus vulgaris* are cited as examples.

The *Geological Survey of New Zealand* forwards to us Bulletin No. 2, a quarto on the "Geology of the Alexandra Sheet, Central Otago Division," by Prof. James Park, of the University of Otago. The region is a mountainous one in the South Island, and is of importance in the production of gold. The possibility of the alluvial gold having been derived from folia of quartz in the old mica-schists, a view quoted (p. 33) with hesitation from Mr. A. McKay, reminds us of the problems of the Klondike. The uptilted lacustrine gravels, on which the Pleistocene moraines rest unconformably, are regarded provisionally as Pliocene, but raise an interesting stratigraphical question. The photographic illustrations, one of which we reproduce, are admirable, and may be commended to the notice of the authorities who hold the public purse at Cape Town. The petrographic section, where the rocks are described from the point of view of the laboratory, includes analyses of several of the schists, and photographs of rock-slices on the unnecessarily liberal scale adopted in the first bulletin of this survey.

The *Summary Report of the Geological Survey Department of Canada* for 1906, which bears two dates on its title-page, 1906 and 1907, informs us that the survey has decided to send its maps and reports "free to any *bona fide* applicant in Canada." This surpasses even the generosity of the United States Survey, which still, we believe, places a price upon its maps. The colour-printed sheets of part of Nova Scotia, surveyed by Mr. Hugh Fletcher, and sent us with the report, are as large as those for which we charge eighteenpence in England. Of course the topography shows far less detail, but the scale is, like ours, one inch to one mile, and the sheets have the price of 10 cents printed on them. We gather, however, on the other hand, that the sums paid in Canada to the junior members of the staff are not at all adequate, considering the competition with mining companies, which draw away the best geologists. The same difficulty has been met in India (Circular of the Department of Commerce and Industry, September 7, 1906) by a courageous increase in the salaries of the official geologists. The Canadian Survey spreads its operations over an enormous field, the areas examined being largely determined by the economic requirements of the year. The routes of projected railways naturally receive attention. This is Mr. A. P. Low's first annual report.

The Manuherikia River, New Zealand, forming a gorge along fault rifts in the schist series.

We fancy that Mr. G. R. Mansfield's paper on the Roxbury conglomerate near Boston (*Bull. Mus. Comp. Zoology at Harvard*, vol. xlix., 1906, pp. 91–272) would not have been a third as long had it not been presented as a thesis for a degree. Pages 105–151 contain a disquisition on conglomerates in general, according to the custom of American geologists when introducing a special subject in a literary form. The conclusions on p. 259 make us wonder whether the Roxbury conglomerate was worth describing at all; but this is probably because our sense of irritation, in this busy world, inclines to make us unfair to an obviously accurate observer.

G. A. J. C.

THE FEDERAL CONFERENCE ON EDUCATION.

IT is often made evident that the Government in this country leaves very important matters to be initiated and even carried on by private enterprise. Those who do not already know, will hardly be surprised to learn that the Federal Conference on Education, which was opened by Lord Crewe on May 24 in Caxton Hall, was organised by an independent society, the League of the Empire, and the League may well be proud, for it is understood that the next conference, which will be held in 1911, will be convened by the Government.

The business of the conference was divided as follows:—There were first of all the meetings of the representatives of colonial and Indian education departments and their committees. These took place behind closed doors, and were attended by the officials of the English, Welsh, Scotch, and Irish Boards. This official conference discussed a number of important matters, and we give some of the results of their deliberations. For instance, they decided that at present, owing to the way in which certificates are awarded and various local conditions, it is impossible to arrive at any complete recognition of the teachers' certificates issued by different educational bodies in different parts of the Empire. The desirability was recognised of teachers and inspectors acquiring experience in other parts of His Majesty's dominions than their own, and the conference thought that financial and administrative arrangements should be made to enable this to take place.

While it was not deemed desirable to attempt uniformity as to curricula and text-books, it was urged that the different education departments should define year by year with precision the terms used in their publications. Other important conclusions expressed were that a conference of representatives chosen by the Governments should be held every four years, and that the Imperial Government should summon the first. Furthermore, the present conference was unanimously agreed as to the importance of a central bureau of educational information.

The next series of meetings to be considered are those of the full conference, consisting of the representatives already mentioned and delegates from universities and associations. On Monday, May 27, Lord Reay presided, and higher technological education was considered, and various speakers, including Prof. Hopkinson (of Cambridge), Dr. Headlam (Principal of King's College, London), Dr. Bodington (Vice-Chancellor of the University of Leeds), and Dr. G. R. Parkin (University of New Brunswick), urged that technical training should go on side by side with the study of classics, poetry, and philosophy. Afterwards the following resolution, proposed by Dr. Clay, was unanimously agreed to:—

"That it is desirable that the Colonial Office and the Board of Education should cooperate in issuing officially, particulars as to the courses of study, fees, expenses of living, &c., at colonial universities, technical colleges and agricultural colleges, together with statements of the advantages attaching to their degrees and diplomas, and that information should be circulated in the colonies as to similar advantages and facilities which exist in this country."

On the following day, Mr. Inch (Superintendent of Education, New Brunswick) took the chair, and Mr. C. W. Bailey (Liverpool University) supported the idea that freedom should be given to each individual school, while Dr. H. J. Spencer (Headmasters' Association) pointed out with regard to the suggestion that each school should shape its own curriculum according to the needs of its pupils that there were several types of a good general education, any one of which might be chosen.

On Wednesday, May 29, under the presidency of the Vice-Chancellor of Cambridge University, two topics were discussed; first, the advisability of various educational bodies recognising each other's certificates of admission was generally agreed upon, and afterwards the question of cooperation between the old boys' associations throughout the Empire was discussed. Dr. Gow (Headmaster of Westminster) spoke of the difficulties of organising permanent associations of old boys of English public schools who go to the colonies, while Mr. L. A. Adamson (Victoria Secondary Schools' Association) made the following suggestions:—(1) that it is desirable to form a union of the great boys' schools of the Empire; (2) that this will best be done through their "old boys'" associations; (3) that the League of the Empire be asked to act as the organising centre.

At the open meeting on May 27, Sir Philip Magnus presided, and Sir Horace Plunkett gave an address on agricultural education in which he traced the work that had been going on in Ireland, and said that the problem of rural life was to be solved mainly by education, general and technical. During the discussion, Lord Monteagle pointed out that the farmer should be taught to appreciate technical instruction by practical demonstrations, and that the interest of the children should be awakened by nature-study.

Lord Elgin took the chair at a similar meeting on May 28, when the connection between elementary and secondary schools was discussed. The chairman pointed out that it was now the boast of Scotland that the path was open from the parish school to the university, and he thought that Scotland had done a great deal to bring about what is required. Several representatives from the colonies described in some detail the state of affairs in their own countries.

Meetings were arranged by the three standing sections of the League and other sections which were constituted for the occasion. The following is a list of sections with their chairmen:—History, Prof. Bury; nature-study, Sir John Cockburn, K.C.M.G.; museums, Lieut.-Colonel Plunkett; universities, Sir Arthur Rücker; technical, Sir Philip Magnus, M.P.; teaching of English, Prof. Saintsbury; training of teachers, Canon G. C. Bell.

Such a large number of papers were read in the various sections that it is impossible to summarise or even enumerate them here. In the technical education section many important aspects of the subject were dealt with in a series of special papers, which included the questions of training and research, both in this country and in the colonies.

The museums' section was chiefly occupied in passing the following useful resolutions:—

(1) "That the formation of school collections illustrative of science or art is a valuable aid to education" (proposed by Dr. R. F. Scharff).

(2) "That when school collections are made to illustrate natural history or other branches of knowledge, arrangements for the exchange of such collections between various parts of the Empire will assist the objects for which the League is instituted" (proposed by Dr. Chalmers Mitchell).

(3) "That teachers and others should discourage the making of such collections as might tend to the extermination of rare plants or animals, and should assist in preserving such objects by fostering a knowledge and love of nature" (proposed by Sir Harry Johnston, G.C.M.G.).

(4) "That this conference recognises the value of arrangements for the circulation of museum objects, as organised at the Victoria and Albert Museum, South Kensington, and at the Dublin Museum of Science and Art, at Sheffield Museum, and elsewhere, and warmly advocates an extension and development of the system" (proposed by Prof. Kidd).

(5) "That this conference recommends the organisation of a permanent collection of objects specially interesting and useful to those engaged in educational work, in connection with one of the great museums in London. That such a collection should include typical school museums and the outlines of a local educational museum" (proposed by Mr. John Maclaughlan).

In the nature-study section the following resolutions were carried:—

(1) "As nature-study gives that wide knowledge of the world and its products which is required throughout life, it should be inculcated at all stages of sound general education, and this section recommends its earnest encouragement in the home, in the school, and in the outside world. Furthermore, this section trusts that the education authorities of the Empire will endeavour to extend and encourage knowledge self-gained from original observations, as a vitalising factor in the progress to full intellectual efficiency" (proposed by Mr. T. R. Ablett).

(2) "That the supply of teachers acquainted with true methods of nature-study being the greatest present requirement, special efforts be made to provide facilities for the proper preparation for the work, of students and teachers in training" (proposed by Miss Rees George).

The museum section arranged exhibits consisting of a large series of travelling cases from Dublin Museum, and one of the cases illustrating the structure of birds now being arranged in the Lawson Memorial Wing of Eton College Museum.

In connection with the nature-study section were a number of exhibits illustrating the main phases of nature-study in this country, including the work of the Royal Drawing Society. The hon. secretary of the section on May 27 gave a lantern lecture entitled "Illustrations of Nature-study."

A large series of photographs was sent by the Government of New Zealand illustrating its educational work, and a very large number of publishers and makers of apparatus exhibited in the trade section.

Mr. S. H. Butcher, M.P., acted as chairman of the official conference, and Mrs. Ord Marshall as honorary secretary.

THE BIOLOGY OF THE COLORADO BEETLE AND ITS ALLIES.[1]

DR. TOWER, who is already well known as the author of a careful monograph on the development of colour in insects, has set forth in this bulky volume the results of his prolonged researches into the life-histories and interrelations of a group of plant-feeding beetles, one species of which is celebrated as a dreaded potato pest. The work certainly bears ample witness to the patience and ingenuity of this observer, who is one of that ever-increasing school of zoologists holding the view that further light can be thrown on the mysterious problem of evolution mainly by observation of and experiments on the living animal.

The first chapter treats of the geographical distribution of the genus Leptinotarsa; southern Mexico is regarded as the centre of origin of the group, whence it has spread southwards to the Isthmus of Panama and northwards to the United States. Much interesting information and speculation on the dispersal of the Colorado beetle *L. decemlineata* is supplied. Spanish caravans and wandering herds of bison are regarded as the agencies whereby the hooked and spined seed-pods of *Solanum rostratum*, the characteristic food-plant of Leptinotarsa, were transported from Mexico to Texas, Arizona, and the eastern slope of the Rocky Mountains; the insects followed in the track of their food-plant, and became established in these areas. The westward advance of civilisation in the middle of the nineteenth century brought with it the cultivated potato, which proved a most acceptable food to the beetles; all obstacles to the eastward extension of this destructive insect were now removed; in 1872 it had reached the Atlantic sea-board, and in less than fifty years it was generally distributed over the United States and southern Canada.

In chapter ii. the variation of colour patterns and structural characters is examined both qualitatively and quantitatively. The nature of the material not lending itself to minutely accurate measurements, the author has evolved a highly complicated series of formulæ which express succinctly forms of coloration on different parts of the body; these formulæ are "seriated into classes," and the percentage of individuals possessing given colour-formulæ

[1] "An Investigation of Evolution in Chrysomelid Beetles of the Genus Leptinotarsa." By William Lawrence Tower. Pp. x+320; illustrated. (Washington, D.C.: Carnegie Institution of Washington, 1906.)

is recorded. The author proves to his own satisfaction "that the highly complicated methods of biometry are no more reliable in their results as far as this material is concerned than other methods far less cumbersome and slavish." The nature of coloration and its ontogeny in the adult beetles and in the larvæ is discussed in chapter iii., and Dr. Tower adheres to his former view that colour originates from definite centres, and all patterns are merely extensions of these centres; all species start in life with an identical arrangement of colour-producing centres, which become modified, suppressed, or accentuated in different stages and in different species. Strong evidence against atavistic influences on the colour-development is adduced in the case of three species. Large numbers of specimens in all stages of growth were subjected to the most various conditions of temperature and humidity, and the conclusion is reached that like results are produced by diverse stimuli, *e.g.* any factor, such as heat, above or below the normal has the effect up to a certain point of producing increased pigmentation, beyond that point, of retarding it. The author believes that stimuli applied before the germ-cells begin to develop produce somatic variations only, which are not heritable; on the other hand, if the beetles were subjected to abnormal conditions when their germ-cells were sensitive to such stimuli, heritable variations resulted, and he attributes the inheritance of characters produced in the experiments of Weismann, Standfuss, and others to the fact that the stimuli acted on sensitive germ-cells, not on the soma. The subject is open to considerable argument, and doubtful critics may be referred to pp. 212–5 of Dr. Tower's monograph for a complete exposition of his views. Of high interest are the observations on the protective value of the gaudy coloration of these beetles. All the species have on the elytra and round the edge of the thorax, rows of glands whence exudes an oily and distasteful fluid; young fowls turned loose in a potato field, where *L. decemlineata* was common, eagerly attacked the insects at first, but soon learnt to avoid them, and subsequently could not be induced to eat them even when offered in company with edible insects. Specimens with the yellow stripes of the elytra covered with blackened shellac were given to experienced fowls, and then were readily seized, but as soon as their distasteful properties were realised they were dropped.

Limitations of space forbid a discussion of the experiments on selective and pedigree breeding, but they are of much interest and of great importance; the experiments extended over several years, but were brought to an abrupt conclusion through the carelessness of some workmen; Dr. Tower has with indomitable perseverance recommenced them, and his final conclusions will be awaited with eagerness. In the last chapter Dr. Tower confesses the faith that is in him; he will have none of the "Weismannian id-biophore-determinant hypothesis." He puts his finger on the weak spot in the theory of de Vries, and asks how mutants fare under natural conditions; his experience with Leptinotarsa shows him that they are rigorously exterminated. Variations he regards as epigenetic, not predetermined, evolution is continuous and direct, and new species have arisen in magrating races by direct response to the conditions of existence, natural selection acting as the conservator of the race by limiting the variations to a narrow range of possibilities. R. S.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. T. B. Wood, university reader in agricultural chemistry, has been appointed Drapers' professor of agriculture in the University. Mr. Wood has been secretary of the Board of Agriculture since the foundation of the board, and the marked success of the agricultural department at Cambridge is in no small sense due to his energy and initiative. The professorship was vacated owing to Prof. Middleton being appointed assistant secretary to the Board of Agriculture and Fisheries. Mr. Wood is the author of many scientific and practical papers on agriculture, and he is co-editor of the *Journal of Agricultural Studies*.

Keith Lucas has been appointed an additional demonstrator in physiology; and F. A. Potts has been appointed assistant to the superintendent of the museum of zoology.

Demonstrations in practical physics will be given during the long vacation, commencing on Monday, July 8. The chemical laboratory of the University will be open for the use of students during the months of July and August. Notice is also given that during the month of July, Mr. Fearnsides will deliver a course of elementary lectures on "The Study of Rocks."

An examination for one "Surveyors' Institution Scholarship" will be held on July 24–27. The scholarship will be tenable for three years, and of the value of 80*l.* per annum. Candidates will be examined in (*a*) elementary chemistry and physics; (*b*) more advanced chemistry, physics, botany, and geology.

OXFORD.—In the Convocation to be held on June 26, it will be proposed to confer the honorary degree of D.Sc. upon the following men of science, nominated by the Chancellor on the occasion of the Encænia following his installation:—Sir Norman Lockyer, K.C.B., F.R.S.; Sir Richard D. Powell, president of the Royal College of Physicians; Sir William Ramsay, K.C.B., F.R.S.; Sir William H. Perkin, F.R.S.; Prof. W. Watson Cheyne, C.B., F.R.S.; and Dr. Ludwig Mond, F.R.S.

THE report read at the annual meeting of the City and Guilds of London Institute on May 28 referred to the negotiations which have taken place with the Board of Education with the view of the Central Technical College of the institute being included in the scheme for the establishment of the Imperial College of Science and Technology at South Kensington. The draft provisions dealing with the purpose and scope of the new institution, and the manner in which the Central Technical College will be associated with the scheme, have been approved by the executive committee.

As was explained in an article in NATURE of May 16 (p. 56), the new Imperial College of Science and Technology is shortly to be incorporated in accordance with a charter which is to be considered immediately by a committee of the Privy Council. The suggested charter provides for the continuance of the Royal School of Mines and of the diploma of Associate of the Royal School of Mines, and the Central Technical College is to retain its individuality and to continue to exercise its privilege of awarding its diplomas of associate and fellow. A question was asked in the House of Commons on May 30 whether, under the proposed charter, it is intended also to retain the title and associateship of the Royal College of Science. The President of the Board of Education replied that the new governing body when established will consider the question and decide whether it is expedient to continue the name Royal College of Science and its diploma, and to secure to present associates of the college their existing privileges.

THE Imperial Department of Agriculture for the West Indies has established agricultural schools at St. Vincent, Dominica, and St. Lucia, and the result has been to provide a good practical training in agricultural science to a selected number of boys. Instruction is given in the theory and practice of agriculture and in agricultural botany and chemistry, in addition to the subjects of an ordinary education. Each boy receives daily training in raising the crops under cultivation and in the care of live-stock. At each school a portion of the land is divided into experiment plots for testing varieties of different plants, the introduction of new plants of economic importance, and methods of controlling insect pests and fungoid diseases by insecticides and fungicides. Besides these facilities, the *Agricultural News* of Barbados reports that rabbit breeding is taken up, and pure-bred Belgian hares have been introduced in order to improve the local stock. Poultry raising also receives attention, and now, by the use of incubators, a good supply of well-bred chickens is available for disposal throughout the different islands. The pupils become acquainted with all the details of work in the field before the theoretical knowledge of science necessary for keeping abreast with agricultural progress is learned. It has been found that the blending of practical xperience with theoretical knowledge is the most desirable nethod of producing young men qualified to take up esponsible positions.

The first annual conference of the Association of Teachers n Technical Institutions was held at the University of Leeds on May 22 and 23. The president, Mr. V. A. Mundella, of the Northern Polytechnic Institute, London, occupied the chair, and about one hundred delegates were present. Mr. Graham, secretary for higher education in Leeds, said that one of the great difficulties from an educational point of view, especially where it is wished o give students an all-round view of their particular calling, is that of the technical teacher teaching a bread-and-butter subject. If teachers could be convinced that it is absolutely necessary that the pupils should understand the scientific principles underlying that subject and get an all-round view of their particular trade, and not one particular little picture of it, a very great service would be done to technical education. In his presidential address, Mr. Mundella directed attention to the great leakage represented by the passing outside the pale of educational effort of children beyond the age of twelve, and he urged that up to the age of seventeen secondary education, widely diversified to meet local conditions, the standing of pupils, and the wishes of parents, should be made compulsory. There would thus be a perfectly natural development of the child. Scholarships, he said, not meet the requirements, and grammar schools and lic schools have no effect on the problem of second y education, which is the provision of suitable schools for the 600,000 children who leave the present element ry schools. The examination system for scholarships is fundamentally wrong, besides being very expensive. It works out for the whole country at about 20*l.* per scholar on the average, a sum almost twice as great as would maintain the child in a provided secondary school belonging to the local authority. Mr. H. A. Clark, head of the engineering department of the Northern Polytechnic Institute, read a paper entitled "Notes of an Educational Visit to the United States." He referred to the brotherly feeling between English and American men of science, and described his journey through the States and the various institutions visited. Mr. Barker North, chairman of the West Yorkshire branch of the association, read a paper on the preliminary training of technical students. He condemned the preliminary training of students entering technical colleges as very inefficient, this being in the main due to the desire of educational committees to secure large classes, paying inadequate attention to the training of the students, and unmindful of the fact that it was better to produce six highly-trained men than six dozen inefficiently trained. A paper by Mr. J. Fitzgerald, of the South-Western Polytechnic Institute, and Mr. E. L. Bates, of the London County Council School of Building, Brixton, on syllabus and examinations as applied to building subjects, was read by Mr. Bates. At the outset Mr. Bates referred to the impossibility of one individual becoming proficient in more than one craft. He also dealt with the best course of technical instruction for the craftsman and the general foreman. Several discussions of an instructive kind followed the reading of papers.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 14.—"On the Specific Inductive Capacity of a Sample of Highly Purified Selenion." By O. U. **Vonwiller** and W. H. **Mason**. Communicated by Prof. Threlfall, F.R.S.

The paper contains an account of the application of methods of measurement described by Pollock and Vonwiller (*Phil. Mag.*, June, 1902) to the determination of the specific inductive capacity of selenion. Two methods were employed, one an absolute electrometer method employing forces of a frequency of about fifty per second, and the other a resonance method employing electric oscillations of a frequency of 24 millions per second, which is believed to be more accurate than any high-frequency method hitherto employed. The selenion was cast into the form of a plate, 15 cm. diameter and 1 cm. thick, this plate being cast in such a manner as to ensure its being in the vitreous condition, after which it was ground with carborundum powder until the surfaces were flat and parallel. After each set of measurements the plate was broken up into small pieces, and the density of these pieces compared with that of the plate as a whole.

The following results were obtained :—

Density at 13°·8 C., 4·29.

Specific inductive capacity—by electrometer method, 6·13 at 16° C.; by oscillation method, 6·14 at 23°·6 C.

Specific resistance in the dark, approximate—between $2\cdot2\times10^{16}$ ohms at 20° C. and $6\cdot5\times10^{15}$ ohms at 25° C.

Resistance measurements were made in the dark, and it was noticed that the specific resistance fell considerably in the light as in the case of the conducting variety of selenion.

It was found that a thin reddish film forms on the surface of the selenion, though it is only exposed to air, and the comparatively high conductivity of this film gave considerable trouble before it was discovered.

February 28.—"The Enzymes associated with the Cyanogenetic Glucoside Phaseolunatin in Flax, Cassava, and the Lima Bean." By Prof. W. R. **Dunstan**, F.R.S., Drs. T. A. **Henry** and S. J. M. **Auld**.

The authors show there is reason to believe that these three plants, flax, cassava, and the lima bean, contain a mixture of the two glucosidolytic enzymes, emulsin and maltase.

The same authors had previously proved that the production of prussic acid from the lima bean, cassava roots, and the seeds or embryo plants of flax is due to the decomposition of the cyanogenetic glucoside, phaseolunatin (α-dextrose ether of acetone cyanohydrin), contained in each of these plants, by an enzyme which resolves this substance into acetone, dextrose, and prussic acid (Proc. Roy. Soc., 1902, lxxii., 285; 1906, lxxviii., 145; and *Ann. Chim. Phys.*, 1907 [viii.], 10, 118).

Since the mixture of enzymes obtained in the usual manner from any one of these three plants decomposes phaseolunatin and amygdalin, the characteristic glucoside of bitter almonds, whilst the enzyme which occurs with amygdalin in the almond decomposes amygdalin, but not phaseolunatin, it seemed clear that flax, cassava, and the lima bean must contain either a mixture of emulsin, with some other enzyme capable of hydrolysing phaseolunatin, or a new enzyme having the property of decomposing both glucosides.

Fischer's generalisation that the glucosidolytic enzymes so far systematically examined are divisible into two classes, the one capable of decomposing the α-alkyl ethers of the hexoses and the other the stereoisomeric β-alkyl ethers of these sugars, has rendered it possible to classify an unknown glucosidolytic enzyme by ascertaining whether it is active towards the α-alkyl ethers of the hexoses or towards the stereoisomeric ethers, and E. F. Armstrong has extended Fischer's work in this direction by showing that when the α-alkyl ethers of the hexoses are hydrolysed by enzymes of the maltase type the sugars immediately liberated are the α-forms, and that similarly the stereoisomeric β-ethers on hydrolysis by appropriate enzymes furnish the β-forms of the hexoses.

These methods have been applied to the investigation of the mixture of enzymes contained in these three plants and to the determination of the nature of the dextrose residue in phaseolunatin.

It was found that the mixture of enzymes has the property of hydrolysing amygdalin and salicin, which are both known to be β-glucosides, and similarly it decomposes α-methyl glucoside and maltase, which both have the α-structure.

Further, phaseolunatin is decomposed by yeast maltase and by the mixture of enzymes occurring with it in the three plants already named, yielding, in the first instance, the α-form of dextrose, so that it must be regarded as an α-dextrose ether of acetonecyanohydrin. Accepting Fischer's generalisation, it seems clear from these data that flax, cassava, and the lima bean contain at least two glucosidolytic enzymes, the one of the emulsin or β-type, the other of the maltase or α-type, and that it is the latter to which the decomposition of phaseolunatin is due, since this glucoside is derived from α-dextrose.

April 18.—"The Fermentation of Glucosides by Bacteria of the Typhoid-coli Group and the Acquisition of New Fermenting Powers by *Bacillus dysenteriae* and other Micro-organisms." Preliminary communication. By F. W. **Twort.** Communicated by Dr. Leonard Hill, F.R.S.

(1) A large number of glucosides may be fermented by many members of the typhoid-coli group of bacteria. The fermentations vary with the micro-organism tested, and the variations are as marked inside each subgroup of bacteria as between adjacent subgroups.

(2) The sugar-fermenting powers of an organism may be artificially changed by growing the said organism for a succession of generations in media containing a sugar which at the commencement of the experiment it was unable to ferment.

By this means a pathogenic organism may be altered until it gives fermentative reactions characteristic of a non-pathogenic member of its group. It is possible, indeed, that pathogenic organisms in the typhoid-coli group may so alter their characters that they become unrecognisable when growing for some time outside the body in soil, water, &c. If this is so, it might partly account for the difficulty experienced in isolating *B. typhosus* from these situations.

It also seems possible that a non-pathogenic organism may lose its fermenting powers and become pathogenic should it find a suitable medium such as the alimentary canal, and regain its old characters when outside the body. This is, however, only a suggestion, which at present is in no way proved.

In view of the results obtained with the typhoid-coli group of organisms, it seems quite possible that other organisms may show similar changes, and that the fermentation tests worked out by Mervyn Gordon for the Streptococci may also be inconstant, if the same means of experimentation are employed.

May 2.—"On the Variation of the Pressure developed during the Explosion of Cordite in Closed Vessels." By Prof. C. H. **Lees**, F.R.S., and J. E. **Petavel.**

(1) As most of the modern explosives used in ballistics follow the law of combustion by parallel surfaces, it appears from the results described that their properties may be defined by four constants, which may be determined without difficulty by direct experiment.

(2) The constants b and c (of formula 1) fix the maximum pressure which will be attained under any given charging density. The constants a_0 and a (of formulæ 4 and 9) measure the rate of combustion and determine the time which elapses between the ignition of the charge and the development of the maximum pressure.

(3) When the explosive is made up in a cylindrical form, the time occupied by an explosion for the same gravimetric density is proportional to the diameter of the cylinder.

(4) The rate of increase of the pressure is most rapid when about two-thirds of the maximum pressure has been attained.

(5) The maximum rate of rise of pressure per second is equal approximately to $1{\cdot}54a$ into the square of the maximum pressure in atmospheres divided by the diameter of the cordite in centimetres.

(6) When the explosion is fired under a high gravimetric density, the "effective" time of combustion may for practical purposes be taken as equal to the time required if the combustion proceeded always at its maximum rate.

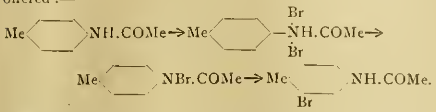
For cordite Mark I. this time is given by $T=36\,D/P$ if the diameter D is measured in centimetres and the maximum pressure P in atmospheres, or $T=0{\cdot}6\,D/P$ if the units are inches and tons per square inch.

Throughout the above investigation the cooling effect of the walls of the containing vessel during the combustion was taken as small enough to be neglected.

Challenger Society, May 3.—Mr. L. W. Byrne in the chair.—Mr. **Byrne** exhibited and made remarks upon rare deep-water fish of the N.E. Atlantic obtained from various sources.—Dr. **Fowler** exhibited a new horizontal closing tow-net which he had designed for use at different depths down to about 100 fathoms, pointing out that recent work had shown the necessity for a more precise knowledge of the depth at which an organism was captured in the upper zones than was furnished by the ordinary method of open tow-nets of the common surface pattern.—Dr. **Fowler** also exhibited a new "constant resistance" net, designed to avoid damage to delicate organisms collected for morphological or embryological study; it was so arranged that the area of the mouth automatically diminishes in proportion as the resistance (pace) increases.

Royal Meteorological Society, May 15.—Dr. H. R. Mill, president, in the chair.—The standard rain gauge, with notes on other forms: Dr. **Mill.** When the late Mr. Symons founded the British Rainfall Organisation forty-seven years ago, such observations as were being carried on were made with rain gauges of the most varied patterns, set up at any height from the ground that suggested itself to the observer, and read irregularly at almost any hour of the day or night. Since that time there has been a steady approximation to uniformity, and now the greater number of rain gauges in use are of a few definite patterns, set, for the most part, at nearly the same height above the ground. Dr. Mill strongly recommends the Snowdon pattern rain gauge, which is 5 inches in diameter, has a vertical rim to the funnel of 4 inches, and has an inner can and also a bottle. He does not recommend rain gauges with shallow funnels, nor the Howard and Glaisher patterns.—Account of a captive balloon being struck by lightning at Farnborough during a thunderstorm on April 11: Colonel J. E. **Capper.** The lightning flash appeared to travel along the wire until it reached the wagon; then a sudden bright light appeared and ran right up the wire into the clouds in which the balloon was hidden. The wire was fused, being burnt entirely away where it first touched the iron pulleys which guide the wire when running out. One side of the balloon and net was burnt, probably owing to the hydrogen catching fire, but the other side was uninjured.—A remarkable excavation made by lightning in peat earth on August 2 or 3, 1906, in a moorland district of Northumberland: Prof. A. **Herschel.**—Apparatus for measuring fog densities: J. W. **Lovibond.**

Chemical Society, May 16.—Prof. R. Meldola, F.R.S., past-president, in the chair.—The relation between the crystalline form and the chemical constitution of simple inorganic substances: W. **Barlow** and W. J. **Pope.** Close packed, homogeneous assemblages made up of two or more kinds of spheres of nearly the same size must approximate in marshalling to holohedral cubic symmetry or holohedral hexagonal symmetry with the axial ratio $a:c=1:0{\cdot}8165$. All the known crystalline forms exhibited by the elements can be interpreted in the light of the above geometrical principles, which also explain how binary compounds composed of two elements of the same valency crystallise in the cubic system and how silver iodide crystallises in the hexagonal system. The axial ratios of CsI_3 and RbI_3 are also in accordance with the geometrical principles stated above.—Experimental investigation into the process of dyeing: J. **Hübner.** It is shown that the absorption of dyes by cotton and wool is similar in many points to the absorption of these colours by inorganic materials such as graphite and charcoal, and hence it is deduced that dyeing is a purely physical phenomenon.—Esterification constants of substituted-acrylic acids, part ii.: J. J. **Sudborough** and E. R. **Thomas.** The results illustrate the retarding effect which a double bond in the $\alpha\beta$ position has on the velocity of esterification.—The addition of bromine to the α- and β-chloro- and bromo-cinnamic acids and their methyl esters: J. J. **Sudborough** and G. **Williams.**—The addition of bromine to unsaturated compounds, part i.: J. J. **Sudborough** and J. **Thomas.**—Separation of cadmium from zinc as sulphide in the presence of trichloroacetic acid: J. J. **Fox.** For the complete separation of cadmium and zinc by this means two precipitations are desirable, but this is unnecessary when the proportions of cadmium and zinc are about equal, or when cadmium is present in excess.—The mechanism of bromination of acylamino-compounds. Preliminary notice: J. B. **Cohen** and W. E. **Cross.** In the ordinary process of brominating acylamino-compounds in acetic acid solution, the crystalline product, which is first formed, yields, on pouring it into water, the nuclear brominated compound. This intermediate compound has been isolated in the case of aceto-*p*-toluidide. The following provisional explanation of the action is offered :—



—Mixed semi-ortho-oxalic compounds: G. D. **Lander.** The amide chlorides of methyl and ethyl oxanilates are stable below 100°. On decomposition by heat they pass, by loss of hydrogen chloride, into the imide chlorides, which are further resolved into alkyl chloride, carbon monoxide, and phenylcyanate.—Some derivatives of γ-pyranol allied to certain derivatives of brazilein and hæmatein. Preliminary communication: W. H. **Perkin,** jun., and R. **Robinson.** *o*-Hydroxybenzaldehyde and its derivatives condense with certain acetophenone or hydrindone derivatives to form derivatives of γ-pyranol. Thus β-resorcylaldehyde and acetophenone condense readily in presence of hydrogen chloride to give 7-hydroxy-2-phenyl-1 : 4-benzopyranol hydrochloride. With 1-hydrindone, 7-hydroxy-2 : 3-indeno-1 : 4-benzopyranol hydrochloride is formed. β-Resorcylaldehyde and 5 : 6-dimethoxy-1-hydrindone are condensed by hydrogen chloride in methyl-alcoholic solution to give 7-hydroxy-5 : 6-dimethoxy-2 : 3-indeno-1 : 4-benzopyranol hydrochloride. The substances thus produced may also be obtained by the action of alcoholic hydrochloric acid on the *o*-hydroxybenzylidene-1-hydrindones, and, conversely, the latter are again produced from the pyranols by the action of alcoholic potash.—Arsenic di-oxide: J. T. **Hewitt** and T. F. **Winmill.** The authors have examined Bamberger and Philipp's arsenic di-iodide, and find that it has the formula As_2I_4. Pyridine decomposes it immediately, liberating arsenic.—The formation and reactions of imino-compounds, part iv., the formation of 1 : 4-naphthylenediamine from ethyl γ-imino-α-cyano-γ-phenylbutyrate: J. F. **Thorpe.**—Mercury derivatives of pseudo-acids containing the group .CO.NH.: S. J. M. **Auld.** Unlike cyanuric acid, which forms two isomeric mercuric salts, all the pseudo-acids containing the group .CO.NH. examined have given only one derivative, in all cases an N-salt containing the group .CO.Nhg.—The influence of substitution in the nucleus on the rate of oxidation of the side-chain, iii., oxidation of the nitro- and chloronitro-derivatives of toluene: J. B. **Cohen** and H. J. **Hodsman.** —The reducibility of magnesia by carbon. Preliminary note: R. E. **Slade.** The two methods, which furnished a positive result, confirm the experiments of Lebeau, but whereas this author considers that the reduction only occurs at or above the boiling point of magnesia when the vapours come in contact, the present research seems to show that the reaction can take place at temperatures below the melting point of this oxide.—The reaction between organo-magnesium halides and nitro-compounds. Preliminary note: R. H. **Pickard** and J. **Kenyon.** Aromatic nitro-compounds react very vigorously with an organo-magnesium halide in ethereal solution.—A method for the determination of the equilibrium in aqueous solutions of amines, pseudo-acids and bases and lactones: T. S. **Moore.**—The "true" "ionisation constants" and the "hydration constants" of piperidine, ammonia, and triethylamine: T. S. **Moore.**

Institution of Mining and Metallurgy, May 16.—Prof. William Gowland, president, in the chair.—Siberian mines and mining conditions: A. L. **Simon.** A description of the mines and mining conditions more particularly in the province of Tomsk, the Ural and Orenburg districts, and the Kirghese Steppe. Beginning with a brief historical note, the paper dealt with climate, travelling conditions, the Russian system of weights and measures, mining laws and administration, the methods adopted in applying for claims, prospecting, opening out and working iron, copper and gold mines in Siberia, with details of costs and labour conditions.—Notes on a modern stamp mill: Gilmour E. **Brown.** A series of notes on various details of two stamp mills, compiled from personal experience and observation, containing figures relative to wear, cost of renewal, and the general efficiency of different component parts of the installation.—The use of zinc in assaying copper matte, &c.: Donald M. **Levy.** A description of results obtained by the employment of zinc for separating copper from the solution when assaying mattes, the copper and iron contents of which were both to be determined. The method described involves the use of only one reagent for the two operations. Figures were given of a series of comparative experiments showing the success of the method in practice. —A method of leaching gold ore tailings: R. S. **Botsford.** A brief note showing how, by slow and careful upward leaching, and continuous drawing off from below with the addition of fresh solution above the ore, a material saving was effected in the time occupied by the leaching process.

PARIS.

Academy of Sciences, May 27.—M. Henri Becquerel in the chair.—The suspended collimator of M. Schwarzschild: G. **Lippmann.** The arrangement described by the author in a recent number of the *Comptes rendus* was anticipated by M. Schwartzschild in 1904.—The flora and the relative levels of the coal borings of Meurthe-et-Moselle: R. **Zeiller.** More than 10,000 specimens of fossil imprints of plants have been obtained from these trial borings. These represent 145 species, some of which are new, and of which a detailed account is given.—The positions of the datum stars concerning the planet Eros deduced from the Toulouse negatives: B. **Baillaud.** An examination of the causes of the differences between the results of the reduction already published and those obtained from the same plates by Mr. Hinks.—The absence of polarisation of the prominences: P. **Salet.** Light from the edges of the sun and of the prominences is not polarised, and hence there is a contradiction between the theories of Schmidt and Julius and Fresnel's theory of polarisation.—Applications of a theorem of approximate convergence: Ernst **Fischer.**—The viscosity of fluids: Marcel **Brillouin.** A tentative formula for the viscosity of fluids is given and applied to the case of carbon dioxide, the viscosity of which has been studied experimentally both in the liquid and gaseous states.—A new property of gases issuing from flames: Maurice **de Broglie.** The gases from flames contain centres electrically neuter, possessing the properties of taking a charge under the influence of the radium radiation or Röntgen rays, and of being arrested by an ordinary cotton-wool filter and destroyed by heat. Gases containing these centres, after washing in dilute saline solutions, acquire a higher ionisation.—The sensibility of the electrostatic telephone: Henri **Abraham.**—Measurements of wave-lengths in the iron spectrum for the establishment of a system of spectroscopic standards: H. **Buisson** and Ch. **Fabry.** A completion of results already published by measurements in the ultra-violet.—Some double sulphites of hypovanadic acid: Gustave **Gain.** The alkaline bases possess the property of combining easily with hypovanadic acid in presence of sulphurous acid, giving well-defined double sulphites. Details are given of the compounds obtained with potassium, ammonium, rubidium, cæsium, thallium, sodium, and lithium.—Lead selenide: H. **Pélabon.** A study of the fusibility curves of mixtures of selenium and lead.—The methyl ethers of allyl and propargyl carbinols: M. **Lespieau.** A study of the action of allyl bromide and monochlormethyl ether on magnesium. The resulting mixture of di-allyl and the ether

$$CH_2{=}CH{-}CH_2{-}CH_2.O.CH_3$$

could not be separated by fractional distillation, but the separation was easily effected after converting into the bromine addition products.—A new crystallised principle from kola: M. **Goris.** Hitherto only two definite compounds, caffeine and theobromine, have been isolated from kola; the author describes a method of treatment by means of which a third substance can be obtained, kolatine, a phenolic substance of the formula $C_8H_{10}O_4$.—The ferment of the fig (*Ficus carica*): A. **Briot.** The coagulation of fresh milk by extract of fig is retarded or prevented by the existence in the milk of an antiferment. Heat destroys this antiferment, and hence boiled milk is more easily coagulated than fresh milk by this ferment.—The measurement of the mechanical work furnished by oxen of the Aubrac breed: M. **Ringelmann.**—The frontal gibbosity in fishes of the genus Ptychochromis: Jacques **Pellegrin.**—The duration of the larval life of Eucyphotes: H. **Coutière.**—The results furnished by the complete realisation of the physiological conditions which should be satisfied by the respiratory apparatus to permit man staying and working without danger in irrespirable atmospheres: J. **Tissot.** The conditions necessary are laid down in the following order, from the points of view of mechanics, chemistry, security, and efficiency.—The work developed during phonation: M. **Marage.** The work is measured by VH, where V is the volume of air which escapes from the lungs in a given time, and H its pressure. The author was able to make measurements of these magnitudes in two subjects, one with an artificial larynx, the other with normal vocal cords and with a tracheal cannula. For public speaking, the study of breathing is of the first importance; more energy is expended in speaking in a low pitch than a high one.—Researches on the action of waters containing sulphur compounds in the mercurial treatment: A. **Desmoulières** and A. **Chatin.** It is now well known that syphilitic patients under mercurial treatment who are taking sulphurous waters can tolerate doses of mercury compounds four or five times as great as those permissible without the use of such waters. This tolerance has been usually attributed to the precipitation of the mercury as sulphide, an insoluble form, but according to the authors' researches this is not the case. The effect is produced by increasing the solvent power of the blood serum with respect to the mercury albuminates.—Contribution to the study of the oscillations of the coast line in the Bay of Callao: P. **Berthon.**—The volcanoes of the Logudoro and Campo d'Ozieri, Sardinia: G. **Deprat.**—The dômes of the Coal-measures in French Lorraine: J. **Bergeron.**—The exploration of the free atmosphere above the Arctic regions: M. **Hergesell.**—A new theory of anthelia, paranthelia, and the white halos of Bouguer and Helvetius: Louis **Besson.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 6.

ROYAL SOCIETY, at 4.30.—On the Two Modes of Condensation of Water Vapour on Glass Surfaces, and their Analogy with James Thomson's Curve of Transition from Gas to Liquid: Prof. F. T. Trouton, F.R.S.—The Mechanical Effects of Canal Rays: A. A. Campbell Swinton.—On the Velocity of Rotation of the Electric Discharge in Gases at Low Pressures in a Radial Magnetic Field: Prof. H. A. Wilson, F.R.S., and G. H. Martyn.—The Osmotic Pressure of Compressible Solutions of any Degree of Concentration: A. W. Porter.—The Distribution of Blue and Violet Light in the Corona on August 30, 1905, as derived from Photographs taken at Kalaa-es-Senam, Tunis: Prof. L. Becker.

ROYAL INSTITUTION, at 3.—Chemical Progress—Works of Berthelot, Mendeléff, and Moissan: Sir James Dewar, F.R.S.

LINNEAN SOCIETY, at 8.—Contributions to our Knowledge of the New Zealand Holothurians: Prof. A. Dendy and E. Hindle.—Observations on Australasian Polyclads: Prof. W. A. Haswell.—Report on the Marine Fishes collected by Mr. J. Stanley Gardiner in the Indian Ocean: C. Tate Regan.—The Lithothamnia of the *Sealark* Expedition: M. Foslie. Notes sur les Ixodidæ recueillis dans les iles de l'Océan Indien, par M. J. Stanley Gardiner: Prof. L. G. Neumann.—*Exhibitions: Orobanche Ritro* and some New Varieties of Plants from the Channel Islands: G. Claridge Druce.

CHEMICAL SOCIETY, at 8.30.—The Relation between Absorption Spectra and Chemical Constitution, Part vii., Pyridine and some of its Derivatives: F. Baker and E. C. C. Baly.—The Interaction of Methylene Chloride and the Sodium Derivative of Ethyl Malonate: F. Tutin.—Molecular Weight of β-Naphthol in Solution in Solid Naphthalene: E. P. Perman and J. H. Davies.—Synthesis of Hexatriene Derivatives, Preliminary Notice: I. Smedley.—The Constitution of the Diazo-Compounds: J. C. Cain.—*p*-Cresol Sulphoxide and Sulphide: S. Smiles and T. P. Hilditch.—*p*-Dioxyphenylsulphoxide: S. Smiles and A. W. Bain.—Coloured Azo-derivatives of 1:3-Diphenylbarbituric Acid. Dynamic Isomerism among the Hydrazones of 1:3-Diphenylalloxan: M. A. Whiteley.—Dibromoaminoazobenzene: J. T. Hewitt and N. Walker.

RÖNTGEN SOCIETY, at 8.15.—Some Recent Investigations in Connection with Crookes' Tubes: A. A. Campbell Swinton.

FRIDAY, JUNE 7.

ROYAL INSTITUTION, at 9.—Studies in High Vacua and Helium at Low Temperatures: Sir James Dewar, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Chalk of Surrey, Part ii., The Western Area: G. W. Young.

MALACOLOGICAL SOCIETY, at 8.—Description of a New Species of Clathurella, probably from Ceylon: H. B. Preston.—Nudibranchs from New Zealand and the Falkland Islands: Sir Charles Eliot.—Note on the Name "Bourcieria": E. R. Sykes.—Description of Two New Species of Australian Helicoids, and Note on the Presence of a Double Wall in some Species of the Diaphora Group of Ennea: H. C. Fulton.

SATURDAY, JUNE 8.

ROYAL INSTITUTION, at 3.—The Contest between Guns and Armour: Sir William H. White, K.C.B., F.R.S.

MONDAY, JUNE 10.

ROYAL GEOGRAPHICAL SOCIETY, at 8.45.—Oceanic Circulation: Dr. Otto Pettersson.

TUESDAY, JUNE 11.

MINERALOGICAL SOCIETY, at 8.—Hamlinite from the Binnenthal: H. L. Bowman.—Note on Faceted Beads of Zinc: T. V. Barker.—On Chlormanganokalite: Dr. H. J. Johnston-Lavis and L. J. Spencer.

THURSDAY, JUNE 13.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Some Points in the Development of *Ophiothrix fragilis*: Prof. E. W. MacBride, F.R.S.—On Certain Phenomena of Inactivation and of Inhibition exhibited by Precipitin Antisera: D. A. Welsh and H. G. Chapman.—The Inhibitory Action upon Subsequent Phagocytosis exerted on Active Normal Serum by Inactive Normal Serum through which Bacilli have been passed: J. C. G. Ledingham.—*Miadesmia membranacea*, Bertrand; a New Palæozoic Lycopod with a Seed-like Structure: Miss M. Benson.—Observations on the Life-history of Leucocytes. Part III.: C. E. Walker.

CHEMICAL SOCIETY (Extra Meeting), at 8.30.—Discourse entitled Some Borderline Problems in Botany: Prof. J. B. Farmer, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—On Partial Differential Equations of the Second Order: Prof. A. R. Forsyth.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Improvements required in Inland Navigation: H. R. de Salis.—Bye-product Coking Plant at Clay Cross: W. B. M. Jackson.—Notes on Bye-product Coke-ovens, with Special Reference to the Koppers Oven: A. V. Kochs.—Bye-product Coke-ovens: P. Schwarz.—Water Supplies by Means of Artesian-bored Tube-wells: H. F. Broadhurst.—Gypsum in Sussex: W. J. Kemp and G. A. Lewis.—The Use of Duplicate Capell Fans: G. M. Capell.

FRIDAY, JUNE 14.

ROYAL INSTITUTION, at 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY, at 8.

INSTITUTION OF MINING ENGINEERS, at 10.30 a.m.—The Reform of British Weights and Measures: A. Hopkinson.—The Thick Coal of Warwickshire: J. T. Browne.—Description of the Ozokerite (Mineral Wax) Mine at Boryslaw, Galicia, Austria: D. M. Chambers.—Notes on the Structural Geology of South Africa: Dr. C. Sandberg.—The New Rand Gold-field, Orange River Colony: A. R. Sawyer.—Cast-iron Tubbing: What is the Rational Formula? H. W. G. Halbaum.

CONTENTS.

THURSDAY, JUNE 13, 1907.

MEDICAL TREATMENT BY HEALTH RESORTS.

Climatotherapy and Balneotherapy: the Climates and Mineral Water Health Resorts (Spas) of Europe and North Africa. By Sir Hermann Weber and Dr. E. Parkes Weber. Being a third edition of The Mineral Waters and Health Resorts of Europe, much enlarged in respect to Medical Climatology. Pp. 833. (London: Smith, Elder and Co., 1907.) Price 15*s.* 6*d.* net.

As the causation and character of chronic ailments are better understood, more and more reliance is placed upon baths and climates for their treatment. The health resorts combine many conditions favourable to health, and, in fact, represent more or less a return to nature, a reaction which becomes necessary in proportion to the increase of civilisation. The work of Sir Hermann and Dr. Parkes Weber upon these topics is well known in America and Europe, and is conveniently presented in the present volume, which has been much enlarged in the section of climatotherapy. It now affords the most complete account of the therapeutics of climate, waters, and baths that has yet been published in our language.

The real difficulty in the use of these natural agencies has been ignorance. Indeed, so vast an amount of detailed information of localities, which is apt to get out of date, must be combined with special experience and power of selection, that not even every physician is likely to be an expert in these subjects. In cases of difficulty, and where individual characters have to be primarily considered, the expert must, of course, have the last word, but for everyday purposes this book presents a clear account of general principles and a mine of useful information, and will form a work of reference helpful alike to the practitioner and the public.

Change of climate is but one of the objects of going abroad. The influence of environment at the health resort, and of travel *per se*, both upon bodily and mental functions, are rightly emphasised in this work. They are, indeed, often a more essential element of treatment than either climates or baths. As regards climate, it will now be generally admitted that there are comparatively few disorders for which the climates of Great Britain are not as well adapted as any other. If a necessary exception be made for some forms of consumption and of chronic joint disease and defective circulation, and for failing vitality of old age—for all of which a less humid and more sunny winter climate is sometimes advisable—our health seekers might well, as respects climate, remain within our own shores. The present authors, after a survey of many climates, give little countenance to the common complaint of the "changeable weather" of these islands, but rather affirm that "frequent moderate changes of weather are favourable to health and vigour." Although we may be limited, as the meteorologists inform us, to less than one-third of our possible sunshine, whilst Italy with a more translucent air enjoys more than one-half; although the microbes and spores in the atmosphere of our towns may reach to many hundreds or thousands in the cubic metre, whilst they are absent from the alpine, arctic, and ocean airs, yet notwithstanding our people have developed, thanks partly to the climate, a power of resistance to disease which gives them, on the whole, a standard of health and energy probably unsurpassed in the world.

We note the useful distinctions drawn between the various marine climates. The *warmer* group for winter use include the equable and humid climates like those of Madeira, the West Indies and Ajaccio, and also relatively dry climates like those of the western Riviera. Again, the *colder* seaside resorts of northern Europe and the Baltic are valuable bracing stations in summer. In dealing with the effects of climates of high altitude, an interesting fact, to which Sir H. Weber has already directed attention, is again stated, namely, that an elevation of 500 feet to 800 feet in Great Britain is equivalent or more than equivalent to 2000 feet or 3000 feet in southern Europe. The statement is well within the truth, and many instances could be adduced in confirmation, for example, the highlands of the north-east of Scotland. The quality of the air in that region appears to resemble that of the Alps without the rarefaction, and it is a remarkable fact that some of the disorders, such as degenerative vascular changes, dilatation of the heart, and nervous prostration, which are unfavourably affected by an alpine climate, are markedly benefited in our own more northern but less elevated and equally bracing climates. The effect of latitude upon conditions of disease might well receive more detailed treatment in a future edition.

The recent additions to our knowledge of soil and subsoil as factors in climate are here well summarised, but our appreciation of the effect of local variations is still very imperfect. Here, as elsewhere, there exists a body of valuable but empirical observation, which needs to be collated and systematised. For example, the influence both of soil and subsoil upon rheumatism is of acknowledged importance.

The second half of this volume is devoted to balneotherapy. This is a branch of medical science and practice in which, thanks to the conscientious work of modern spa physicians, a very salutary change has been effected of late years. Like other branches of treatment, it was once vitiated by charlatanism, and later obscured by irrational tradition and routine. Balneotherapy has been founded anew upon exact observation, and the present treatise is a striking testimony to the fact. We are here furnished with a good *résumé* of the effects of the different classes of mineral waters, of which some of the most active are but weakly mineralised. Not many years ago it was often denied by competent authority that ingredients in such dilution could have any therapeutic effect, and the curative results experienced were ascribed to the imagination. It is now recognised that dosage is not to be measured by bulk. How far we have travelled from the older doctrine may be appreciated on reading such statements as the following:—"in very dilute solutions the salt molecules are supposed to be held in solution almost entirely in a state of dissociation, as *ions*" (p. 319); and "It must be confessed, however, that minute quantities . . . apparently too insignificant to deserve mention, may ultimately turn out to have a real importance" (p. 327).

The selection and employment of baths in chronic disorders belong mainly to the spa physician. The present volume contains much suggestive material, but there is still room for a good practical treatise on the use of baths by a practising balneologist. The need for an "after-cure" in all serious cases is here very properly insisted upon. It may be safely affirmed that the failure of health-resort treatment is due in most cases either to the neglect of the "after-cure" or else to the common error of indulgence in a too prolonged course of baths, or in baths at too high a temperature. The valuable place of *sub-thermal* baths, given at temperatures below blood heat, has never been sufficiently emphasised as a mode of treatment at all the spas.

The discussion of the indications for climatic and spa treatment in the closing chapters should be of service to all those who have to do with the selection of a health resort.

THE CORAL PORITES.

Catalogue of the Madreporarian Corals in the British Museum (Natural History). Vol. vi., The Family Poritidæ, ii., The Genus Porites, Part ii. By H. M. Bernard. Pp. vi+173. (London: Printed by Order of the Trustees of the British Museum, 1906.) Price 20s.

WITH the publication of the second volume of the Poritidæ it may be said that Mr. Bernard's system of cataloguing the corals in the British Museum has been given a fair trial. A great deal of skilled labour has been devoted to this work, and a great deal of money has been spent upon it. It is therefore right that the merits of the system itself should be re-considered in the light of the results obtained.

That the catalogue is of some value no one would be disposed to deny. We have now, not only a record of the existence of a number of specimens of corals in the British Museum, but a careful, detailed account of their form of growth and skeletal characters. For those whose business it is to catalogue or study certain genera of corals, it is now possible to ascertain, without making a special journey to London for the purpose, that their specimens are similar to others in the possession of the British Museum. Students of coral structure have, moreover, the advantage of considering the general remarks on the variation in the mode of growth, of the arrangement of the septa, pali, &c., made by an authority who has had a very large number of specimens to examine.

But Mr. Bernard has abandoned the time-honoured plan of arranging his specimens in groups of species and has adopted the system of ticketing each specimen with the name of the locality in which it was found and a meaningless number. Thus the specimen in the Paris Museum, which has for nearly a hundred years been known as the type of *Porites clavaria*, Lamarck, is recorded in the British Museum catalogue as *Porites americana incertae sedis secunda*.

It is true that the attempt to apply the Linnean system to the Madreporaria and other orders of Cœlenterata is beset with many very great difficulties. Everyone who has worked at the systematic zoology of these animals has met these difficulties, and has probably realised that in the present state of knowledge his solution of them is crude and unsatisfactory. But we are still in the early period of the history of coral morphology, and until our knowledge of the anatomy of the coral polyps, of their tentacles, of their mesenteries, of their mesenteric filaments, and of other features of their anatomy is considerably extended, we are not in a position to conclude that the Linnean system is not applicable to them. The advantage of using the Linnean system, however, even in the present state of knowledge, is that it enables the naturalist who has made a special study of a genus to express his opinion, by the arrangement of the specimens into specific groups, of the relations he believes they bear to one another. His opinion may not be sound, it may even prove to be misleading, but the stimulus it gives him to careful and accurate observation is the very soul of his work, and alone gives life to systematic zoology.

In Mr. Bernard's catalogues we find simply a bald statement of facts. There are descriptions and figures of specimens, there are tables and lists, but there is not one word concerning the thoughts or opinions of the man who has devoted so considerable a part of a lifetime to the collection of these facts. It is like a quantity surveyor's estimate of bricks and stones without an architect's plan of the building they are to construct. We do not get in this system what we might expect to get, the benefit of the author's long experience, and, on the other hand, for those who would follow him in the systematic zoology of corals his volumes offer nothing but discouragement.

The time has come when a new line of research should be undertaken, namely, a systematic study of the soft parts of a large number of specimens of some one genus such as Porites, and a comparison made of the relation of the anatomy of the zooids to the different forms of skeletal growth. In this investigation some of Mr. Bernard's tables may prove useful, but the naturalist will have to go through a great deal of the work again in order to make the record valuable for systematic purposes. Such a study may achieve a great deal in clearing up the difficulty of distinguishing between characters that are intrinsic and transmitted by heredity to successive generations and characters that are due to the immediate influence of the environment. It may indicate to us the characters that are of value and those that are not of value for purposes of classification. In the meantime, it would be a serious mistake if those in charge of collections of corals were contented to adopt the *non possumus* attitude of Mr. Bernard and make no serious attempt to arrange their specimens in systematic groups.

One of the most important observations recorded in this volume is that there seems to be a fairly constant difference between the Atlantic and Indo-Pacific specimens of Porites. This difference lies simply in "the fact that the trabecular, horizontal and synapticular elements which compose the skeleton are thicker and coarser in the Atlantic and West Indian forms than they are in those of the Indo-Pacific." This difference is one which may prove to be of great importance in the re-arrangement of the species that will be made in the future, and although there are some exceptions (p. 19) that may require special investigation, it will be of interest to inquire how far a difference in the anatomical character of the polyps coincides with this difference in a skeletal character.

Mr. Bernard devotes one chapter of his introduction to what he terms "metameric" growth in Porites. This principle of growth is well known to workers in the various groups of corals, but it is not one to which zoologists have hitherto applied the expression "metamerism." The metameric segmentation of a living animal body such as we see, for example, in the developing larva of a Polygordius is one thing, a linear series of gemmations in which the last of the series alone survives is another. To confound the two by using the same word for them will certainly not assist in the elucidation of the problems of coral growth. The phenomena of "overgrowth" in corals, as this process may more conveniently be called, are not fully understood, and may be due to several natural and circumstantial causes, but none of them seems to be due to any process that is at all comparable with the metameric segmentation of a worm or of an arthropod.

Although it has been necessary to express freely an opinion as to the value of the method employed in this volume, we may express our admiration of the careful descriptive account of each specimen in the catalogue and of the excellence of the plates.

S. J. H.

REALISTIC SCHOOL MATHEMATICS.

A School Course of Mathematics. By David Mair. Pp. viii+379. (Oxford: The Clarendon Press, 1907.) Price 3*s*. 6*d*.

FOR some years past the Civil Service Commissioners have systematically set themselves the task of framing their examination questions so as to make them of practical interest instead of merely being a test of a candidate's capability in abstract mathematics.

Mr. Mair, in the present book, has given a most useful and interesting collection of such of these examples as he considers should be within the range and powers of boys while still at school. These questions are given in sets at the end of the various chapters, which are devoted to the discussion of a few typical questions. These typical questions are discussed with variations and from different points of view, the discussion being thrown into the form of questions by the teacher, and answers supposed to be given by the pupil.

It is somewhat difficult to realise how these discussions are intended to be made use of unless they are meant only as typical, to be taken merely as suggestions, and not to be followed in detail; it would certainly not do for the class to have the book open during the discussion, and it would take too long for the class to write down the questions to which they are asked to give an answer, and yet in many cases the questions are somewhat difficult to answer unless the pupils can have them in writing. Moreover, in some cases the work involved in the discussion before the pupil has satisfactorily arrived at the generalisation which the teacher is striving to bring him to is so lengthy that it could not be completed in a single sitting, and consequently the continuity of thought required would be seriously interrupted. This difficulty seems not to have been contemplated by the author.

Moreover, he does not seem to have sufficiently realised that the young pupils for whom he is catering in the earlier chapters are incapable of the sustained thought and the considerable efforts of memory and chains of reasoning which he requires, and, most serious defect of all, even if the pupils are brought to perceive and retain the mathematical truths thus presented to them, these truths are so detached from each other and are so various in kind that they do not form in any sense a *mathematical course*.

In spite of this, however, the book will be of very great use. Thus, in some schools it is already being used with the upper army classes for the sake of the excellent examples with which it is crowded, the question and answer part being for the most part ignored with these classes, and, with regard to the text, if the teacher can find time to go carefully through the book, he will find a great deal of help given him as to the best way of bringing home some mathematical facts to boys in a more realistic and vivid manner than he might otherwise be able to do. For example, the author has a special way of his own for introducing boys to logarithms. This method is very carefully worked out, and is particularly worthy of study. Possibly each teacher will elaborate some modification of his own which he prefers, but he certainly should very carefully consider the author's method, which is most ingenious and well worked out so far as he goes, though there is a gap at the end which he has jumped. The author's treatment of questions in solid geometry also is good, giving them a reality and vividness which will make this part most valuable as an introduction or as a companion to the theorems of the eleventh book of Euclid or its modern equivalent.

The impression left on the reviewer's mind is that the book in no way supersedes the regular class books on the various subjects, but that it may be a most valuable adjunct to them in two ways, first, by suggesting methods of presentment of new mathematical ideas by means of concrete illustrations which will bring them home more vividly and interestingly to the pupil, the method of question and answer being often used to make the pupil think for himself—though, indeed, this is generally done now by good teachers as occasion serves—and, secondly, by the teacher taking the class from time to time through a selected set of the examples when they have assimilated the underlying book-work.

There is one thing which the author has touched on, though apparently only in an example (No. 7, p. 293), which one would have liked to see brought into much greater prominence, viz. the graphic solution of a quadratic equation $x^2-bx+ac=0$ by drawing lines $OA=a$, $BC=c$, perpendicular to a line $OB=b$, and drawing a circle on AC as diameter, cutting OB in P, Q: the roots being OP and OQ. This method gives the clue to the geometrical solution of many problems some of which would otherwise be difficult; for example, the construction of a triangle of given area when two sides are given in position, and a point in the plane through which the third side is to pass; also the construction of a right-angled triangle from the data given in the book on p. 261; also the division of a line in extreme and mean ratio; and, indeed, any problem the solution of which depends on a quadratic. It is a most valuable link between algebra and geometry. Another method which is applicable to the case of $x^2 \pm bx = a^2$, and is perhaps better than the first for this particular case (though really only a modification of the above general method), is given on p. 264. The book is, in fact, bristling with ideas and suggestions, and we wish it the great success it undoubtedly deserves. A. L.

EGYPTIAN ANTIQUITIES.

Egyptian Antiquities in the Pier Collection. Part i. By G. C. Pier. Pp. 27+xxi plates. (Chicago: University of Chicago Press, 1906.) Price 17s.

MR. GARRETT CHATFIELD PIER, of New York, is an amateur of Egyptian antiquities, and has begun to publish a catalogue of his collection, of which the first part has reached us. The book is produced by the Academical Press of the University of Chicago, which, at the instigation of its Egyptological specialist, Prof. Breasted, is beginning to take an important part in Egyptian archæological work.

We find various traces of Prof. Breasted in Mr. Pier's book. The learned professor's "particular wanities" in the way of transliteration of Egyptian names, such as "Ikhnaton" for Akhenaten, or "Harmhab" for Haremheb, either stamp Mr. Pier as a faithful follower of Prof. Breasted or show that the professor revised Mr. Pier's Egyptology. Mr. Pier's use of the Berlinish algebraic transliteration (*e.g.* "s;-r‘ Nb-m;‘-t-r‘-nb-t;wj" for what might just as well be written *sa-ra Neb-maat-Ra neb-taui,* p. 5) points the same way. But Mr. Pier should be careful, if he uses this highly learned transliteration, to use it consistently, and not write sometimes "Nub-khprw-r‘" (p. 19), sometimes "‘,’-ḫprw-r‘" (p. 22), sometimes "Mn-ḫpr‘," sometimes "Men-khepr-r‘" (p. 21), or "Ishrw" (p. 6) for "Jšrw," or "Thy" (p. 13) for "Tjj," in such a sentence as "Śtn-ḥmt-wr-mrj-f-Thy (surely, surely, Tjj! ‘nḫ-ty," which also exhibits confusion between the orthodox Teutonic "j" and the slightly heretical English "y." Thy is the queen whose tomb has just been discovered at Thebes; if the German transliteration is used for her name at all, it must appear as "Tjj," but in reality there is no need whatever to use pedantically, in a guide to a collection of objects of purely anthropological interest, a transliteration of ancient Egyptian which is utilised only by a few German or germanised philologists for purely philological purposes.

Mr. Pier's collection does not, so far as published, appear to contain anything of extreme interest, compared, that is, with such important private collections as those of Mr. Hilton Price or Mr. Macgregor. He seems to be chiefly interested in objects of the prehistoric period and scarabs of the XVIIIth Dynasty, of which he possesses some fine specimens. Of later scarabs he does not appear to own many, which may account for the inaccurate statement on p. 15:—"with the Twenty-sixth Dynasty richer materials are used for scarab seals and plaques, such as carnelian, amethyst, serpentine, &c., *rarely, if ever, inscribed.*" We italicise the erroneous statement, which may well seem odd to those who know how constantly the little stone scaraboid plaques of the Saïte period were inscribed with all manner of sentences, wishing a good new year, invoking Khonsu as a protection, and so forth. But probably Mr. Pier has not yet devoted much attention to these later objects. He is thinking of the fact that the XIIth Dynasty amethyst and other stone scarabs were but rarely inscribed: this is so.

Mr. Pier draws his scarabs extremely well, much better than his flint implements, of which he publishes some scratchy pen-and-ink representations [Plates v.–ix.: Plate ix. (of a slate) is especially bad]. The mirror on Plate x. is also very badly drawn, and the two dishes on Plate xi. are not much better. Mr. Pier would be well advised to reproduce these things by means of photography in future, and to confine his artistic efforts to scarabs and hieroglyphs, which he knows how to draw.

His coloured plates of ceramics are very successful, though not so successful as Mr. Henry Wallis's in his "Egyptian Ceramic Art." Mr. Pier's blues, yellows, and violets do not so perfectly reproduce their originals, and Mr. Wallis's do. But it would be indeed difficult to rival Mr. Wallis's drawings or Mr. Carter's in the publication of the "Tomb of Thoutmosis IV."

So far as the literary part of the book is concerned, quite apart from the usual aberrations of American spelling, Mr. Pier has one or two specialities of his own. One is "faun-colored" (for "fawn-coloured"), which occurs two or three times, and so cannot be a misprint. Presumably Mr. Pier has forgotten what a "fawn" is, or what colour it is, and is thinking of a Greek faun. True, if we are to believe the sculptors, the fauns and hamadryads did live naked in the open air most of the time, so were probably slightly tanned. And what does Mr. Pier mean by "hackling" (p. 10)? Was a "hackling implement" the sort of flint you threw at a prehistoric election candidate: to "heckle" him? Or does Mr. Pier mean simply "hacking"? One talks of a dog "putting up his hackles." We pass on, unconvinced. On p. 11 we read a description of a vase as "handled for suspension or portage." By *portage* Mr. Pier probably means "carrying": his word is an odd one, and sounds as if it were of Canadian origin; we have not met with it in this particular sense before, and we do not like it at all.

Real misprints are rare. We notice "Chelleen" for "Chelléen" (p. 6), and one or two others of no importance.

The disadvantages of the book are such as the author can easily remedy in the succeeding parts, and we hope that he will continue his plan to its end. Such catalogues of private collections are extremely valuable to the student, and those collectors who publish them are to be congratulated on the scientific spirit that impels them to make their antiquities known. H. H.

OUR BOOK SHELF.

Heat Shadows. By Walter Jamieson. Pp. viii+30. (London: Blackie and Son, Ltd., 1907.) Price 6*d*. net.

THIS pamphlet describes some new experiments in conduction and radiation of heat. The author has prepared a series of grades of paper sensitised to heat by impregnating them with a "sympathetic ink" which turns green on heating (*i.e.* on drying). The tint attained in any experiment may be considered as depending roughly upon the amount of heat absorbed; thus the paper acts as a calorimeter rather than as a thermometer. This law would be true if the absorbed heat were all transformed into the latent heat of steam; since, however, the paper sensibly warms (and, therefore, radiates), the law is not so exact; though even so there is a time-temperature compensation. The double iodides sometimes employed for the purpose are thermoscopes rather than calorimeters, for their transition points are somewhat too high, and when reached the transformation is rapid and automatic; that is, it is independent of the heat supply.

Specimens of the sensitive paper were received along with the pamphlet, and we have been able to test it. We think that it will prove very useful for demonstrating the phenomena of conductivity and radiation in schools where thermopiles are out of the question. Too much stress must not be laid, of course, upon quantitative experiments. The first experiment is to fasten a strip of the paper, sensitive side up, upon a board with a thick copper wire between. If the wire is heated at one end the green tint spreads out more widely near the heated end. We do not think that the teacher is justified in *measuring* the width of the coloured band and in thus trying to find the law of the decrease of temperature; he should be content with the inference of "more or less." Most of the experiments are excellent. We think those on radiation are the best.

As a bright surface Mr. Jamieson employs a test tube coated with a metallic paint. This forms a very good coating, but the inquiring child (and teacher) may wonder whether the varnish with which it is applied has anything to say to the result.

This metallic coating is also employed by the author for coating electrical condensers, proof planes, &c., and is very readily applied both to the inside and outside of any jar

Handbook of American Indians North of Mexico. Edited by Frederick Webb Hodge. Pp. ix+972. In two parts. Part i. (Washington: Government Printing Office, 1907.)

THIS volume is Bulletin 30 of the Bureau of American Ethnology in connection with the Smithsonian Institution. The handbook contains a descriptive list of the stocks, confederacies, tribes, tribal divisions, and settlements north of Mexico, accompanied with the various names by which these have been known, together with brief biographies of Indians of note, sketches of their history, archæology, manners, arts, customs, and institutions, and the aboriginal words incorporated into the English language. All the tribes north of Mexico are dealt with, including the Eskimo and those tribes south of the boundary more or less affiliated with those in the United States. Under the tribal descriptions a short account of the ethnic relations of the tribe, its location at various periods, and statistics of population are included. There are many illustrations. Though confessedly incomplete, the handbook represents a vast amount of research by an army of observers, and students of ethnography will look forward to the publication of the second part with keen anticipation.

A German Science Reader, with Notes and Vocabulary. By Dr. W. H. Wait. Pp. vii+321. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1907.) Price 4*s*. 6*d*.

THE greater part (180 pages) of this book consists of selections from standard German works on the chief departments of science. The extracts describe some fundamental facts and principles of chemistry, physics, geology, mineralogy, astronomy, and anatomy; and they have been selected from the point of view of interest as well as that of instruction. Helpful notes are given on each division of the book, and also lists of words commonly mispronounced and of words and phrases with special or idiomatic meanings. A vocabulary at the end of the book gives the English rendering of words used in the German text. Any student of science having a slight acquaintance with German grammar will find in the book all the assistance required to enable him to read the extracts with interest and profit. As an introduction to German scientific literature, the volume will be found of real service both by teachers and students.

Les Bases de la Philosophie naturaliste. By André Cresson. Pp. iv+179. (Paris: Félix Alcan, 1907.) Price 2.50 francs.

THE title of this little volume serves to define its purpose. The author provides a short and impartial explanation, likely to be understood by a reader of average intelligence, of the fundamental principles upon which modern philosophy rests. The scope of the book will be clear from the titles of the six chapters into which it is divided: the first deals with the old anthropocentric view of things, and this is followed by chapters on science and the inorganic world, science and life, science and mind, science and society, and conclusions.

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 intended for this or any other part of NATURE *No notice is taken of anonymous communications.]*

The Origin of Radium.

I cannot let Prof. Rutherford's letter in Nature of June 6 pass without directing attention to one striking consequence, in which I personally am interested. During 1904 and 1905 I published (Nature, May 12, 1904, January 26, 1905, and *Phil. Mag.*, June, 1905, p. 768) the result of an experiment which went to show that a kilogram of uranyl nitrate, purified initially from radium by precipitating barium as sulphate in its solution, and kept 550 days, generated a quantity of radium which, although only one-thousandth part of what is theoretically to be expected on the view that a direct change of uranium X into radium takes place, was still one hundred times the amount initially present. Boltwood (*Am. Journ. Sci.*, September, 1905, xx., 239), working with one hundred grams of uranyl nitrate purified from radium initially by repeated crystallisations from water, was unable to observe any detectable increase after a period of 390 days, and concluded that "the results obtained by Mr. Soddy are without significance," and averred that my results were due to the introduction of radium salts during the tests.

Now such a criticism and such an imputation on the part of one investigator dealing with the work of another surely ought only to have been made if it was the only possible explanation of the discrepancy. As it was, to me at least, it was not even the most obvious explanation. Boltwood did not give consideration to the all-important influence of the method of purification of the uranium from radium on the results obtained. My result, that the rate of production of radium from uranium was only one-thousandth of the theoretical, brought into being the present theory of the existence of several hypothetical intermediate transition forms between uranium and radium. It is obvious that, according as the method of purification employed does not or does remove these transition forms as well as the radium, so one will or will not expect to observe an initial production of radium in a solution of uranium. Now the method of precipitating barium as sulphate in a uranium solution is designed to *remove only* the radium, whereas the method of repeated crystallisation from water adopted by Boltwood is well calculated to *purify* the uranium, that is, to free it from all other accompanying substances. Hence there is no necessary discrepancy between the results of the two experiments. This view has been put forward by Rutherford ("Radio-active Transformations," p. 159).

I would not now have raised this matter had not history apparently repeated itself, and Prof. Rutherford's most recent results (Nature, June 6, p. 126) enabled me, without making any special claim to infallibility, to exhibit clearly the real nature of Boltwood's criticism. In the *American Journal of Science* for December, 1906, p. 537 (Nature, January 3), Boltwood published a "Note on the production of Radium from Actinium" in which evidence was given that actinium is the parent of radium. This was quickly followed (Nature, January 17, p. 270) by some confirmatory evidence of a similar character by Rutherford, who, however, pointed out that there was no proof that actinium was itself the true parent of radium, although this parent was undoubtedly present in the actinium solutions employed. Now Rutherford shows in last week's issue that actinium *purified from radium in a different manner* yields no appreciable growth of radium. Is Boltwood's previous positive result then "without significance"? Surely not. But if Boltwood's result on the production of radium from actinium can be explained, as, of course, it can be explained, without charging him with introducing radium into his solution, so in the same way can mine with uranium. Indeed, whereas the intermediate product, which is the parent of radium, is a *necessary* companion of *any* uranium preparation which has not recently been subjected to a purification process capable of removing it, it has yet to be shown that the association of this parent with actinium is genetic and not purely fortuitous.

I hope this exposure of an old criticism, made without due consideration of the complexity of the problem, will clear the way for the publication of some further results. In the two years that have elapsed since the publication of my last paper I have had the advantage of the cooperation of Mr. T. D. Mackenzie in the steady and continuous prosecution of the work under the most favourable conditions. We have from the commencement, which dates prior to Boltwood's first communication on the subject, had as the basis of the work the all-important influence of the method of purification adopted, and we have used throughout a new method of purification, which, though not without difficulty and danger in its application to the purification of large quantities of uranium salts, was deliberately chosen as affording a reasonable guarantee that it would separate the uranium from all other substances present. Mr. Mackenzie has purified with the utmost care three separate kilograms of uranyl nitrate by this method, and I may anticipate our results to the extent of saying that, so far, they entirely confirm and extend the results obtained by Boltwood in which re-crystallisation was the method of purification employed. The first preparation, containing after purification about 500 grams of uranyl nitrate, has been kept for 600 days, and has not shown the slightest detectable increase in the amount of radium initially present. Now that these three purified preparations have been set up in a form to allow of continuous and extended observation, our attention is being directed to the residues from the three kilograms, which should contain the parent of radium, if my earlier positive result was correct. After all, it would be a little surprising if this parent of radium was entirely absent from commercial salts of uranium, for although Boltwood and Rutherford have found it in preparations of actinium, it must not be forgotten that the only source of actinium is that from which commercial uranium salts are prepared.

Frederick Soddy.

The University, Glasgow, June 8.

The Structure of the Æther.

In the current number of the *Philosophical Magazine* I have given in some detail certain objections to identifying the magnetic vector with translational æthereal motion, and to a large extent these are on all fours with Prof. Hicks's objection, which is cited by Sir Oliver Lodge in the same number, and of which I had lost sight. Very briefly, thus: if bodily æther flow were (within a constant factor) identical with magnetic induction, or were even an essential feature thereof, our judgment as to whether or not a given region was pervaded by magnetic induction would depend on the arbitrary origin of coordinate axes relatively to which we chose to measure velocities, motion of bodies through the æther being physically indistinguishable from an equal and opposite motion of the æther with those bodies at rest.

Much the same difficulty (concerning the essential relativity of motion) seems to me to arise when resultant æthereal momentum is taken to correspond to the vector product of the electric and magnetic vectors; in this case, moreover, further difficulties are encountered. Consideration of a progressive train of electromagnetic waves shows that, with this æthereal-flow interpretation of the Poynting vector, we should have a resultant æthereal motion made up of a steady flow in the direction of wave propagation, together with to-and-fro motions parallel to that direction and kinematically exactly simulating the motion of a gas which is transmitting waves of sound. This clearly implies *compressibility of the aether*, not merely as a minute residual phenomenon, but as a fundamental relation of electromagnetism.

And what would happen in the case of such a body as the sun, which consistently radiates more energy than it receives by radiation? There would be a flow of æther outward in all directions, maintained throughout immense periods of time. This difficulty seems almost insuperable.

There appears to me to be much evidence in favour of the view that the resultant velocity of the æther (referred to suitable axes) is everywhere zero—at least so far as electromagnetic phenomena are concerned.

Though I find myself in agreement with Prof. Richardson's conclusion that magnetic intensity is not to be identified with speed of æthereal flow, as explained in his letter to NATURE of May 23, I venture to dissent from his arguments. These proceed from the contention that, on the contested assumption, certain integrals would become infinite. Now, in the first place, it appears to me from mere inspection that both these integrals (which I have not actually evaluated) are in reality finite; in the second place, neither integral expresses a magnitude which bears directly on the point at issue, one of them being justly criticised by Sir Oliver Lodge in NATURE of June 6 as apparently devoid of mathematical meaning. The question proposed is as to the momentum due to an electric charge upon a moving sphere, and in this connection the really significant magnitude is the kinetic energy, expressed in terms of the translational velocity. Differentiating this expression with respect to the velocity, we have at once the momentum, the result obtained being independent of any physical theory as to the ultimate nature of the energy in a magnetic field. C. V. BURTON.

Cambridge, June 8.

Decomposition of Radium Bromide.

YESTERDAY, on opening a glass tube containing 1 milligram of radium bromide which had been hermetically sealed for almost exactly twelve months, there was a very strong odour of bromine which hung about the tube for about ten minutes. The amount of the bromide decomposed in this period would be about $5{\cdot}4\times10^{-7}$ grams according to Rutherford; the amount of bromine corresponding to this would be about 2×10^{-7} grams. Perhaps some chemist could say definitely whether this amount of bromine would be detectable by its odour. The volume of the tube was about 4 cubic centimetres.

ALFRED W. PORTER.

University College, London, June 8.

The Mass of the α Particle.

APPARENTLY the following simple and obvious method of calculating the mass of the α particle has been overlooked.

According to Rutherford, the number of α particles emitted per second by a gram of pure radium is $2{\cdot}5\times10^{11}$. Of these particles, one-quarter comes from each of the four elements Ra, RaEm, RaA, RaC. The particles from these four elements are emitted with velocities $0{\cdot}82\ V_0$, $0{\cdot}87\ V_0$, $0{\cdot}90\ V_0$, $1{\cdot}00\ V_0$ respectively, where V_0 is $2{\cdot}6\times10^9$ cm./sec.; they all cease to produce ionisation when their velocity is $0{\cdot}43\ V_0$. Hence the loss of kinetic energy of all the α particles emitted from one gram of radium in passing over their ionising ranges is

$$\frac{2{\cdot}5\times10^{11}}{4}\times\tfrac{1}{2}m\times\{(0{\cdot}82)^2+(0{\cdot}87)^2+(0{\cdot}90)^2+1^2-4\times(0{\cdot}43)^2\}(2{\cdot}6\times10^9)^2=m\times5{\cdot}3\times10^{29},$$

where m is the mass of an α particle.

At the same time, it is known that one gram of radium gives out 105 gram-calories per hour (mean value), or $1{\cdot}22\times10^6$ ergs per second. If we may identify this quantity of heat energy with the kinetic energy lost by the α particles in ionisation we have

$$m\times5{\cdot}3\times10^{29}=1{\cdot}22\times10^6$$

or

$$m=2{\cdot}3\times10^{-24}.$$

The ratio e/m for the α particle is $1{\cdot}56\times10^{14}$ electrostatic units. The two most probable theories of the nature of the α particle are (1) that it consists of an atom of helium carrying a charge 2ϵ, where ϵ is the electronic charge $3{\cdot}4\times10^{-10}$, and (2) that it is a molecule of hydrogen carrying a charge ϵ. On the hypothesis (1) the mass of the particle is $4{\cdot}26\times10^{-24}$; on the hypothesis (2) it is $2{\cdot}13\times10^{-24}$. The calculation given indicates that (2) is correct, and explains the failure of Greinacher and Kernbaum to obtain helium from the α rays of polonium (*Phys. Zeit.*, 1907, p. 339).

If it be assumed that the whole of the kinetic energy of the α particles, and not only that part of it which is spent in ionisation, appears as heat energy, the value for m is found to be

$$1{\cdot}78\times10^{-24}.$$

I have thought it best to give the maximum estimate of that quantity which can be attained by this method.

NORMAN R. CAMPBELL.

Trinity College, Cambridge, June 3.

The "Renal-portal System" and Kidney Secretion.

I RECENTLY published a short paper (Proc. Zool. Soc., 1906) on the significance of the so-called "renal-portal system" found in most of the lower Vertebrata. In this paper I advanced strong reasons for supposing that the "renal-portal system," or, as I prefer to call it, renal cardinal meshwork, is non-excretory in nature. I showed that, both developmentally and structurally, there was every reason to doubt whether the renal cardinal meshwork takes any part in the formation of the plexus of blood-vessels which surrounds the urinary tubules (although, of course, these are connected with each other), and that therefore the blood apparently supplied to the kidney by the "renal-portal" (post-renal) vein is in all probability not utilised in the production of the kidney secretion. This conclusion, opposed to that held by most physiologists and morphologists, I supported by citing the physiological experiments of Nussbaum (*Pfluger's Archiv*, xvi., xvii., 1878; *Anat. Anzeig.*, i., 1886) and Beddard (*Jour. Physiol.*, xxviii., 1902), which afforded valuable confirmation. These experiments, as is well known, proved that after the arterial supply of the frog's kidney had been eliminated all secretion immediately stopped, notwithstanding the facts that the "renal-portal" circulation was still in full swing and that powerful diuretics were employed. The sole objection to regarding these experiments as conclusive was that, in consequence of the kidney being deprived of oxygenated blood, the tubular epithelium had degenerated, and was therefore not in a condition to secrete. While recognising this objection, yet for the other reasons which I had already advanced I ventured to maintain that, even if the blood in the post-renal vein could be artificially oxygenated, no secretion would occur.

Unfortunately, I was not aware of more recent physiological work on this subject when I made this last suggestion. Since then, however, Prof. Halliburton has kindly directed my attention to the papers of Bainbridge and Beddard (*Biochemical Journal*, i., 1906) and Cullis (*Jour. Physiol.*, xxxiv., 1906), in which the reverse result has been obtained; that is to say, according to these later experiments, a secretion can be obtained from the "renal-portal" circulation provided that the tubule epithelium is maintained in a healthy condition by means of a sufficient supply of oxygen, and that powerful diuretics like urea and phloridzin are employed. This result at first sight appears to be contradictory of my previous conclusion and confirmatory of the generally accepted "portal" theory of the renal cardinal meshwork, but it is the object of these remarks to show that such is, after all, not necessarily the case.

In the first place, these recent experiments have clearly shown that the "renal-portal" circulation will not yield the slightest secretion in the absence of powerful diuretics; in other words, the result obtained by Bainbridge, Beddard, and Cullis is at best an abnormal one. Under more normal conditions, *i.e.* in the absence of diuretics, with a healthy tubule epithelium and with the "renal-portal system" alone working, no secretion whatever occurs.

Secondly, the very fact that when the venous blood contained in the renal cardinal meshwork alone "supplies" the kidney, the tubule epithelium degenerates, proves that in the normal living animal this blood is not in contact with the tubules, *i.e.* does not take part in the formation of the blood-plexus surrounding the tubules, since, as the experiments prove, these latter require the oxygenated blood derived from the renal arteries in order to live and much more to secrete.

Thirdly, it must be remembered that in the experiments of Bainbridge, Beddard, and Cullis, the elimination of the arterial circulation of the kidney does away with the blood current which normally flows *away from* the region of the tubules, and, this being the case, the venous blood of the renal cardinal meshwork, encountering no resistance, is enabled to penetrate to the tubule plexus, carrying with it the injected diuretics which cause the secretion observed. There is no reason why the secretion should not occur under these abnormal conditions. The tubule epithelium is well supplied with oxygen, the veins are gorged with impure blood, and in experiments in which at all large secretions were obtained the pressure was artificially raised by forced injection or otherwise.

It is easy, then, to account for the secretion obtained by the investigators named, and at the same time to believe that the venous blood takes no share in the formation of the kidney secretion under normal conditions.

It has always surprised me, speaking as an outsider, that physiologists have so readily assumed that they possess in the frog and other animals with "portal" kidneys so many convenient anatomical contrivances in which the glomeruli and the renal tubules are supplied by separate vessels. It is true that the renal cardinal meshwork is continuous with the blood plexus surrounding the tubules, but surely it is very unsafe to assume from this one fact that the venous blood is used by the tubules for secretory purposes. Another equally patent fact, that the similar tubules of mammals employ arterial blood, should suffice to cast doubt on the assumption. And when we recall to mind the statements of Hyrtl (*Wiener Akad. SB.*, xlvii., 1863) and Vialleton (*C. R. Hebdom. Séances Soc. Biol. Paris*, liv., 1902), among others, that in those "portal" kidneys in which the vascularisation has been histologically examined, viz. those of the frog and certain sharks, the renal cardinal meshwork is structurally distinguishable from the tubule plexus (the former consisting essentially of large channels putting the post-renal vein into communication with the post-caval, and the latter consisting of capillaries which open into the channels), there is still more reason for supposing that the flow of blood is from the tubule plexus into the renal cardinal meshwork, and not in the contrary direction. The numerous experiments which have been based on the aforesaid assumption have, I should imagine, given rise to incorrect ideas as to the normal functions of the urinary tubules.

If I needed any additional physiological evidence in support of my contention that the post-renal vein has nothing to do with the vascular plexus of the urinary tubule, *i.e.* does not supply the kidney for excretory purposes, I find it to hand in the recently issued British Association Report for 1906, York. In a report on "The 'Metabolic Balance Sheet' of the Individual Tissues," p. 427, it is shown to be exceedingly probable, by the relative amounts of oxygen used up by the kidney tissue of a frog and a mammal respectively, that the "renal-portal" vein of the frog bears a very different relation to the kidney tubules as compared with that of the renal vein of mammals—which is the conclusion I am maintaining. It is further stated that "when the same kidney is perfused at different times through the aorta and through the renal-portal system, there is a greater consumption of oxygen in the former case than in the latter (double to treble in four experiments)." If we assume what is generally held to be a well-established fact, viz. that the kidney-tubule epithelium plays quite as important a part in kidney secretion as the glomerular epithelium, then it is difficult to understand, on the portal theory of the kidney, why the quantity of oxygen absorbed by the kidney tubule is totally out of proportion to the work done by it. Obviously the only rational conclusion to draw is that in the above experiment the oxygen perfused through the "renal-portal" vein did not come into contact with the tubule.

To sum up, I think I may say that I have clearly shown that the recent work of Bainbridge, Beddard, and Cullis does not disprove my original contention that the renal cardinal meshwork is, under natural conditions, non-excretory, that, in short, the so-called "renal-portal" vein does not supply the renal tubules, as physiologists commonly assume, and that, in consequence, experiments based on this assumption are liable to give rise to misleading ideas.

W. Woodland.

Mendelism and Biometry.

In the striking and suggestive review of Mr. Punnett's work on "Mendelism," in Nature of May 23, the reviewer cites, without naming the author, a view expressed by Mr. A. D. Darbishire (*Manchester Memoirs*, 1906) to the effect that "the Mendelian deals with units and the biometrician with masses," and states that this idea, "though plausible, is based on a fallacy," for "the Mendelian's units *are* the biometrician's masses, except when the latter exceeds his limits and includes within his masses more than one such unit."

I have no doubt that Mr. Darbishire read the review with as much enjoyment as myself, but it seems to me that his statement of the case is dismissed with scarcely sufficient consideration. The reviewer's points, if I understand aright, are two:—(1) that Mendel's laws (by which he seems to mean, not merely the law of segregation, but the laws of observed proportions) are really mass-laws and not laws of the individual; (2) that the biometrician's masses are the masses to which Mendel's laws apply. But surely (1) Mendel's laws are based on definite conceptions as to the germ-cells of the *individual*—and that is the important point—and are true of the *individual* to a degree of approximation which is the higher the greater the number of offspring (quite a high degree in such a case as Mr. Lock's maize). Further, (2) if the "Mendelian's units" were the "biometrician's masses," there should be inheritance of individual variations, within each of two races A and *a*, for any character to which Mendel's laws applied on crossing those races; for inheritance of individual variations is what the biometrician has observed for nearly all characters in his masses.

I indicated the importance of an investigation on this point some time ago (*New Phytologist*, i., 234)—for it is almost a fundamental question whether a single determinant, such as may be assumed to exist for a unit Mendelian character, is or is not capable of variation from individual to individual—but I am not aware that any such investigation has been made. The reviewer's assumption may, therefore, be true, but it is unproven, and theories at present in the field (Pearson, *Phil. Trans.*, 1904; Yule, *Conference on Genetics*, 1906) are based on the opposite assumption, viz. that heritable individual variations are due to the character concerned being determined by *n* allelomorphic couplets, and not by one. If this be true, the "biometrician's masses" are precisely masses to which Mendel's laws, in their simplest form, do *not* apply.

The question referred to above, whether a unit Mendelian character exhibits heritable individual variations or no, seems to be one that urgently calls for experimental investigation.

G. Udny Yule.

Mr. Yule is probably right. The question is this: Is the inheritance which the biometrician always finds within the limits of his masses due to the fact that he is dealing with a large number of Mendelian units, or that he is measuring the intensity of heredity *within* such a unit?

If the former, Mr. Yule is right in saying that I criticised the view expressed by Mr. Darbishire unjustly. If the latter, the mass of the biometrician *is* the unit of the Mendelian. But before we can give an answer to this question we must know, as Mr. Yule points out, whether there is inheritance of fluctuating variations within the limits of a single Mendelian character such as "tall," in peas. If we may argue from stature in man to stature in peas, we should compare the character tall (or normal) in peas to tall (or normal) in man, and dwarf in peas to dwarf in man. We know that there is inheritance within the character tall in man, and, if this analogy is legitimate, we should expect to find it so in peas. If it were, the answer to the question whether the view expressed by Mr. Darbishire were right or not would depend on whether we still called the character tall the unit or extended the conception of unit to the smallest heritable variation within the category tall.

The Reviewer.

SOME INSTANCES OF UNSCIENTIFIC ADMINISTRATION.

In recent letters to Nature and the *Times*, I had occasion to criticise the lack of science displayed by the Indian authorities during their conduct of the operations against plague in the great outbreak of 1896. The Editor of Nature, who has so frequently and ably urged the claims of science on the public, now asks me to give any more instances of the same nature which I may have observed.

Probably few any longer accept the teaching of Hume, that the object of government is no other than "the distribution of justice." The function of an ideal civilised government might be described as the performance of all acts for the good of the public which individual members of the public are by themselves unable to perform—that is, the organisation of public welfare. The individual can certainly add much by intelligence and virtue to his own welfare; but these qualities do not suffice to protect him altogether against those evils which can be combated only by concerted action, such as the depredations of disease and of external and internal human enemies; and where he is powerless, the Government, and only the Government, can help him. Now such concerted action is likely to be successful only when it is based on sufficient knowledge; and a scientific administration differs from an unscientific one just in this particular, that it seeks the necessary knowledge, while the other acts blindly. In nothing is this more manifestly the case than in connection with that departmen of public administration which is charged with the protection of the public against disease—a department second to none in importance, because it concerns not only our sentiments and our pockets, but our health and our lives. Before such protection can be obtained, two things are absolutely necessary—first, an exact knowledge of how diseases are caused and how best they may be checked, and, secondly, an efficient organisation to act upon that knowledge when it is obtained. I will now try to examine how far, within the range of my own subject and experiences, this ideal of a scientific administration has been reached.

My experiences commenced in the Indian Medical Service in 1881. The Indian governmental machine is a bureaucracy placed mostly in the hands of soldiers and Indian civilians, who are selected from the British middle-classes by competitive examinations in branches of knowledge among which (be it noted) science, except mathematics, does not hold a very prominent position. The medical establishment, to the care of which the health of about three hundred millions of people is mostly entrusted, is divided into a civil and a military branch with corresponding duties, and contains, I think, more than a thousand qualified medical men, chiefly British, belonging to the I.M.S. and R.A.M.C., with a large subordinate staff of apothecaries, hospital assistants, and so on. The heads of this organisation are medical men, but they do not generally, I think, have seats on the supreme executive councils.

When I entered the I.M.S. it had a great reputation, which it still possesses, and, together with the Army Medical Department, had done fine work. Both these services were on the whole very well organised; but I could not help noticing several anomalies. Many of the Indian diseases are, of course, different from those met with at home. Our knowledge of them was then chiefly in the clinical stage, and very insufficient, both for treatment and prevention; and what we possessed was due, not to any organised official inquiries, but to the efforts of individuals. I remember being struck even then with the absence of organised research. It is true that pathological laboratories existed in the universities (under men burdened with other duties); that Government had specially appointed two commissioners, Lewis and Cunningham, to study this subject; that temporary inquiries had been made on leprosy and on certain local outbreaks; and that there was a good Indian medical journal; but these were obviously insufficient to enlighten us on the multitude of strange and mysterious diseases we were called upon to deal with. Why did not Government carry on much more extensive researches? The time-worn answer always was, because they could not afford it. But, surely, if they could afford such a large and expensive medical establishment, they should also be able to afford those researches which were essential to making that establishment effective. Of what use was the one without the other? An inefficient machine is the most expensive of all. Did they think that we medical men should know all about these diseases by intuition? But no!—content with having appointed a legion of "doctors" to fight disease, they never seemed to consider that it was necessary for those doctors to know how to do it.

But this invariable cry of "no funds" was palpably untrue. Many of the administrative and judicial offices in India were being paid above their market value, and were of little public importance compared with medical research. Huge sums, which would pay for such research for years, were being spent on engineering works of only local value. Even within the medical budget, money was being wasted on certain sinecures and useless administrative posts. Indeed, logically it would have been wise in the Government to sacrifice almost anything in the department in order to obtain the necessary information about disease, for the simple reason that without such information the work of the department was largely useless—the old castor-oil treatment and conservancy-cart sanitation had their limits! But what struck me most was the fact that Government failed to make use of literally hundreds of potential investigators whom it could have set to work for almost nothing. The medical services in India must be always kept on something approaching a war footing—that is to say, with a staff in excess of peace requirements. In other words, there must always be a large number of medical men, generally juniors, who in times of peace have little to do and are employed doing it in the military hospitals. I was one of these for about twelve out of my eighteen years' service, and therefore know the facts about which I write. For most of this time my official duties occupied me for less than, say, two hours a day, and I knew scores of my colleagues who were equally busy—we amused ourselves for the rest of the time. Now why did not, and why does not, the Government make use of all these men for investigation? Young, ardent, vigorous, intelligent, "spoiling" for work they were, and are, of the stuff that is now doing most of the scientific work of the country—precisely the same as those who have been labouring in my department in this university—who have even sacrificed their lives for Athena Hygieia. They had, and have, leisure and opportunities unparalleled. A microscope, a few test-tubes, a word from the chief, a little approbation, some evidence that scientific work leads, if successful, to preferment, and the authorities could have had almost for nothing scores of enthusiastic and, I will expressly add, capable workers for the great cause of medical science. But the pigeon-holed report and the official snub awaited us, and we returned disappointed to our idleness.

It is advisable to emphasise this point, because it illustrates the brainless character of much of the administration. In 1884 (I think) I asked my chief if he would like me to investigate fevers during my abundant leisure; he replied that my duty was not to investigate, but to cure—as if we could do the second without the first! Many men have told me that they have received similar replies, and two brothers of mine quite rightly left the naval medical service because of this attitude in the authorities. A man who discourages enthusiastic juniors from doing gratuitous work in addition to their duties must be a fool of a very advanced type, and it is surprising that such men should ever be able to find their way into administrative posts. In addition to the actual discouragement of voluntary research (which I will discuss further presently), the organisation made no adequate provision to ensure scientific efficiency in the staff. There were no examinations for promotion. Leave and opportunities for study could scarcely be obtained, and even now there are difficulties—see, for instance, *British Medical Journal*, May 11, 1907, p. 1156. That first essential, recent scientific literature, was most difficult of access, and the authorities still seem to have made no adequate attempt to improve matters in this respect. Microscopes and bacteriological apparatus were generally wanting, although they are absolutely necessary in tropical clinical practice for the detection of numerous parasites, and this fault has not even yet been entirely removed, to judge by the report of the Army Medical Department for 1905, p. 224. The heads of the department frequently showed ignorance of recent scientific advances, as was apparent from their antiquated statistical methods and regulations for dealing with epidemics and their general lack of ideas; and, lastly, the annual "Records of Service" of officers, upon which their preferment was supposed to be based, was a hopelessly stupid form which made no attempt to distinguish their real scientific and professional ability—so that, as everyone remarked, appointments, like kissing, went by favour!

About the year 1880 occurred that important epoch in human history when we first learned the nature of the great transmissible diseases which afflict us—when Koch and Laveran threw open the gates of medical bacteriology and protozoology, and special laboratories sprang up everywhere in Europe and America, and even at last in Britain. As may be supposed from the foregoing, India was not in haste to follow, and the authorities, who had done so little for research themselves, did not trouble to utilise the researches of others. In 1883 Koch discovered the cause of cholera, that scourge of India, and the discovery should have been immediately followed by numerous official investigations. But, though the disease destroys about half a million people annually in India alone, little was done in that country, and neither the Government nor the people have, I believe, ever taken the trouble to thank Koch for his work. Ten years later, however, Hankin, of Agra, carried out his admirable researches on the mode of propagation, and enunciated his method of prevention by the treatment of wells. This again should have received close official scrutiny with a view to its general adoption or rejection, but from recent reports it appears to be still *sub judice*—as if it were not worth troubling about; and no one has ever dreamed of acknowledging indebtedness to Hankin. Tyhpoid, perhaps the principal enemy of Europeans in India, has never received adequate official inquiry as regards its modes of propagation in that country, and the discoverer of the prophylactic no longer enjoys State employment.

An amœba which is probably the cause of one form of that important disease, dysentery, was well studied for the Indian Government by Cunningham long ago, but the matter was not followed up. The cause of another form was discovered by Shiga in Japan. Some of the most prevalent and distressing complaints in many parts of India are those caused by *Filaria bancrofti*; but Manson's discovery of the carrying agent, a mosquito, though confirmed in India by Maitland, James, and others, has never, to my knowledge, been followed by sufficient practical action. The spirochaetes of relapsing fever, though finely studied by Vandyke Carter, of Bombay, many years ago, still require a determination of their carrying agent. Sprue, ankylostomiasis, beri-beri, unclassed fevers, guinea-worm, and other parasites received little official attention. The case of malaria is perhaps the most astonishing. It causes about a third of the admissions into hospital, and a mortality, directly and indirectly, possibly of some millions a year in India; while nothing does more to hamper military, engineering, and agricultural undertakings. Its cause was discovered in 1880 by Laveran in Algeria—a discovery which enabled us generally to make an immediate definite diagnosis with the microscope. Excepting Vandyke Carter's confirmation, in 1887, literally nothing of consequence was done on the subject in India for fifteen years, though during that period the Italians and others were piling research on research. Not only did these momentous advances seem to be quite unknown to the authorities, but they were almost entirely neglected in the hospitals, and not even the necessary microscopes were provided—equivalent to a failure to supply surgeons with instruments.

My own researches on this subject, commenced about 1901, gave several illustrations of these curious defects. Literature and apparatus were for the most part unobtainable, except by purchase from England, and advice or instruction on scientific details were equally hard to acquire, though arrangements for these should have been organised long previously. In 1895 a rich native State asked for my services to investigate the malaria which seriously incommoded its population, and offered to pay the expenses; but the presiding Civil Service genius vetoed the suggestion. I was even refused ordinary leave of absence to undertake researches at my own cost, although my services could easily have been spared. In 1897, just at the moment when I had at last succeeded in cultivating the parasites of malaria in gnats, and after I had reported this important fact, to my surprise I was suddenly ordered off for months to a place where malaria was almost absent. I was then, very wisely, placed on special duty to continue my work, but, a year later, after I had worked out the life-history of the parasites in mosquitoes, as I could not obtain definite assurance that my special duty would be prolonged, I left the country. Before doing so I gave advice as to the best method of dealing with malaria (by appropriate drainage), but for years no serious effort was made to act upon the advice. It is, or was, usual to thank officers who had been placed on special duty for their services if successful, but mine, I suppose, were not thought to be sufficiently important for this little *douceur*.

I have mentioned some cases of neglect to recognise work done because they involve an important general principle. A scientific administration, if it cannot afford to pay for research, would at least attempt to encourage voluntary investigations by such inexpensive methods as promotion, good conduct pensions, special thanks, and recommendations for State honours. But I cannot remember a single instance in British administration in which the two former have been given for medical researches, even of the most distinguished character (though it is done in America); while the two latter, if offered at all, are offered on the lowest scale. While soldiers, judges, and governors who have merely performed their ordinary duty are often covered with decorations in consequence, the men whose exceptional work will affect the lives of millions now and in the future are not considered good enough. Even in the medical profession it is generally the practitioner, who is already rewarded by his fees, rather than the pioneer, who is lucky if he is not ruined, who receives most of the public recognition. I may add that there are cases where men have actually suffered for their investigations. Many years ago, King, of Madras, succeeded in preparing a good vaccine from a calf inoculated with variola, but was immediately accused of trying to disseminate small-pox, was deprived of his appointment, and was not reinstated without strong efforts on the part of his friends. More recently, Haffkine, in spite of his immense services, lost his appointment because some cases of tetanus poisoning were attributed to his plague prophylactic; and still remains out of employment, although it has been clearly proved that the disaster was not possibly due to him or to his laboratory. The fact is that the public has little sense of the value of scientific investigations, and absolutely no sense of gratitude towards those who carry them out, usually at the cost of much trouble and expense to themselves.

The obvious retribution for all this childish unwisdom is that the public itself suffers on an enormous scale—millions sicken or die from diseases which a little more investigation and scientific administration would probably bring under comparatively easy control. Perhaps the most dramatic example of this was the terrible outbreak of plague in India in 1896. The people besotted with superstitions, the sanitary organisation insufficiently developed on its scientific side, and the Government knowing nothing of these matters and too weak to exert the necessary discipline, were caught unprepared. Although the disease had been raging for two years previously in Hong Kong, the authorities made no sufficient arrangements to exclude it from India, or to detect and suppress it should it effect an entry. When it came it was allowed to remain undetected for months, and was then met only with vacillating counsels and a painful feebleness of action. Only those who are utterly ignorant of the manner, and the only manner, in which epidemics must be fought against will attempt to justify such a story of ineptitude. The result for India alone has been the loss of more than four millions of lives, and the people are still dying of plague at the rate of seventy-five thousand a week!

In 1897–9 we ascertained definitely that the malarial infection was produced by the bites of mosquitoes, and this discovery immediately disclosed several methods of prevention, such as drainage of the breeding pools of the insects, protection from bites by means of gauze, and so on. Considering that the disease is a most serious, ubiquitous, and continuous pest in most tropical countries, causing an untold amount of inconvenience, expense, sickness and death, we had a right to expect that the new knowledge would be immediately acted upon everywhere for the protection of the public, as all Governments possess sanitary officials and funds specially appointed and allotted for such work. I have been watching the progress of events ever since with mingled feelings of amusement and dismay. What a tragi-comedy could be written on the subject! There were the officials, there were the funds, there was the knowledge; but to persuade the first to apply the second for the purposes of the third was often an impossibility. They said they had no funds, that they did not accept the proofs, that there was no malaria in their district, that there were no mosquitoes—any and every excuse. The simple truth was that they did not like the trouble. Years passed, but little or nothing was done. The officials remained in undisturbed possession of their leisure. We wrote, lectured, demonstrated, undertook expeditions, sent up deputations, interviewed ministers; but even now, after nearly ten years, but little has been accomplished compared with what might have been done from the first had our Governments possessed those essentials of good administration, science, and discipline. One asks why, if the State thinks it worth while to employ sanitary departments at all, it does not see that they do the work for which they are paid?

Probably a similar state of things prevails in most departments of our administration. Look, for instance, at our large cities with their unspeakable slums filled with pale, dirty, and unhealthy people lounging round the innumerable public houses, or at the crowded mud hovels of the Indian towns—a constant reproach to our systems of municipal management. Then what clearer evidence of the increasing irrationalism, irresolution, and weakness of party government could we have than that given by the successive Vaccination Acts, culminating in the ridiculous "conscientious objection" and "statutory declaration"; or by the appointment of a Royal Commission to consider the utility of experiments on animals—which is like appointing one to consider the truth of the multiplication table? Or, going into another field, we shall find that military men make precisely similar complaints about want of science and discipline in regard to their department, complaints which are certainly causing grave uneasiness among the more thoughtful of our citizens.

To what is all this attributable? In official life it is probably due to the fact that even notorious inefficiency does not always retard advancement, nor even notorious merit accelerate it, with the result that the upper grades are often filled with men of no ideas who have reached their position, not by public services, but by seniority, wire-pulling, or even by the mere inertia of their mediocrity. Going still higher, it is attributable, I think, to our system of party government, because the ministers who should be constantly engaged in a rational State with the organisation and conduct of their departments are, under party government, constantly engaged in that party warfare which, when carried to the present excess, becomes a mere idle game played for the amusement of the mob. Lastly, it is due to our defective public education, which lays too much stress on literary, philological, and dogmatic trifles, and not enough on the hard facts and still harder methods of science, so that the whole nation is tending to become irrational in thought and unpractical in action. We frequently have to look in vain for that wise and strict organisation without which the vast machine of the State cannot perform its proper work. We hear only the jangling of wheels and cranks out of gear, and the cries of the inexpert engineers who think to mend matters by belabouring each other.

Those who have not considered the subject from my point of view will certainly think that there is too much black in this picture, but I could easily cite innumerable more instances, and, personally, have no doubt of my main proposition, that British administration is generally not scientific enough and not strict enough—it does not sufficiently seek knowledge or enforce action. But I do not, of course, deny that it possesses great virtues. It is imperturbable, scrupulous, just, and pure, and, I may add, is rapidly beginning to attach more importance to science. For example, India, which formerly spent, I suppose, less than one-thousandth part of the medical budget on investigation, is now spending perhaps as much as a hundredth part. More laboratories have been equipped, and there have been official investigations on kala-azar, malaria, Malta fever, plague, typhoid, and other diseases, and on veterinary subjects; the Government has long set an example to other countries in the sale of cheap quinine in malarious areas, and something like a third of many municipal budgets is spent on sanitation, mostly water supply, conservancy, and drainage. Outside India we have recently seen very fine official researches on Malta fever and sleeping-sickness, so that matters are improving. But in my own humble opinion even this is not enough, and I think that the expenditure on research should reach 5 per cent. of that on all medical and sanitary work. Numbers of subjects, such, for example, as measles and scarlet fever in this country, remain almost untouched, greatly to the disadvantage of the public, and in a hundred directions we find action crippled by want of knowledge, and, therefore, correspondingly expensive and inefficient.

But the whole subject of science and the State possesses a most important, and indeed ominous, political significance. The invention of locomotives, by reducing the time required in travelling to about one-third or less, has, so to speak, diminished the world's diameter in the same proportion, and, by bringing the nations more closely face to face, has greatly increased the acuteness of international competition. In this competition scientific organisation becomes more and more vital to success, and in the wars of the last decade we have actually witnessed the complete collapse of two unscientific peoples before their more intelligent adversaries. Now no one will deny that the British stand in the front rank of scientific nations, but it is equally evident that this eminence is due entirely to private individuals, and not at all to the Government, that is, to the party politicians. For years they have allotted only about one three-thousandth part of the national income for scientific work, that is, for obtaining knowledge, equivalent to the annual expenditure for that purpose of six shillings and eightpence by a person possessing a thousand pounds a year; and it may be suggested that the amount of scientific intelligence and knowledge shown in our party political administration should be calculated at about the same rate. Nor can it be contended that the people at large show a much greater interest in science, a much greater knowledge of scientific facts, or a much greater proficiency in scientific habits of thought. Quite recently the Boer war gave us an explicit warning of what such nescience is likely to lead to, and we can only hope that the nation will have the sense to reform its methods in consequence before it is too late. For a full discussion of the subject, however, I must refer the reader to a recent book called "The Problem of National Defence," by my brother, Major Charles Ross, D.S.O. (Hutchinson and Co.), in which he examines from a military standpoint the same defects as I have alluded to above in connection with medical matters. The two cases are really parts of the same problem—how are we to be governed in the future by science rather than by nescience? But whether a nation so wedded to old habits will be able to change in time to save itself is another question which it is impossible to touch upon here.

I fear that some of these remarks will appear to many to be too severe, or perhaps too personal; but I can only state my own opinions, however small their value; and have attempted to do so as frankly as possible, because otherwise there is little use in writing on the subject at all. I should like to add, in conclusion, that my object is not to find fault, but to suggest lines of improvement for the future; and, unfortunately, the one cannot be attemoted without the other.

RONALD ROSS.

INCANDESCENT ELECTRIC LAMPS.[1]

THE closing months of 1906 and the opening months of 1907 are likely to be long remembered by electrical engineers as a period of a remarkable recrudescence of interest in the subject of incandescent electric lamps. For many years the familiar carbon filament lamp has been the only commercial incandescent electric lamp, in spite of its threatened extinction by the invention of the Nernst lamp in 1897–1898. The feeling of uncertainty caused by this discovery was short-lived; after a wealth of prophecy on its probable effect on the industry it was soon found out that months, even years, of experiment were necessary to perfect the Nernst lamps commercially, and the drastic changes recommended to supply engineers were postponed for a time in consequence. Finally, the lamp, capable though it proved of taking a definite place in the art of electric lighting, was found to be hardly even a serious competitor of the carbon filament lamp.

In spite, therefore, of the predictions of 1898, the electrical world settled down with the conviction that the threatened revolution was not destined to be achieved. But in the meantime inventors were busy—foreign inventors that is to say, the English manufacturers being always too busy to invent—and from time to time rumours were heard of other approaching revolutions. Rendered callous, possibly, by the history of the Nernst lamp, little attention was paid to these warnings until the introduction of first the osmium lamp of Dr. Welsbach and then the tantalum lamp of Messrs. Siemens proved the truth of the old saying connecting smoke with fire. Finally came the practical realisation of the tungsten lamp almost simultaneously by Kuzel, Just and Hannaman, and Welsbach, and this for some unknown psychological reason seems to have suddenly awakened English engineers. Once awake they atoned for their long slumber by a copious use of ink, and the technical Press of the period referred to at the beginning of this article simply teems with matter relating to the new lamp developments.

All that is valuable in these articles will be found conveniently crystallised in the papers and discussions in the Journal of the Institution of Electrical Engineers. A paper by Mr. Swinburne on the new lamps opens the latest volume; it is followed by one on light standards and the present condition of high-voltage carbon filament lamps, by Mr. C. Paterson, and the series is rounded off by a paper on carbon filament, Nernst and tantalum lamps, by Messrs. Haworth, Matthewman, and Ogley. Combining these papers with M. Rodet's excellent little book on incandescent electric lamps, the reader can obtain a very fair idea of the present position of this subject.

So far as the carbon filament lamp is concerned, the position is far from satisfactory, as the study of Mr. Paterson's paper shows. It may justly be argued that the test results shown by the author are hardly numerous enough to justify the title. Six lamps each from ten British makers is a small number on which to base a condemnation of British methods, and a lamp-maker who manufactures four or five million lamps a year may rightly complain on being judged by the performance of a chance six. But making all allowance, it must be admitted that there is still much to be desired; nor does it seem probable that a much nearer approach to perfection is likely to be attained without cooperation between manufacturers and supply engineers. To make a lamp for a given voltage to have a definite candle-power and take a definite cur-

[1] "Les Lampes à Incandescence électriques." By J. Rodet. Pp. xi + 200. (Paris: Gauthier-Villars, 1907.) Price 6 francs.
"Journal of the Institution of Electrical Engineers." Vol. xxxviii. No. 182. Pp. 211–371. London: E. and F. N. Spon, Ltd., 1907.) Price 5s.

rent involves the solution during a difficult manufacture of two simultaneous equations, and the percentage of lamps correctly solving them is small. It is the unavoidable outfalls which play such havoc with his balance-sheet, so that it is small wonder if the lamp-maker is tempted to be a trifle lax in his rating. If cooperation existed and station engineers would see the sweet reasonableness of adjusting their supply voltages in different districts or different towns, so as to afford a market for all the lamps a manufacturer produces, it would be possible for him to turn out a better article at a lower price with undeniable advantage to the industry generally.

The information concerning the new lamps is much more meagre and conjectural. It would seem that the osmium lamp is already moribund or dead, and that we have only to reckon with the tantalum and tungsten filament lamps, the former taking 2 to 2·5 watts and the latter 1 to 1·2 watts per candle. The tungsten lamp appears to have a brilliant future before it. A lamp working at a little more than 1 watt per candle brings electric lighting almost to the level of gas for cheapness. The light units, though at present large (30 candles and upwards), are no larger than the gas mantle units, and so it may reasonably be supposed that the public will not object to them, though they undoubtedly do away with one of the benefits of electric light. The chief drawback in England is the low voltage, the lamps being at present only suitable for voltages of about 100. It is conceivable, should lamp-makers fail in producing a high-voltage tungsten filament lamp, that engineers will change back to low voltage, in spite of the eagerness with which they struggled to enforce the change to high voltage a few years ago. The competition of gas is excessively severe, and in some way must be met; at present the tungsten lamp offers the only means of meeting it in interior lighting.

The next few years promise to be of exceptional interest so far as the development of electric lighting is concerned; a radical improvement has long been wanting, and there seems every reason to believe that it has at last been made. The present condition of affairs is full of possibilities, and no one can say what the position will be a few years hence. Perhaps to his interesting account of the birth of the carbon filament lamp M. Rodet may be able to add in his next edition the melancholy tale of its death.

MAURICE SOLOMON.

DR. MAXWELL T. MASTERS, F.R.S.

THE botanical and horticultural world has sustained a severe loss by the death on May 30 of Dr. Maxwell T. Masters, the well-known editor of the *Gardener's Chronicle*, and the author of many botanical works.

Dr. Masters was born in 1833, and was educated at King's College, subsequently removing to Oxford, where he became sub-curator of the Fielding Herbarium under Dr. Daubeny. He was botanical lecturer at St. George's Hospital from 1855 to 1868, and was elected to the fellowship of the Royal Society in 1870. He was a corresponding member of the Institute of France, and was also an officer of the Order of Leopold. He achieved distinction in his earlier days by the publication of his "Vegetable Teratology," a most valuable work, which has been translated into several European languages. But his most definite contributions to botany in later years were those dealing with the Coniferæ, a difficult group which had long interested him, and in which he displayed a remarkable and detailed knowledge. He contributed many papers on the structure and taxonomy of the species to the publications of the Linnean and Horticultural Societies.

But it is especially in matters appertaining to horticulture that he will be best known to most people. His position as editor of the *Gardener's Chronicle* gave him considerable influence, and he always used his best efforts with single-hearted devotion to promote the welfare of horticulture and to look after the interests of those who were engaged in gardening as the practical business of their lives.

He always took the keenest interest in the Royal Horticultural Society, and for many years presided over the Scientific Committee.

He will be sorely missed by a large circle of friends, as well as by many others in the gardening world, to whom his name has become almost a household word.

NOTES.

AT the meeting of the council of the British Association on Friday last, June 7, Mr. Francis Darwin, F.R.S., was unanimously nominated to the office of president for the year 1908–9.

WE have to deplore the deaths at Cambridge, on Friday last, June 7, of Prof. Alfred Newton, F.R.S., professor of zoology and comparative anatomy in the University, and Dr. E. J. Routh F.R.S.

THE ladies' soiree of the Royal Society will be held at Burlington House on Wednesday next, June 19.

SIR WILLIAM PERKIN, F.R.S., has been elected president of the Faraday Society for the session 1907–8.

TWELVE tablets were unveiled in the Hall of Fame of New York University on Memorial Day, May 30, among them being one in memory of Maria Mitchell, the astronomer, and another in memory of Louis Agassiz.

DR. NANSEN, president of the Social and Political Education League, will deliver his presidential address, on "Science and Ethical Ideas," at University College, Gower Street, on June 26. Sir Oliver Lodge will preside.

REUTER reports that a typhoon occurred in the Caroline Islands in the latter part of March and devastated the Olcai group of those islands. A great wave swept the land and buried it under a layer of sand.

WE learn from *Science* that Dr. C. R. Wieland, of the Peabody Museum, Yale University, has left America for a stay of five months in Europe, where he will visit the plant collections of northern and southern Europe for a special study of cycads. The results of his investigations will be published in his second volume on cycads.

A MEETING of the International Council for the Exploration of the Sea is being held in London during the present week. In the absence through illness of the president of the council, Dr. W. Herwig, his place is being taken by the vice-president, Dr. Otto Pettersson, of Stockholm. Among the members of the council and experts now present in London are Dr. P. P. C. Hoek, general secretary, and his assistant, Dr. H. M. Kyle; Dr. Lewald, Prof. Krümmel, Prof. Brandt, Prof. Heincke, Dr. Henking, and Dr. Ehrenbaum, from Germany; Mr. A. Hamman and Prof. Gilson (Belgium); Captain Drechsel, Mr. Martin Knudsen, and Dr. C. G. J. Petersen (Denmark); Dr. Homen and Mr. J. A. Sandman (Finland); Prof. Nansen, Dr. Hjort, and Dr. Helland Hansen (Norway); Prof. Max Weber, Dr. Redeke, and Dr. Wind (Holland); Prof. Otto Pettersson, Dr. F. Trybom, and Mr. G. Ekman (Sweden); Mr. Walter Archer, Prof. D'Arcy Thompson, Dr. Mill, Dr. Garstang, Dr. Masterman, Dr. H. Reid, Mr. E. W. L. Holt, Dr. Wemyss Fulton, Dr. E. J. Allen, and Mr. D. J. Matthews (Great Britain). His Majesty the King will receive the delegates at Buckingham Palace on Friday afternoon. The first formal meeting of the council takes place to-day, June 13, at the Foreign Office, when Sir Edward Grey will open the proceedings. The members of the council are being entertained at dinner during the week by Lord Carrington, the Lord Mayor, the Secretary for Scotland, the Fishmongers' Company, and the Royal Geographical Society, whilst the chairman of the council of the Marine Biological Association will give a luncheon at Christ's College, Cambridge, on June 16. On Monday, June 10, Dr. Pettersson delivered a lecture at the Royal Geographical Society on some features of the hydrographical work done in connection with the international cooperation, and Tuesday and Wednesday were occupied by meetings of various committees of the council.

THE first meeting of the science group of the Franco-British Exhibition, to take place next year, was held on Tuesday. The following were present:—Sir Norman Lockyer, K.C.B., F.R.S., in the chair, Major Baden-Powell, Sir John A. Cockburn, Captain Creak, C.B., F.R.S., Sir David Gill, K.C.B., F.R.S., Colonel Hellard, R.E., Sir Thomas Holdich, Dr. H. R. Mill, Prof. Perry, F.R.S., Mr. F. W. Rudler, Dr. W. N. Shaw, F.R.S., and Dr. T. E. Thorpe, F.R.S. The question of classification was considered under the headings of historical apparatus, instruments of observation, and methods used in exploration of the land, the sea, the air, and the heavens. Special committees were appointed to deal with these subjects.

AT the fifth annual general meeting of the British Academy, held on June 11, Lord Reay presiding, Dr. Henry Bradley, Mr. H. A. L. Fisher, Dr. J. P. Postgate, and Prof. J. Cook Wilson were elected fellows of the academy. The corresponding fellows also elected were:—M. Émile Boutroux (Paris), M. Leopold Delisle (Paris), Prof. B. L. Gildersleeve (Baltimore), Prof. Adolph Harnack (Berlin), Prof. Höffding (Copenhagen), Mr. Justice Holmes (U.S.A.), Prof. William James (Harvard), Prof. Frederick de Martens (St. Petersburg), Prof. Karl Eduard Sachau (Berlin), and Prof. Ulrich von Wilamowitz-Möllendorff (Berlin). In a valedictory address the president, Lord Reay, announced that an anonymous donor had presented to the academy the sum of 10,000*l.*, to endow a fund to be called "The Leopold Schwach Fund" for the furtherance of research in the archæology, art, history, languages, and literature of ancient civilisation, with reference to Biblical study. Lord Reay remarked that this first benefaction was of good augury, for although they might well claim aid from public funds, and maintain that the State should give encouragement to scientific studies promoted by the academy, he would repeat what he said in his first address, viz. that the academy may also stimulate private benefactors, on whose munificence we depend to a large extent in this country for the advancement of scientific knowledge. The British Academy is probably the only academy which is not State endowed, and has not even a domicile, but Lord Reay expressed the conviction that ere long it will be recognised at home as it has been recognised by the sister academies, which have assigned to the British Academy a place of distinction. Sir E. Maunde Thompson was elected president in succession to Lord Reay.

THE adjudicators of the Hanbury medal have decided to award the Hanbury gold medal this year to Mr. David Hooper, curator of the economic and art sections of the Indian Museum at Calcutta. The medal is awarded biennially for high excellence in the prosecution or promotion of original research in the chemistry and natural history of drugs. Mr. Hooper, as recipient of the medal, will also receive the sum of 50*l.*, presented in the name of the late Sir Thomas Hanbury, as an expression of his desire to be associated with the memorial to his brother. He is the author of numerous papers dealing with vegetable materia medica, his latest contribution to scientific literature dealing with the anti-opium plant, and was associated with Brigade-Surgeon Dymock (a former medallist) in the compilation of "Pharmacographia Indica."

IN connection with the celebrations of the bicentenary of Linnæus, described in another part of the present issue, the trustees of the British Museum have had specially printed in honour of the occasion "A Catalogue of the Works of Linnæus (and publications more immediately relating thereto) preserved in the Libraries of the British Museum (Bloomsbury) and the British Museum (Natural History) (South Kensington)." Copies of the catalogue were sent to accompany the addresses presented by Dr. Bather on behalf of the trustees of the British Museum to the Royal University of Uppsala and the Royal Swedish Academy of Sciences at Stockholm. The catalogue was prepared by Mr. B. B. Woodward, the assistant in charge of the general library at the Natural History Museum, with the collaboration of the general catalogue consultative committee as regards the books at South Kensington, and of Mr. W. R. Wilson, of the printed book department, as regards the books at Bloomsbury.

THE annual meeting of the Association for Maintaining the American Women's Table at the Zoological Station at Naples and for Promoting Scientific Research by Women was held on April 20 at Mount Holyoke College. Miss S. E. Doyle, of Providence, was elected president, Mrs. E. L. Clarke treasurer, and Mrs. A. W. Mead secretary. The table of the association at the Zoological Station at Naples has been occupied at different times during the past year by Miss G. Watkinson, Miss F. Peebles, and Miss A. G. Newell. It has been assigned for the spring of 1908 to Miss M. J. Hogue. Nine theses (three of them were sent from foreign countries) were received in competition for the 1000-dollar prize offered for this year. The theses showed wider range of endeavour than those received in the two previous contests, as they dealt with botanical, anatomical, morphological, physiological, and chemical problems. Several were of decided merit, but since, in the opinion of the examiners, no one was of adequate merit to deserve the award, the association decided to exercise its right to withhold the prize. The fourth prize is announced for 1909.

THE Herbert Spencer lecture, on "Probability, the Foundation of Eugenics," delivered at Oxford on June 5 by Mr. Francis Galton, has been published by the Clarendon Press. The author gives a short sketch of the history of eugenics, *i.e.* the "study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally," from his introduction of the word in 1883 to the organisation of the Eugenics Record Office in connection with the University of London. Passing to the application of probability to the theory of eugenics, Mr. Galton gives an interesting outline of a suggested short course of object-lessons in the methods of biometry, the meaning of averages, measures of variability, and so on being explained by reference to actual objects, such as hazel nuts or acorns arrayed like beads on a string. To most people variability implies something indefinite and capricious, and they require to be taught that it can be defined and measured. Mr. Galton then proceeds to point out that human action is guided less by certainty and by probability than by custom, prejudice, or other unreasonable influences; social opinion is the tyrant by the praise or blame of which the principles of eugenics may be expected to influence individual conduct, and public opinion may easily be directed into different channels by opportune pressure. Whenever public opinion is roused it will lead to action, and it is reasonable to expect that it will be strongly exerted in favour of eugenics when a sufficiency of evidence has been collected to make the truths on which it rests plain to all.

A LARGE meeting of people interested in the work and objects of the National League for Physical Education and Improvement was held at Devonshire House on Tuesday. The Duke of Devonshire, in the course of an address to the assembly, described the investigations made by the Physical Deterioration Committee, which collected a great deal of information of the highest importance, and made a number of suggestions of practical importance, especially in the direction of suggesting the steps which should be taken for the purpose of obtaining more accurate information as to the physical condition of the large masses of the people than are at present available. These steps are the indispensable preliminary to any effective action, either by Parliament, or by local authorities, or by the public, towards finding the remedy. One or two of the committee's recommendations relating to the medical inspection of schools and other educational subjects found a place in the Education Bill of last Session, and it is hoped that they will again find a place in an uncontroversial Bill which may be introduced in the course of the present Session. One of the objects of the league is to stimulate that public interest in the matter which seems to have been lacking, and a further object is to assist in organising local effort where it already exists, and where some beginning has been made in the direction of improvement. The meeting was also addressed by Lord Balfour, Prof. Howard Marsh, Sir Gilbert Parker, M.P., and the Bishop of Ripon.

ACCORDING to the *Daily Chronicle*, Giant's Quoit, Veryan, which figures prominently in the legendary and historical records of Cornwall, was reported on June 6, at the meeting of Truro Rural District Council, to have been destroyed by blasting and used for road metalling. The Quoit was delicately poised on a cairn, or beacon of hard rock, and with Giant's Cradle close by was of great archæological interest. A few years ago an effort was made to persuade the Government to appoint an inspector with expert knowledge whose duty it would have been to compile a record of remains of archæological interest and to take steps for their preservation. The frequency of acts of vandalism, such as that in Cornwall last week, shows the need for the appointment of an inspector with archæological knowledge to supervise these national memorials and educate local authorities as to their value.

AN excellent example of the mirage was observed on May 25 seaward of Llanelly, Carmarthenshire, by Mr. John Innes about 3, 4, and 5 p.m. The tide was about full, the day hot, and an inverted image of the land hung in the clouds.

AN auroral display was seen at Pontyates, Carmarthenshire, from 10 p.m. to 11 p.m. on June 6 by the Rev. T. Thomas. He states that the effect on houses and hedges was very weird, and closely resembled the dawn of day; there were no streamers. The phenomenon was also noted at Llanishen, near Cardiff.

THE Brighton and Hove Natural History and Philosophical Society has for fifty years had Alderman C. Clark as its honorary secretary. So long a service in a position of this kind, involving much work and expenditure of time, is very remarkable. In recognition of the active part Alderman Clark has taken in bringing the society to its present prosperous condition, a massive silver salver and an illuminated album containing the names of many past and present members was presented to him at the fifty-third annual general meeting on June 6.

THE statement as to the black tern breeding in Norfolk made in our issue of May 30 is, unfortunately, based on a mistake. It is the black-headed gull—a species still breeding in many parts of the British Isles—that has returned to its old nesting-haunts at Wells.

THE *Museums Journal* for May records the foundation at the Norwich Castle Museum of a section devoted to the study of economic biology, having for its title the Norwich Museum Association. It is desired to make this excellent museum the centre of the scientific life of the county, and to utilise its collections as a basis of instruction in subjects of importance to agriculturists, horticulturists, teachers, students, &c. A few models of insects injurious to agriculturists and horticulturists have already been installed in the central hall of the castle.

As year by year the account of the sugar-cane experiments conducted under the superintendence of Dr. F. Watts in the Leeward Islands is published, it is interesting to observe which of the seedling canes maintain their reputation, and to note the new seedlings that come into prominence. The season 1905–6 referred to in the recent publication issued by the Imperial Department of Agriculture for the West Indies was, like the previous one, characterised by drought, so that the failure in certain cases is attributed to this cause. A strong yellow cane introduced from British Guiana, known as D 625, gave the highest output, probably owing to the dry conditions surpassing such well-known varieties as B 208 and B 156.

A SERIES of analyses of the principal Indian oil seeds made by Dr. J. W. Leather form vol. i., No. 2, of the chemical series of Memoirs of the Department of Agriculture in India. The results, showing an average oil-content varying from 27 per cent. in safflower to 63 per cent. in castor seed, are of primary value to the grower and crusher. The author raises the question as to the deterioration of seed when transferred from one locality to another; thus linseed obtained from various parts of India and grown at Lyallpur in the Punjab gave a reduced proportion of oil. Other reasons may, of course, be advanced for such a reduction, but this explanation is based on the assumption that the yield becomes larger when the plants are acclimatised.

A NEW publication has been launched by the publisher of the *Rivista Geografica Italiana* as a supplement to that journal under the title of *Memorie Geografiche*. The intention is to supply a medium for the publication of monographs or original communications on the subjects of physical geography or terrestrial morphology. Italian geography will receive the preference, but contributions relative to foreign countries will be included. Each number will contain a complete memoir, and a special feature will be made of supplying illustrations and maps. The first number contains a study of the limits of altitude on the slopes of the Comelico Range, by Prof. O. Marinelli. The limits are reckoned for the snow-line, glaciers, shrubs, trees, pastures, barns, &c.

In the report for 1905–6 of the department of botanical research connected with the desert botanical laboratory at Tucson, Arizona, the director, Dr. D. T. MacDougal, refers to a number of problems that are being investigated by the resident staff or with the cooperation of other botanists. In order to test the influence of altitude and climatic factors upon vegetation, small plantations are being laid out at different localities in Arizona and north and south California, where the same plants will be grown and the various modifications noted. Water storage in plants is being studied from several aspects, and some results are already noted. Storage organs are found most abundantly in regions where a scanty rainfall is confined to a short period and during the remainder of the year the precipitation is very slight. A curious storage organ at the base of the cucurbitaceous plant *Ibervillea sonorae* was examined by Dr. MacDougal. Changes in the shape and volume of the "saguara" *Cereus giganteus* were found by Mr. E. S. Spalding to depend mainly on water-content, but partially on temperature and illumination. The development of storage organs on the roots of seedling Opuntias was discovered by Dr. W. A. Cannon.

Two papers by Mr. R. N. Hall, on the prehistoric gold mines of Rhodesia, have been reprinted from the *African Monthly*, and issued by the African Book Company, Grahamstown. In this pamphlet, of forty-five pages, Mr. Hall collects a series of statements to prove that the main working of the Rhodesian gold mines was not due to the Portuguese during the sixteenth to eighteenth centuries, nor to the Arabs and Persians between the tenth and sixteenth centuries. He therefore holds that the mines must have been worked earlier than the tenth century. He maintains that the fragments of Nankin china found in the ruins do not prove that the Zimbabwe was erected in mediæval times, as the specimens were not found under the walls of the temple, and were buried during a subsequent occupation. He emphatically re-states the conclusion that the old mining and ruined temples of Rhodesia date from ancient times, and were due to Semitic immigrants.

The enormous rainfall of 9¼ inches in about half an hour during a thunderstorm at Guinea, Caroline County, Va., on August 24, 1906, is reported in the *Monthly Weather Review* of September last. Mr. E. A. Evans, section director of the Weather Service at Richmond, states that, being much interested in establishing the facts relating to this cloud-burst, he visited Guinea and obtained the following information. There were three "measurements" made in buckets of various dimensions, all in open positions, but the term "measurements" applies only indirectly, as there were no actual measurements taken at the time; the buckets, however, were said to have been full and overflowing. As the storm approached, the lightning became severe, and at the meeting of two clouds, one moving from west and the other from north-east, the rain "poured down in solid sheets." The storm came from the west, and moved almost due northward; the wind was light, and no rain of consequence fell 1½ miles east of Guinea.

Weather in war time was the subject selected by Mr. R. Bentley as his presidential address to Royal Meteorological Society on January 16. To find a new theme after fifty-six previous addresses is of itself not easy; Mr. Bentley's task was laborious, but he showed in a most interesting manner how the operations of war, both on land and sea, were influenced by weather in more than 360 cases, dating from the earliest times. We can only quote a few of the memorable instances. Rain appears to have been the leading factor on land; in A.D. 9 the Roman legions under Quintilius Varus perished in the swamps of Lippe, in Westphalia, owing to the impossibility of moving the wagons; 1870 years later the British experienced disaster from the same cause at Isandlwana, at the hands of the Zulus. On August 13, 1870, Marshal Bazaine excused his inactivity from his inability to cross the Moselle rapidly owing to the flooding of the river after heavy rain. Snow has also played a great part; the author refers to the passage of the Alps by Hannibal, and to the retreat of the French Army from Russia in 1812, among many other instances. Ice has been frequently of assistance; perhaps the most important occasion was the invasion of Denmark in 1658, when Charles X. marched his entire army over the frozen Baltic to besiege Copenhagen. The first exemplification of the result of fog was at the battle of Barnet, on April 14, 1471, when each side outflanked the other without being aware of it; it was owing to fog that Gustavus Adolphus lost his life at Lutzen in 1632. The effect of wind at sea may be exemplified by the buffeting of the various Spanish armadas between 1588 and 1719. In November, 1854, the allied fleets were seriously damaged by the Black Sea storm. This event was one of the principal causes that led to the establishment of storm signals in this country, as a study of the storm showed that if the present system of weather telegraphy had then existed, timely notice of its approach might have been given.

We have received copies of the *plan de voyage* and programme of scientific work of the proposed second Belgian Antarctic Expedition, drawn up by M. Henryk Arctowski. It is proposed to reach the edge of the ice-pack early in the season in about long. 100° W., and to spend some months in making hydrographic and magnetic observations. At a suitable opportunity efforts will be concentrated on making a way through the pack to the Antarctic coast, trusting to the prevailing easterly winds to bring the expedition to the neighbourhood of King Edward VII. Land, where the vessel may be able to put itself *à quai* on the edge of the ice-barrier and to go into winter quarters. Efforts will be made during the following spring to penetrate southward across the ice by means of automobiles. It is intended that the expedition shall be fitted out for three summers and two winters. The scientific programme was discussed at a meeting of men of science held at Brussels on May 4, and on May 12 an enthusiastic meeting was held at Antwerp under the presidency of M. Beernaert, Minister of State, to discuss ways and means.

The Home Office has issued the first part of the general report on mines and quarries for 1906 (Cd. 3478, price 7*d*.). The report contains statistics of the persons employed, output, and accidents at mines and quarries in the United Kingdom. The total number of persons employed was 912,576. The total output of coal was 251,067,628 tons, which is an increase of 14,938,692 tons on that of 1905. The death-rate from accidents per 1000 persons employed was 1·29 at collieries, 1·19 at metalliferous mines, and 1·06 at quarries, the corresponding rates for 1905 being 1·35, 1·45, and 1·04 respectively.

In the *Annals of Mathematics* for April Prof. G. A. Miller contributes a note on the use of group theory in elementary trigonometry. It deals with the various groups of angles the sum or difference of which is a multiple of

15°, 30°, 45°, and its interest would appear to lie, not so much in the use of groups for teaching trigonometry, but rather in the possibilities of using trigonometry for illustrating the elementary study of groups.

IN a paper on the chemical actions of light, M. P. Villard describes in the *Journal de Physique* (vi., May) certain continuation phenomena. An interesting experiment is illustrated showing the effect of green light on photographic papers containing tartaric acid. A sheet of such paper was under-exposed under a stereoscopic negative; one part was then submitted to green and another to violet light. On the green part an excellent image developed, while the violet rays completely fogged the other part. The use of green glass in intensifying prints thus finds a ready explanation.

IN the Journal of the Asiatic Society of Bengal (1907, vol. iii., No. 2) Prof. P. C. Rây describes the preparation of a silver mercuroso-mercuric nitrate by the action of a solution of mercurous nitrite on silver nitrite. The compound formed has the composition $Hg''(Hg',Ag)_2(NO_3)_2$, and is of interest as showing that univalent mercury has the power isomorphously to replace silver. In an article on the "Pursuit of Chemistry in Ancient India," published in the *Modern Review* of Allahabad, Prof. Rây shows, by reference to old Sanskrit writings, the antiquity of the knowledge of chemistry in this country, particularly as regards metallurgical processes and the preparation of medicaments. The existence of an enormous wrought-iron pillar at Katub, near Delhi, which dates back to about A.D. 400, and is larger than any forged in Europe until quite recently, is a striking illustration of the high state of development of the arts in ancient India prior to their decay caused by the introduction of a new caste system under the later religious teachers.

THE uncertainty which still exists regarding the latent heat of fusion of ice forms the subject of a paper by Mr. L. F. Guttmann in No. 4 of the *Journal of Physical Chemistry*. The values obtained by Regnault (79·2) and by Bunsen (80·0) for this fundamental constant differ by more than 1 per cent., and it is contended that Bunsen's result is vitiated by the fact that the value obtained for the density of solid ice at 0° is very variable and uncertain, depending, apparently, on the age of the ice. The value 75·59, re-calculated from Regnault's determinations by introducing certain corrections for the specific heat of ice and water, is considered to represent most accurately the true value for the latent heat of fusion of ice. It would appear, however, that Mr. Guttmann, while referring to the recent work of M. Leduc on the same subject published in the *Comptes rendus* (1906, vol. cxlii., p. 46), has overlooked the more detailed account given by the same author of his investigations in the *Journal de Physique* (see NATURE, vol. lxxiv., p. 41). The difficulties raised by Mr. Guttmann were there dealt with, and, after introducing all necessary corrections, a value of 79·2 was deduced for the latent heat as being in harmony, not only with Regnault's determinations, but also with the corrected values calculated from Bunsen's data.

MESSRS. C. E. MÜLLER, ORME AND CO. have sent us their flow extraction cup apparatus. This apparatus is an improved form of the Soxhlet extractor. Two forms of cup are used; in one case the cup has a siphon, so that the substance which is being extracted is kept covered by the solvent, and a continuous flow of the pure hot solvent is kept running directly through the substance. The other cup, which has a perforated bottom, is placed in an outer cup, which is so arranged that the inner cup stands about 1 cm. above it. By this means the cup is kept continuously surrounded by the hot solvent. We have tested this apparatus, and find the extraction to be both rapid and efficient. The cups are of glass, and are therefore very convenient for weighing the substance both before and after extraction. There is also an arrangement for distilling off the solvent after the extraction is completed.

THE 1907 issue of "The Statesman's Year-book" provides, in the convenient form one has learnt to expect in this invaluable annual, the latest available statistics concerning the States of the world. In some cases the information comes up to within a few weeks of publication. One of the most important of the new features of the volume is the section, which has been entirely re-written, relating to the armies of the various States. Diagrams and tables are included exhibiting the comparative growth of the leading navies in the past with a forecast of the future. Maps are also given showing the Anglo-French Nigerian boundary, the Turko-Egyptian boundary (1906), the new boundary of Aden protectorate, and the increase in value of land and property in Great Britain. This is the forty-fourth publication of the annual, and Dr. J. Scott Keltie, its editor, is to be congratulated on maintaining its high standard of accuracy and usefulness.

A BIOGRAPHICAL sketch of the life and writings of Linnæus, by D. H. Harms, appeared in the *Naturwissenschaftliche Wochenschrift* of May 19.

OUR ASTRONOMICAL COLUMN.

COMET 1907*c* (GIACOBINI).—Circular No. 97 (June 6) from the Kiel Centralstelle gives a set of elements and an ephemeris for the faint comet discovered by M. Giacobini on June 1. From the ephemeris it is seen that the comet is travelling eastwards through Leo, and will pass about $1\frac{1}{2}$ degrees north of δ Leonis on June 14; its brightness is decreasing slowly.

MARS.—In Bulletin No. 26 of the Lowell Observatory Prof. Lowell gives the results of the observations of the south polar cap of Mars made during the favourable presentation of 1905.

Owing to the adverse tip of the planet's axis and the distance of Mars from the earth at the suitable season of the Martian year, the mapping of the southern cap has not previously been attempted. The present communication gives the latitudes of the edge of the snow in successive longitudes as determined from some two hundred drawings. The extent of the snow cap as seen during the presentations from May 10 to August 14 is shown on three diagrams.

The observations indicate that during the beginning of the opposition cloud or mist enveloped the cap, for not until May 15 was the edge of the cap continuously recognised, although snow was seen, in latitude 31°·8 S., on January 25.

In a telegram, published in Circular No. 97 from the Kiel Centralstelle, Prof. Lowell announces that Mr. Lampland has photographed the Martian canals Thoth and Astaboras.

A THIRD ASTEROID NEAR JUPITER'S ORBIT.—From a determination of the orbital elements of the minor planet 1906 VY, Herrn Vladimir Heinrich finds that in this object we have a third member of the Jupiter group of asteroids. According to the elements yet determined, the length of the semi-major axis of the orbit is about 5·19 astronomical units (*Astronomische Nachrichten*, No. 4181, p. 88, June 1).

RADIAL VELOCITIES OF ε AND ζ CYGNI.—Observations made at Bonn during 1904–5–6 indicate that the period of the radial velocity of ε Cygni is possibly shorter than that exhibited by the Lick observations of this star. Prof. Küstner finds a variation, of the radial velocity in regard to the sun, ranging from −6·1 km. (September 23, 1906) to −15·3 km. (October 29, 1904).

The velocities determined for ζ Cygni vary only from +14·3 km. to 15·7 km. (*Astronomische Nachrichten*, No. 4181, p. 87).

MINOR PLANETS DISCOVERED DURING 1906.—In No. 21 (p. 261, May 23) of the *Naturwissenschaftliche Rundschau* Prof. Berberich discusses the minor planets discovered during 1906. In all, the discovery of 126 of these objects was announced, but of these thirteen were undoubtedly objects which had been seen before, whilst sixty-nine await further observation. The orbits of twenty are now known to be elliptical, whilst twenty-one others are probably so; in three cases a circular orbit fits the observational results better. Prof. Berberich gives a comparison between the orbital elements now determined and those previously calculated for the asteroids shown to be identical with bodies discovered earlier. The magnitudes, designations, and details of discovery are also given for those probably having elliptical paths.

THE SPECTRUM OF SATURN.—The results of a photographic study of the spectrum of Saturn, made by Mr. V. M. Slipher during the autumn of 1905, appear in Bulletin No. 27 of the Lowell Observatory. The spectra were taken on plates especially sensitised to the orange-red, and extend to λ 6563. The comparison spectrum, photographed on either side of the planet's spectrum, was that of the moon at about the same altitude, so that differential effects of the earth's atmospheric absorption were eliminated. The following absorption bands appear in the Saturnian spectrum, their relative strengths being in the order given :—λλ 6193, 5430, 6145, 645, 577.

The first named is a very strong band, broad and symmetrical, and traceable down to the band at λ 6145. None of these bands is to be found in the spectra of the rings, although a much weaker absorption than that producing λ 6193 should be indicated if it existed. This points to the conclusion that if the rings possess any atmosphere at all it is much rarer than that surrounding the ball of the planet. No trace of absorption due to the presence of aqueous vapour is shown on the spectrograms.

Mr. Slipher also gives an interesting comparative table of the spectra of the four outer planets, Saturn, Jupiter, Uranus, and Neptune, which indicates that the planets which are similar telescopically have similar spectra. The excellent plate accompanying the paper shows reproductions of the spectra of these four planets taken with various comparisons.

OXFORD UNIVERSITY OBSERVATORY.—The thirty-second annual report of the Savilian professor of astronomy, dealing with the period May 1, 1906, to April 30, 1907, contains but little which is of general interest.

The proof-reading and printing of the astrographic results for the Oxford zone have occupied the time of the staff fully during the past year, and will, with the necessary re-measurement and checking, continue to do so for some few years; consequently, no other serious piece of work can be undertaken. Vols. i. (zone +31°) and ii. (zone +30°), and the greater part of vol. iii. (zone +29°), are now printed, the two former being also bound.

CELEBRATION OF THE BICENTENARY OF LINNÆUS.

THE Linné Fest[1] which has just come to an end was a complete success in every way. The meeting was admirably managed, and the delegates were treated with the most generous hospitality. At Upsala[2] they were especially indebted to the Rector of the University (Dr. Schück) and to Mr. Aksel Andersson, of the University library. The last-named gentleman was tireless in his efforts to rule his troublesome pack, and, indeed, lost his voice in that service, and became as hoarse as a huntsman after a long day. Many of the delegates arrived on May 22; the remainder reached Upsala by special train on the morning of May 23—the first day of the Fest. At the station they were met by the students of the University, looking uncommonly smart in dress coats and white caps, their fuglemen decorated with huge blue and yellow scarves. They struck us as a very fine set of young men as they marched past with their banners and saluted us. The guests were also honoured by the presence of the women students, who wore white caps like those of the men, which they removed in a masculine manner by way of salute to the assembled delegates. At mid-day was held the great meeting in the Aula of the University, when the delegates presented their addresses, heard the oration of the Rector, and listened to Holmgren's hymn in honour of Linnæus and Liljefoss's music to Snoilsky's poem "The Prince of Flowers."

The delegates of each nation formed a group, and the groups went up in alphabetical order, beginning with America and ending with Österrike (Austria), the modified *o* being the last letter in the Swedish alphabet. Each group had a leader, who made a short speech as he passed the Rector's throne, this office being performed for England by Sir Archibald Geikie with conspicuous success. It was a relief to those delegates who are not quite clear about Latin quantities to find that addresses were merely handed in. After their leader's speech the delegates descended into the body of the hall, filed passed the Crown Prince and other Royal personages with bows of varying degrees of elegance, and so got safely back to their seats.

Among the delegates were the following well-known men of science :—Profs. Farlow, Harvard; Warming, Copenhagen; Elfving, Helsingfors; Prince Roland Bonaparte, Académie des Sciences, Paris; France being also represented by MM. Flahault, Giard, and Mangin; Profs. Moll, Holland; Wille, Christiania; Borodin and Palladin, St. Petersburg; Casimir de Candolle, Geneva; Engler, Berlin; Goebel, Munich; Haeckel, Jena; Pax, Breslau; Peter, Göttingen; Pfeffer, Leipzig; Wiesner, Vienna. Halle had the distinction of being represented by a mathematician, Prof. Wangerin, who came as the president of the Leopold. Car. Academy. The delegates from "Storbritanien och Irland" were :—Sir A. Geikie, Royal Society; Dr. Bather, British Museum and Zoological Society; Mr. Carruthers, Linnean Society; Mr. F. Darwin, Cambridge and the Royal Society; Mr. Daydon Jackson, who was personally invited; Mr. Morice, Entomological Society; Prof. Poulton, Oxford; Lieut.-Colonel Prain, Kew Gardens; Dr. Rainy, College of Physicians, Edinburgh, and the University; Dr. Church, Edinburgh. The Society of Arts of London was represented by the Swedish professor Sjögren. Great Britain was in the proud position of having more delegates than any other nation. Prof. Bailey Balfour, whose name occurs on the official list, was unfortunately absent.

At the conclusion of the meeting the delegates were presented to the Crown Prince, who afterwards conferred the Order of the Polar Star on some of them, among whom were Mr. Daydon Jackson and Prof. Poulton.

The festivities were not nearly concluded. There was a concert at 4.30 p.m. given in the Botanic Garden by the students, whose remarkably finished singing was much admired.

In the evening the guests were divided between the hospitable tables of the Rector and the Archbishop. At the Rector's party, the toast of the Linnean Society was given by our host, whose generous reference to the Linnean treasures in London was warmly appreciated by the Englishmen present. The evening concluded with a grand reception in the University buildings.

On the following day (May 24) was held a great "promotion" of doctors, which by a revival of ancient custom took place in the cathedral. The building was filled with a great crowd, and the students again gave a picturesque touch by their massed white caps. The proceedings began with the creation of thirty Swedish D.D.'s named by the King and "promoted" by the Archbishop.

Then came Doctors of Law and Medicine, among the latter being Dr. Rainy, of Edinburgh. Prof. Haeckel was in a class by himself as a Jubilee Doctor. Each M.D. was presented with a remarkable headdress, being, in fact, a tall hat covered with pleated black material, and with these they were respectfully crowned by the promoter. A re-

[1] An interesting gathering took place on May 21 at Råshult, the birthplace of Linnæus, where a ceremony was arranged, including a visit to the church in which he was christened. Many delegates attended at the invitation of the Rector of the University of Lund.

[2] Modern spelling reform has converted the name to Uppsala.

markable feature in the ceremony was the firing of a cannon as each candidate was promoted. The delegates were reminded of another Scandinavian land the King of which gave command to "let the kettle to the trumpet speak, the trumpet to the cannoneer without." In Upsala the trumpet and kettle-drum seemed to be replaced by the electric button.

The Doctors in Philosophy were promoted by Dr. Tycho Tullberg, a collateral descendant of Linnæus. The ceremony consisted in placing a gold ring on the finger and a "laurel crown" on the head of each candidate; in the case of the honorary doctors the crown was made of leaves from a bay tree planted by Linnæus. The British doctors were Mr. Carruthers, Mr. F. Darwin, Sir A. Geikie, and Mr. Daydon Jackson. Among the Swedish doctors was the deservedly popular Prince Eugen, who has made for himself a reputation as an admirable landscape painter.

In the evening there was a great banquet in the Aula of the University, and an evening entertainment given by the students.

On Saturday, May 25, the delegates departed for Stockholm, where the Linné Fest was continued by the Royal Swedish Academy under the auspices of Count Mörner, the president. Here again the delegates were met with excellent arrangements and a warm welcome. A solemn meeting of the academy was held at which the delegates presented addresses, speeches were made, and a cantata was sung, of which the words were by G. Retzius, the music by Valentin. To the general satisfaction of all the delegates, and to the especial delight of those from Britain, the Linnean gold medal of the academy was awarded to Sir Joseph Hooker, and handed to Sir Rennell Rodd, the British Ambassador, for transmission to England. A beautiful bronze medal given to each delegate forms a particularly attractive memento of a memorable occasion.

In the evening a great banquet was given, at which the speeches were made by the president of the academy (Count Mörner), the Crown Prince, Prince Roland Bonaparte, and the Prime Minister. Later in the evening the students gave an entertainment at Skansen, the beautiful zoological and ethnological garden of Stockholm.

One of the most striking features of the Fest was the interest shown in it by the Royal House. The Crown Prince and Princess and other members of the Royal Family were present at the meetings and banquets both at Upsala and Stockholm. The Crown Prince mingled with the guests with a kindness that was much appreciated by the delegates, and the same may be recorded of the other members of the Royal House. A garden-party given by the Crown Prince on Sunday was somewhat marred by the break-up of the fine weather which had added so much to the effect of the Upsala gathering.

Finally must be mentioned the generosity of the authorities of Upsala and Stockholm in presenting the delegates with a valuable reproduction of the portraits of Linnæus and a reprint of his works, including a facsimile of the first edition of the "Systema Naturæ."

Celebration at the Linnean Society.

The reception held by the Linnean Society of London on Friday, June 7, as part of its celebration of the bicentenary of Linnæus, was attended by nearly three hundred guests, many of whom were ladies. The Swedish Minister, some of the Swedish Legation, and several other Swedes were amongst those present. The president of the society, Prof. Herdman, F.R.S., and Mrs. Herdman, received the guests in the library, and prominent among the exhibits were many interesting personal relics of the great naturalist—selections from his herbarium, cases of Lepidoptera, Coleoptera, fishes, and shells, including the celebrated artificial pearls produced by the native fresh-water mussel.

The beautiful medallion by Inlander, which was copied by Josiah Wedgwood, occupied a conspicuous position, and was surrounded by a laurel wreath from the recent festival held at Upsala on May 23 and 24, which was lent by one of the British representatives who received an honorary degree there. A large series of medals which had been struck at various times in honour of Linnæus also were set out in the same case; they included Count Tessin's medals of 1740 and 1758, Ljungberger's large medal, struck by command of Gustaf III. in 1778 on the death of Linnæus, and many of a later date. Recent medals were also shown, such as the Linnean medal of the society, a special copy of which had been presented to the Royal University of Upsala last month, and, latest of all, a bronze copy of the bicentenary medal, struck for the Royal Swedish Academy of Sciences, and awarded on May 25 to Sir Joseph Hooker, G.C.S.I., F.R.S. Two cases contained the correspondence between Linnæus and our own countryman, John Ellis, F.R.S., the letters on both sides being shown; manuscripts of great interest, copies of books interleaved and copiously annotated by Linnæus, his Lapland diary, and his note-book for the eventful year which witnessed his departure from Sweden to take his medical degree at Harderwijk, and the issue of his "Systema Naturæ" in 1735. The foregoing were shown by the Linnean Society, in whose possession they have been since the death of Sir J. E. Smith, the first president, in 1828.

Dr. Tempest Anderson displayed photographs showing the growth of vegetation in St. Vincent since the volcanic eruption in 1902; Prof. Dendy, preparations from his New Zealand specimens; Mr. A. D. Darbishire, Mendelian phenomena; Miss Benson and Prof. F. W. Oliver, the spermatozoid bodies in the fossil seeds of Lagenostoma and Physostoma; Prof. Farmer, apogamic growths from fern-prothallia; and the president, specimens of pearl oysters and plankton gatherings taken during the present spring. Animated photographs of plant-life were shown by Mrs. D. H. Scott, and many other objects of great interest were on view in the library and the galleries.

During the evening a series of short lectures was given in the meeting room by the following:—Prof. Poulton, Prof. Herdman (who prefaced his remarks by a short discourse on the present Linnean celebration), Lieut.-Colonel Prain, and Mr. F. J. Lewis. The rooms were not deserted until nearly midnight.

THE ROYAL OBSERVATORY, GREENWICH.

THE report of the Astronomer Royal to the Board of Visitors, on the work done at the Royal Observatory during the period May 11, 1906, to May 10, 1907, was presented on Saturday, June 8, when the annual visitation took place. A brief summary of this report is given below.

In addition to the routine observations, the transit-circle was employed on a number of stars, of the ninth magnitude and brighter, which may be used as reference stars for the Oxford astrographic zones; 7704 transits were taken during the year.

The second nine-year catalogue (epoch 1900) will probably be ready for press before the end of the current year, and will be divided into two parts, (1) fundamental and zodiacal stars, (2) astrographic reference stars.

The reflecting prism for illuminating the field of the altazimuth has been replaced by a smoothly ground reflector of opal glass, cemented on to the object-glass, and this gives a much more uniform illumination. The observations of the moon and of the lunar crater Mösting A were continued, and, discussed with the similar observations carried out at the Cape Observatory, should give an improved value for the lunar parallax.

The new working list for the 28-inch refractor primarily includes double stars discovered by Hough, and during the year 400 pairs were observed, fifty-eight of them having a separation of less than $0''.5$. The equatorial and polar diameters of Jupiter were measured by the methods described in the previous report, these measures being intended to supplement those made during the opposition of 1895–6. The diameters of the satellites were also measured on two nights with the filar micrometer.

When the 30-inch mirror on the Thompson equatorial was taken out for re-silvering, in November, 1906, it was found to be slightly loose in its cell, so, before re-mounting, twelve wedges of *lignum vitae* were inserted symmetrically round the mirror, and appear to have eliminated the slight movement.

Fifty-five photographs of the sixth, and eleven photographs of the seventh, satellite of Jupiter were secured with the 30-inch reflector, together with 170 photographs of minor planets and comets and twelve of various nebulæ. Of the latter, that of M 31 (Andromeda) and one of the Ring Nebula in Lyra are especially good.

The discussion of the photographs of Eros taken during the opposition of 1900–1 was completed, and a value for the solar parallax, in close agreement with the previously accepted value, was deduced.

With the astrographic telescope 188 supplementary photographs were taken, and 133 of them were passed as satisfactory. Positive copies of the plates covering zones 71°–74° are now completed, and of the 461 chart plates necessary to cover the remaining zones, 75° to the pole, seventy-five have to be repeated for the purpose of reproduction. Vol. ii. of the Greenwich Astrographic Catalogue is now complete, except for the introduction, which will contain the constants for the plates, and these have now been computed. For the area included in zone 81° (from 6h. to 24h.) and the zones 82° to the pole, viz. 254·7 square degrees, the 40m. exposure plates show 75,683 star images, or 297·2 per square degree; in the B.D. the corresponding area (1°) includes 15·7 stars. About 13,000 enlarged prints of the chart plates were made during the year.

During the period covered by the report, the sun was photographed on 210 days, and for 1906, including the Indian and Mauritian negatives, the daily photographic record of the sun's surface was complete except for one day. Twenty-three photographs of portions of the solar disc were secured with the 26-inch photographic refractor, fitted with a negative enlarger, the scale being such as to give a solar diameter of 30 inches.

The magnetic observations were carried on as usual, the principal results for the magnetic elements for 1906 being

Mean declination	16° 3′·6 W.
Mean horizontal force	4·0174 (in British units)
	1·8524 (in metric ,,)
Mean dip (with 3-inch needles)	66° 55′ 17″

There were no days of "great" magnetic disturbance and eight of lesser disturbance.

The mean temperature for the year ending April 30, 1907, was 50°·5, or 0°·9 above the average for 1841–1905, the highest and lowest shade temperatures recorded being 94°·3 (August 31) and 19°·8 (December 30) respectively. Of the 4457 hours that the sun was above the horizon at Greenwich, the Campbell-Stokes instrument recorded 1687 hours of bright sunshine.

The total rainfall was 0·26 inch below the average for the sixty-five years 1841–1905, being 23·86 inches, whilst the number of "rainy days" was 148.

The performance of the chronometers sent in for the annual trial was hardly up to the high standard of recent years, and of the fourteen pocket-chronometers submitted none came up to the standard of purchase. The next trial for chronometers will commence on June 15, and for chronometer watches on August 3.

In concluding his report, the Astronomer Royal refers to the threatened danger to the astronomical efficiency of the observatory occasioned by the L.C.C. generating station near by, the principal point being the recommendation of the committee appointed to consider the matter, that the conditions be reviewed after the lapse of two years. Experiments made last summer showed that the vibrations from the present installation can be effectually damped out by keeping the film of mercury in the amalgamated trough as thin as possible, but there still remains the danger that these vibrations may so cause the large telescopes to oscillate that delicate observations, such as close double-star work, may suffer materially.

A more insidious danger is that the heated gases from the chimneys may affect the accuracy of star observations on the northern meridian, and in that case the errors would not be discovered until the observations were reduced, when, possibly, it would be impracticable to repeat the observations.

TWO HEAVY SEISMOGRAPHS.

TWO new seismographs devised by Dr. Wiechert are now on sale by Spindler and Hoyer, of Göttingen. The fact which will strike most seismologists is the magnitude of the "stationary" mass employed. The horizontal pendulum uses a "stationary" mass of 17,000 kilo., nearly 17 tons. The mass is composed of barytes contained in a cylindrical sheet-iron vessel with a flat bottom. Its dimensions are 2 metres in diameter by nearly 2 metres in height, and, being intended to have freedom of movement horizontally, the vessel is suspended by three iron rods of 3 cm. diameter, the elasticity of which allows the necessary freedom. The next striking feature is the multiplication with which the thrust arm moves the indicator point, and this is 2200! It is brought about by means of four levers, multiplying $5 \times 5 \times 5 \times 17\frac{1}{2}$. The loss owing to the inertia and elasticity of the connecting system amounts to 5 per cent. only. "The instrument renders specially important service in the small European earthquakes where the rapid oscillations are more prominent." It is clear that this statement is justified. For local disturbances and extremely rapid elastic vibrations the instrument should be of great service, but, with such a multiplication, one is compelled to wonder how much the machine requires to be isolated in order to avoid the disturbance due to traffic. It is not surprising to find in a specimen seismogram tremors due to a gas engine $2\frac{1}{2}$ kilometres distant. Other drawbacks to the use of the pendulum are the price, 5000 marks, and the number of times the paper must require to be changed. These purely practical considerations must have weight with anyone who has real work in view.

The vertical seismograph has a "stationary" mass of 1300 kilograms, about one and a third tons. Even this is great as compared with the usual one to two hundred pounds. The multiplication, 160, is also large when one thinks of the usual 12 to 20. "The vertical apparatus often indicates the first movements of very distant earthquakes better than even the 17,000 kilo. pendulum, which multiplies 2000 times; so the Schlüter result is confirmed, from which follows that in the case of first indications we have to do with longitudinal movements." Thus runs the prospectus. The price of this pendulum, too, 2800 marks, is rather prohibitive, although the workmanship in both leaves little to be desired.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Graham-Smith, Prof. Nuttall, and Prof. Woodhead have been nominated to represent the University at the International Congress of Hygiene and Demography to be held in Berlin in September.

The general board of studies has approved Alexander Scott for the degree of Doctor in Science.

Profs. E. H. Liveing and H. Louis have been nominated examiners in the application of science to the art of mining, and Mr. C. T. Heycock an examiner in metallurgy for the diploma in mining engineering for the examination to be held in the Michaelmas term, 1907.

The Balfour studentship will be vacant at Michaelmas next. The names of applicants, together with such information as they may think desirable, should be sent on or before October 1 to the secretary, J. W. Clark, Registry of the University, Cambridge. The studentship is of the net annual value of 200*l*., or such larger sum as the University may from time to time determine. The student need not be a member of the University, and during his tenure of the studentship is required to devote himself to original biological inquiry.

The Vice-Chancellor announces that the advisory committee of the Colonial Office for the tropical diseases research fund recommends that a grant of 100*l*. for two years should be made from the fund to assist in establishing a research studentship in medical entomology in Cambridge, and that Lord Elgin is prepared to approve of the proposal. Candidates for the studentship are requested to send in their applications to Prof. Nuttall, 3 Cranmer Road, Cambridge, on or before Monday, June 17.

LIVERPOOL.—Mr. J. K. Catterson-Smith has been appointed demonstrator in electrotechnology, and Dr. G. D. Hope demonstrator and assistant lecturer in organic chemistry.

From the interest of funds bequeathed to the University by the late J. L. Bowes, the council has decided to allot 100*l*. per annum towards the permanent endowment of the lectureship on organic chemistry.

Grants have been made out of funds provided by H.M. Treasury for the following researches at present being carried out in science laboratories:—for investigation of absorptive properties of vegetable fibres; for plates to illustrate a monograph on the edible crab; for materials used in the investigation of Röntgen radiation; for apparatus for research on brass annealing; for apparatus for investigating high-temperature combustion; for research on three-membered heterocyclic derivatives; for research on continuous and momentary arcs; for suction of gases in pipes; and for research on blood pressure.

The University has decided to confer the degree of D.Sc., *honoris causa*, at the forthcoming graduation in July, on the following men of science:—Prof. A. R. Forsyth, F.R.S.; Prof. F. Gotch, F.R.S.; Dr. C. L. A. Laveran, Chef de Service Honoraire of the Institut Pasteur, Paris; Sir Oliver J. Lodge, F.R.S.; Sir John Murray, K.C.B., F.R.S.; Prof. W. Osler, F.R.S.; Prof. W. Ostwald; Sir William Ramsay, K.C.B., F.R.S.; and Sir Henry E. Roscoe, F.R.S. The degree will be conferred on Dr. Laveran *in absentia*.

MANCHESTER.—His Grace the Duke of Devonshire, who for many years has held the office of president of the Owens College, and more recently of the University, has been elected Chancellor of the University upon the resignation of Earl Spencer. The installation ceremony has been fixed for July 10, and on this occasion a number of honorary degrees will be conferred. Prof. E. Rutherford, F.R.S., whose appointment as Langworthy professor of physics and director of the physical laboratories has already been noted, is now in Manchester making arrangements for taking over the duties of his office in October.

Prof. Arthur Schuster, F.R.S., has been offered, and has accepted, an appointment as honorary professor of physics; his continued cooperation in the work of the department is thus assured.

Mr. W. H. Jackson, who has for the past five years held the position of assistant lecturer in mathematics, has been appointed assistant professor of mathematics at Haverford College, Pa., U.S.A.

OXFORD.—Mr. D. L. Chapman has been selected for the official fellowship in natural science at Jesus College. Mr. Chapman was an exhibitioner of Christ Church, and since 1897 has been a demonstrator in Prof. Dixon's laboratory at the Victoria University of Manchester.

ON Thursday, June 6, the Buckinghamshire Education Committee closed all their schools so that the teachers could attend a conference, organised by Mr. C. G. Watkins, at Aylesbury, at which a number of the delegates of the Federal Conference on Education were present. Among the subjects discussed was the question as to how the rural schools might be kept in touch with the progress and development of educational life. An important difference between rural schools in the colonies and in the mother country was brought out. In the former the teachers are the best teachers, and quickly move as they are promoted according to the work that they can do. Here the best teachers go at once to the better-paid posts in towns; those in the rural districts stay where they are, as there is no system of promotion. Among those from the colonies who spoke on this and other topics were the Hon. Colin Campbell (Minister of Education, Manitoba), Mr. Frank Tate, I.S.O. (Victoria), Mr. A. Williams (South Australia), Mr. J. A. Douglas (Southern Nigeria). Mr. W. M. Webb pointed to the use that could be made of museums fixed and circulating in the training of teachers, particularly in rural districts, and he mentioned the resolutions passed at the Federal Conference with regard to a collection that should bring before teachers fresh methods and new appliances.

THE board of trustees of the University of Illinois has voted that the Engineering Experiment Station be authorised to offer ten research fellowships in the college of engineering each of an annual value of 100*l*. A pamphlet received from the University gives information concerning these fellowships, and describes the facilities for experimental work now available in the college of engineering.

WE have received a copy of a brochure, presented to the British editors on the occasion of their visit to Berlin last month, which provides an instructive account of the Handelshochschule founded by the Berlin Merchants' Corporation. It is the only institution of its kind in Germany which owes its existence to the efforts of a body of business men, and is maintained solely at their expense. The school is particularly meant for commercial students who have gone through a regular apprenticeship, and, besides, have attained that degree of general training which entitles to the privilege of serving the shorter term of one year in the German Army or Navy. Exceptions are made in the case of students otherwise suitably prepared. The object constantly held in view is "to provide instruction and opportunities for research in the sciences necessary and most useful for a commercial career." The approved course of work extends over two years. The school was opened in October, 1906, and during the first session 1371 persons were in attendance on lectures. The inauguration of the scheme serves to show that German merchants possess initiative enough themselves to supply any deficiency which may exist in the State system of education.

A DEPUTATION from the British Medical Association, the Board of Hygiene and Temperance, and the 1904 Committee of the Medical Profession, waited upon the President of the Board of Education on June 6 to urge the teaching of hygiene and temperance in all schools and training colleges under the Board, and the establishment of a medical bureau in the Education Department. Mr. McKenna, M.P., in reply, said that the chief difficulty is to obtain competent teachers, and the next is to get the teachers to teach the children. To come into immediate contact with the schools, it is necessary to have teachers to teach children in 21,000 schools, and these are not available. As to medical inspection, the Bill dealing with this subject has not yet passed through the House of Commons, but it is to be pressed, and Mr. McKenna believes it will obtain the support of the House and become law. Until the Bill is passed it would be undesirable to declare in advance what the settled policy of the Board is as to the details of carrying out the proposals of the Bill. Naturally the desire of the Board will be to have expert medical advice, if the Bill passes, upon the various topics with which it is concerned, but no definite lines could be laid down now on the proposal for the establishment of a medical bureau. On the general question, Mr. McKenna expressed himself as heartily in sympathy, as the whole of the Government are, with the objects laid before him. It is most desirable for children in elementary schools to be taught hygiene and temperance.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 18.—"On Reciprocal Innervation of Antagonistic Muscles." Tenth note. By Prof. C. S. **Sherrington**, F.R.S.

This communication furnishes fresh examples of reciprocal innervation of antagonistic muscles. These examples are taken from the great flexion-reflex of the leg. The paper shows that in that reflex the extensors of the ankle are inhibited concurrently with excitation of flexors of the ankle. It also shows that the adductors of the hip are relaxed by inhibition concurrently with reflex contraction of the abductors, and that the external rotators of the hip similarly are relaxed by inhibition concurrently with contraction of the internal rotators. These new instances of reciprocal innervation of antagonistic muscles are important, because of the desirability of seeing how far reciprocal innervation may be considered a general or widespread principle in the coordination of muscular actions.

The communication next proceeds to show that the muscles of the limbs are divisible into two groups; in one group the reflex action provocable excites the muscle itself and relaxes by inhibition its antagonist muscles. To this group belong, among others, the following muscles:—*biceps cruris, biceps brachii, gracilis, tensor fasciae femoris, semi-tendinosus, tibialis anticus*, and *gluteus minimus*. In the other group the reflex action provocable from the nerve of the muscle inhibits that muscle itself while exciting reflex contraction in the muscles antagonistic to it. In this group come the following muscles:—*vastocrureus, gastrocnemius, soleus, triceps brachii, supraspinatus scapulae* and *anconeus, adductor magnus*, and *quadratus femoris*.

The communication finally reverts to the after rebound of contraction which, as pointed out in a previous communication on this subject, very usually follows reflex inhibition of the limb muscles. It is shown that this after-rebound to contraction is of central origin, and can be produced by direct electrical excitation of the cross-section of the spinal cord itself. The rebound contraction is illustrated by a graphic record of the rebound contraction following reflex inhibition of the gastrocnemius muscle in the cat.

Geological Society, May 15.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—The origin of certain cañon-like valleys associated with lake-like areas of depression: F. W. **Harmer.** In glaciated regions, as shown by Prof. P. F. Kendall, the invasion of a district by an ice-sheet would tend to obstruct the natural drainage, producing lakes, of which the outflow might take place over the advancing ice, between the ice and the hillsides, or it might escape laterally, in a direction at right angles to the longest diameter of the lake and to the course of the pre-existing stream. Overflow channels would assume a gorge-like character, and would present a comparatively recent appearance. During the Glacial epoch the North Sea ice appears to have invaded the plain of the Witham and the valleys of the Welland, Nene, and Ouse, over-riding also the higher land separating them; the Tees ice-stream moved up the Trent basin to the vicinity of Derby, and thence, inosculating with the Derwent glacier, up the Soar valley towards Leicester and Rugby; the Irish Sea ice passed into the northern part of the basin of the Lower Severn; ice from the Brecknock Beacons passed towards the Bristol Channel, and, combined with Irish Sea ice crossing Pembrokeshire from St. David's Head towards Cardiff, may have caused the accumulation of sedentary ice in the Severn valley. After considering the case of Lake Pickering and the Malton Gorge as a typical example, the author passes on to Lake Shrewsbury and the gorge at Ironbridge. Pre-glacial drainage of the upper Severn and Vyrnwy was probably northwards; when a glacial lake was first formed over the Cheshire plain it may have drained towards the Trent, possibly by Rudyard and Madeley; when these gaps were closed, the lowest outlet seems to have been towards the south, and the Severn Gorge at Ironbridge was cut. Lake Trowbridge and the gorges of Clifton and Bradford-on-Avon are next dealt with, the latter being attributed to the overflow of a glacial lake occupying the Trowbridge plain, and the former to the blocking of the Flax-Bourton valley by ice. The gaps in the Jurassic escarpment at Lincoln and Ancaster are explained as overflows from a lake caused by the damming of the Trent outlet towards the Humber. This gave rise at first to the more northern, and later to the southern gorge. Finally, Lake Oxford and the Goring Gap are dealt with in considerable detail.

Royal Microscopical Society, May 15.—Lord Avebury, F.R.S., president, in the chair.—Diffraction rings due to a circular aperture: Prof. A. W. **Porter** and P. F. **Everitt.** The differences between the theoretical and the observed radius of the first dark diffraction ring mentioned in Mr. Nelson's paper, read March 21, 1906, were considered to be due to the method of observation, because the values obtained from observations made by Mr. Everitt, under the best conditions, were in very close agreement with theory.

Zoological Society, May 28.—Dr. J. Rose Bradford, F.R.S., vice-president, in the chair.—The form of the brain in the extinct lemurs of Madagascar, with some remarks on the affinities of the Indrisinæ: Dr. G. Elliot **Smith.** This formed a supplement to the paper on recently discovered subfossil Prosimiæ from Madagascar, read before the society by Mr. H. F. Standing on March 19. From an examination of cranial casts of an extinct species of lemur and of Mesopropithecus and Palæopropithecus, and of brain casts of Nesopithecus and Megaladapis, in conjunction with information derived from the study of recent lemurs, the author had arrived at the conclusion that Propithecus, Avahis, Indris, Mesopropithecus, Nesopithecus, Palæopropithecus, Chiromys, and Megaladapis must be regarded as the diversely specialised members of one family, all of which exhibited in greater or less degree distinct evidence of retrogressive changes from a more primitive and also more pithecoid type.—Some notes on the abdominal viscera of Chlamydoselachus: Mrs. O. A. Merritt **Hawkes.** Observations on the alimentary canal, including the associated glands, the dentition, and the spiral valve of this fish. The results were compared with the accounts of these organs previously given by Garman and Günther, and attention was directed to any discrepancies which had been noted. The female reproductive organs were also examined, and evidence was cited supporting the conclusion that Chlamydoselachus was viviparous. The interesting discovery was recorded that a vestigial seventh branchial arch was present.—Second report on the batrachians and reptiles collected in South Africa by Mr. C. H. B. Grant: G. A. **Boulenger.** The report dealt with fifty-eight species—nineteen Batrachia and thirty-nine Reptilia—of which two were described as new.—Hydroids of the Cape Verde Island marine fauna collected by Mr. Cyril Crossland: J. **Ritchie.** The collection contained twenty-seven species, and added considerably to our rather meagre knowledge of the hydroid fauna of the northerly portions of the west coast of Africa. The majority of the specimens hitherto described from Cape Verde Island had been obtained in comparatively deep water, but the present collection was a littoral one, and contained examples of only one species before recorded from the locality, viz. *Sertularia versluysi*, Nutting. Of the twenty-seven species represented in the collection eighteen were already known, while the remaining nine were described as new to science. Of the new forms, the most interesting was a gymnoblast, the peculiar branching and simple gonophore of which separated it so widely from known genera that a new genus had been established for it.

Cambridge.

Philosophical Society, May 6.—Dr. Hobson, president, in the chair.—The influence of a strong magnetic field on the spark-spectra of lead, tin, antimony, bismuth, and gold: J. E. **Purvis.** The strength of the field was 40,000 units. The more important results were:—(1) Comparing the metals *separately*, there were lines belonging to the same type in having the same number of constituents, the same ratio of intensities of these constituents, the same polarisations, and the same distances apart when represented on the same scale of vibration numbers. (2) Comparing the metals *with one another*, there were lines which were comparable similarly, and this was particularly well marked amongst lines which were divided into four. (3) There were lines of Au, Sb, and Pb yielding four constituents which were essentially identical in every way with lines of the principal series in the spectra of Cu and Ag. (4) The constituents of some of the triplets of lines in the spectra of the different metals were also comparable with the constituents of some of the quadruplets in that the constituents vibrating perpendicular to the lines of force were polarised in the same direction and had the same distances apart when represented on the same scale of $d\lambda/\lambda^2$.—The β rays from potassium: N. R. **Campbell.** An account is given of an investigation into the nature of the rays from potassium which were described in a recent paper by the author and Mr. Wood. The experiments were directed mainly to showing that the rays carry a charge, and must therefore be β rays, since their penetration indicates that they cannot be α rays. For this purpose the deviation of the rays in an electrostatic field was observed and compared with that of the β rays from uranium. The conclusion reached in the earlier paper is confirmed, that the potassium rays are β rays the average velocity of which is less than that of the β rays of uranium. Incidentally, convincing proof was obtained of the photographic action of the rays. It seems beyond doubt that potassium must be classed among the radio-active elements.—The number of electrons in an atom: N. R. **Campbell.** A somewhat speculative calculation of the number of electrons in a radio-active atom based on the energy liberated in radio-active processes. The estimation of the average energy of an intra-atomic electron is based on observations of the velocity of the slow δ rays from radium. The conclusion is reached that the number of electrons is probably of the same order of magnitude as that deduced on the assumption that the whole mass of an atom is the sum of the masses of the contained electrons. General arguments are offered for the view that the number of electrons in a radium atom cannot be less than 1300, and is probably very much greater.—The longitudinal impact of metal rods with rounded ends: J. E. **Sears.** The paper deals with the determination of the velocity of propagation of elastic waves in metal rods by means of observations on the duration of their longitudinal impact. The experiments were carried out with rods of steel, copper, and aluminium, and in every case the observed value of the wave-velocity was within $\frac{1}{3}$ per cent. of that calculated from static tests by the formula $v=\sqrt{Eg/\rho}$, with the proper correction for adiabatic propagation. It was also observed that, for the exceedingly short times involved in these experiments, stresses far exceeding the elastic limit of the material can be applied without producing any permanent effects.—Selective absorption of Röntgen rays: G. W. C. **Kaye.** A Röntgen-ray bulb was constructed so that a pencil of kathode rays fell on an antikathode which was one of a batch of metals mounted on a small carriage which could be moved along inside the tube by a magnet from outside. The quantity of Röntgen rays passing through a thin aluminium window in the tube was measured by their ionising effect. Absorbing screens of different metals were placed in turn between the ionisation chamber and the aluminium window. Using a plate of aluminium as the absorber, the relation between the amount of transmitted radiation and the atomic weight of the metal used as antikathode was found to be approximately a linear one over a wide range of atomic weights. Screens of a few other metals were employed, and the results indicate that a metal is specially transparent to the Röntgen radiation from an antikathode of that metal, and that this abnormal transparency is shared in less degree by metals of atomic weight differing little from that of the antikathode. The effect seems to indicate that the Röntgen rays emerging from the interior of the antikathode to the surface undergo selective absorption, leaving the remainder specially penetrating to further layers of the same substance.—The transmission of earthquakes through the earth (second paper): Rev. O. **Fisher.**—Note on the influence of extraneous forces upon the proportion of the sexes produced by canaries: W. **Heape.** The breeding results in two aviaries are examined. In the one (N), the young produced were in the proportion of 76·99 cocks per 100 hens; in the other (G), 353·3 cocks per 100 hens were bred. This remarkable difference in the proportion of the sexes produced in these two aviaries is shown to be consistent both in detail and in the total results. Moreover, it is shown that a pair of N's birds transferred to G's aviary produced a large excess of cocks, and a pair of G's birds bred in N's aviary produced young of which the sexes were closely in accord with the average proportion obtained in the aviary that year. Examination of details regarding the food supplied and the temperature and surroundings to which the birds were subjected in these two aviaries indicates the probability that these factors exerted selective action on the generative elements dehisced by the parent birds, and may be interpreted as evidence of the exercise of extraneous forces on the proportion of the sexes produced.

PARIS.

Academy of Sciences, June 3.—M. Henri Becquerel in the chair.—The origin of the irregularities of the lunar surface: MM. **Lœwy** and **Puiseux.** A critical discussion of the theories of Laplace and G. H. Darwin concerning the moon's origin, and the present condition of its surface.—Selenium hexafluoride: Sir W. **Ramsay.** A reply to the criticisms of M. Lebeau on the selenium hexafluoride discovered by Prideaux.—Magnetic observations at Tananarivo: Ed. Él. **Colin.** The results are summarised in three tables showing the absolute measurements of declination, inclination, and the horizontal component from May, 1906, to April, 1907.—Tetramethyl-dioxyacetone: Louis **Henry.** An account of the study of the reaction between mesoxalic ester and magnesium methyl bromide by M. Joseph Lemaire. The magnesium compound being used in excess, the pentamethyl derivative $(CH_3)_2.C(OH).C(CH_3)(OH).C(OH)(CH_3)_2$ was looked for. The actual product, however, proved to be

$$(CH_3)_2.C(OH).CO.C(OH)(CH_3)_2,$$

the physical properties of which are given.—Some applications of the theorem of Landau-Picard: C. **Carathéodory.**—Integral invariants: E. **Goursat.**—An apparatus for the study of telephonic currents: Henri **Abraham** and M. **Devaux-Charbonnel.** The essential part of the apparatus is the moving coil galvanometer for alternating currents described by H. Abraham in an earlier paper. This can be arranged so as to measure, not only the amplitudes, but also the phases and strength of telephone currents.—The speaking condenser: Pierre **Sève.**—A self-recording pyrometer with fixed photographic plate: M. **Wologdine.** The time ordinate is obtained by a mirror rotating round a horizontal axis at a uniform rate.—An apparatus for the preparation of a constant stream of pure oxygen: Gustave D. **Hinrichs.** The centre bulb of a Kipp is filled with well-washed granular pyrolusite, the liquid consisting of hydrogen peroxide acidified with one-twelfth of its volume of concentrated sulphuric acid.—The action of silicon tetrachloride on silver and copper: Em. **Vigouroux.** With silver, the tetrachloride is partially reduced to the sesquichloride; the silver not converted into chloride is free from silicon. With copper, the metallic ingot remaining contains about 2·4 per cent. of silicon.—The transformation of the esters of the α-bromo-fatty acids into the corresponding α-iodo-compounds: F. **Bodroux** and F. **Taboury.** The α-bromo-ester is treated with anhydrous magnesium iodide in presence of ether. The reaction is energetic and practically quantitative.—A new method of synthesis of biprimary compounds containing an odd number of atoms of carbon: dimethoxyheptane, 1.7 $CH_3O(CH_2)_7O.CH_3$: J. **Hamonet.**—The synthesis of the auramines by means of the oxalic esters: A. **Guyot.**—The action of organo-magnesium compounds on the cyclic alkylidene ketones: Henri **de Béville.**—A new type of bisazoic compound: H. **Duval.**—An alkaline micrograpite collected at Graham's Land by Dr. Charcot's Antarctic Expedition: E. **Gourdon.**—The dehiscence of some stamens: M. **Pauchet.**—The *rôle* of comparative anatomy in the distinction between the species of the genus Cistus: M. **Gard.**—A new method of separating and estimating the organic acids in fruits and vegetables: J. M. **Albahary.**—The cultural mutation of *Solanum tuberosum*: Edouard **Heckel.**—The xylophage parasites of *Manihot Glaziovi*: P. **Lesne.**—The structure of the spinal medulla: N. A. **Barbieri.**—Fluorine in the shells of non-marine molluscs: P. **Carles.** Fluorine was found in all the non-marine molluscs examined, but in quantities much smaller than in the shells of marine molluscs.—The influence of the rapid displacements of air caused by the motor-car on the general nutrition: A. **Mouneyrat.** Both in normal and anæmic persons the number of red corpuscles in the blood is increased by moderate use of the motor-car. In neurasthenia accompanied by insomnia there is also a marked improvement.—A new method for the experimental diagnosis of tuberculosis: H. **Vallée.** Von Pirket has recently proposed the lesions arising from the application of a dilute solution of tuberculin to the skin of tuberculous subjects as a means for diagnosing tuberculosis in man. The author has studied this skin reaction with animals with results generally confirming those of Von Pirket. In healthy animals (cattle, horses, guinea-pigs) no appreciable skin reaction is produced; with tuberculous animals, on the other hand, the skin reaction is well marked.

DIARY OF SOCIETIES.

THURSDAY, JUNE 13.

ROYAL SOCIETY, at 4.30.—Some Points in the Development of *Ophiothrix fragilis*: Prof. E. W. MacBride, F.R.S.—On Certain Phenomena of Inactivation and of Inhibition exhibited by Precipitin Antisera: D. A. Welsh and H. G. Chapman.—The Inhibitory Action upon Subsequent Phagocytosis exerted on Active Normal Serum by Ioactive Normal Serum through which Bacilli have been passed: J. C. G. Ledingham.—*Miadesmia membranacea*, Bertrand; a New Palæozoic Lycopod with a Seed-like Structure: Miss M. Benson.—On the Identification of Chitin by its Physical Constants: Miss I. Sollas.

CHEMICAL SOCIETY (Extra Meeting), at 8.30.—Discourse entitled Some Borderline Problems in Botany: Prof. J. B. Farmer, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—On Partial Differential Equations of the Second Order: Prof. A. R. Forsyth.

INSTITUTION OF MINING ENGINEERS, at 11 a.m.—Improvements required in Inland Navigation: H. R. de Salis.—Bye-product Coking Plant at Clay Cross: W. B. M. Jackson.—Notes on Bye product Coke-ovens, with Special Reference to the Koppers Oven: A. V. Kochs.—Bye-product Coke-ovens: P. Schwarz.—Water Supplies by Means of Artesian-bored Tube-wells: H. F. Broadhurst.—Gypsum in Sussex: W. J. Kemp and G. A. Lewis.—The Use of Duplicate Capell Fans: G. M. Capell.

MATHEMATICAL SOCIETY, at 5.30.—Note on a Special Set of Classes of Partial Differential Equations of the Second Order: Prof. A. R. Forsyth.—Various Extensions of Abel's Lemma: Prof. T. J. I'A. Bromwich.—On the Number of Representations of a Number as a Sum of $2r$ Squares, where $2r$ does not exceed 18: Dr. J. W. L. Glaisher.—An Extension of Eisenstein's Law of Reciprocity: Mr. A. E. Western.—On Certain Singular Points of Surfaces: Mr. A. B. Basset.—The Minimum Necessary Postulates as to a Function to be Defined as Analytic over a Region: Prof. E. B. Elliott.

FRIDAY, JUNE 14.

ROYAL INSTITUTION, at 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.—(1) Note on the Colours of α and o Ceti; (2) The Relation between Star Colours and Spectra: W. S. Franks.—On the "Owl Nebula," M 97, N.G.C. 3587: E. E. Barnard.—Ancient Eclipses: P. H. Cowell.—Note on the Visual Spectrum of Mira Ceti in December, 1906: Rev. A. L. Cortie.—The Spectrum of Mira Ceti in December, 1906, as Photographed at Stonyhurst College Observatory: Rev. W. Sidgreaves.—Observations of Comets *d, e, g*, 1906, from Photographs taken with the 30-inch Reflector of the Thompson Equatorial: Royal Observatory, Greenwich.—*Probable Papers*: Observations of Jupiter: Rev. T. E. R. Phillips.—Description of an Equatorial Reflecting Telescope driven by a Hydraulic Ram: T. E. Heath.—The Work of the Mount Wilson Observatory: Prof. G. E. Hale.

PHYSICAL SOCIETY, at 8.—Observations on the Electric Arc: W. L. Upson.—The Poulsen Arc as a Means of Producing Electrical Oscillations (with Experiments): Dr. J. A. Fleming.—Exhibition of a Direct Reading Conductivity Bridge for Rods: R. Appleyard.

INSTITUTION OF MINING ENGINEERS, at 10.30 a.m.—The Reform of British Weights and Measures: A. Hopkinson.—The Thick Coal of Warwickshire: J. T. Browne.—Description of the Ozokerite (Mineral Wax) Mine at Boryslaw, Galicia, Austria: D. M. Chambers.—Notes on the Structural Geology of South Africa: Dr. C. Sandberg.—The New Rand Gold-field, Orange River Colony: A. R. Sawyer.—Cast-iron Tubbing: What is the Rational Formula? H. W. G. Halbaum.

MONDAY, JUNE 17.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—In the Equatorial Forests of Africa: Major P. H. G. Powell-Cotton.

TUESDAY, JUNE 18.

ROYAL STATISTICAL SOCIETY, at 5.

ZOOLOGICAL SOCIETY, at 8.30.—On Growth-forms and supposed Species in Corals (illustrated by Lantern Slides): Dr. F. W. Jones.—Notes on Limnocnida from Lakes Tanganyika and Victoria Nyanza: R. T. Günther.—On *Lacerta ionica*, Lehrs, a Variety of *Lacerta taurica*, Pallas: G. A. Boulenger, F.R.S.—On Neotropical Lycænidæ, with Descriptions of New Species: Hamilton H. Druce.—Descriptions of *Velifer hypselopterus* and a New Fish of the Genus Velifer: C. Tate Regan.—On the Anatomy, Classification, and Systematic Position of the Teleostean Fishes of the Sub-order Halotriognathi: C. Tate Regan.—A Monographic Revision of the Monkeys of the Genus Cercopithecus: R. I. Pocock.—Notes upon some African Species of the Genus Felis recently exhibited in the Zoological Gardens: R. I. Pocock.

WEDNESDAY, JUNE 19.

GEOLOGICAL SOCIETY, at 8.—The Constitution of the Interior of the Earth as revealed by Earthquakes (Second Communication): Some New Light on the Origin of the Oceans: R. D. Oldham.—(1) The Swansea Earthquake of June 27, 1906; (2) The Ochil Earthquakes of September, 1900, to April, 1907: Dr. C. Davison.—(1) The Inferior Oolite and Contiguous Deposits of the Bath-Doulting District; (2) The Inferior Oolite and Contiguous Deposits of the District between the Rissingtons and Burford: L. Richardson.—The Flora of the Inferior Oolite of Brora (Sutherland): Dr. M. C. Stopes.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—Weather and Crops, 1891–1906: F. C. Bayard.—The Relation of the Rainfall to the Depth of Water in a Well at Cirencester, 1903–1906: C. P. Hooker.—*Exhibit*: The "Step" Anemometer, an Instrument designed to obviate the "Sheltering" Error: W. Child.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Eye-pieces for the Microscope: E. M. Nelson.—Lecture, illustrated by Lantern-slides, on the Life-history of the Tiger Beetle, *Cicindela campestris*: F. Enoch.

THURSDAY, JUNE 20.

ROYAL SOCIETY, at 4.30.—*Probable Papers*. Bakerian Lecture, On the Atomic Weight of Radium: Dr. T. E. Thorpe, C.B., F.R.S.—On the Origin of the Gases Evolved by Mineral Springs: Hon. R. J. Strutt, F.R.S.—On the Presence of Sulphur in Some of the Hotter Stars: Sir J. Norman Lockyer, K.C.B., F.R.S.—The Fluted Spectrum of Titanium Oxide: A. Fowler.—Preliminary Note on a New Method of Measuring Directly Double Refraction in Strained Glass: L. N. G. Filon.—Studies of the Processes Operative in Solutions, II., The Displacement of Chlorides from Solution by Alcohol and by Hydrogen Chloride: Prof. H. E. Armstrong, F.R.S., E. V. Eyre, and A. V. Hussey; III. The Sucroclastic Action of Nitric Acid as Influenced by Nitrates: R. Whymper; IV. The Hydrolysis of Methylic Acetate in Presence of Salts: Prof. H. E. Armstrong and J. A. Watson; V. The Discrimination of Hydrates in Solution: Prof. H. E. Armstrong, F.R.S., and R. J. Caldwell.

CHEMICAL SOCIETY, at 8.30.—Some Properties of Radium Emanation: A. T. Cameron and Sir W. Ramsay.—The Affinity Constants of Aminosulphonic Acids as Determined by the Aid of Methyl Orange: V. H. Veley.—Azo-derivatives of 1:3-Diphenylbarbituric Acid. Dynamic Isomerism among the Coloured Hydrazones of 1:3-Diphenylalloxan: M. A. Whiteley.—A Series of Coloured Diazo-salts Derived from p-Amino-aceto-α-naphthalide: G. T. Morgan and W. O. Wootton.—(1) Colour and Constitution of Azo-compounds, Part I.; (2) Colour and Constitution of Azo-compounds, Part II.: J. T. Hewitt and H. V. Mitchell.—The Oxidation of Hydrazines by Free Oxygen: F. D. Chattaway.—Calmatambin, a new Glucoside: F. L. Pyman.—The Decomposition of Hyponitrous Acid in Presence of Mineral Acids: P. C. Rây and A. C. Ganguli.—The Chemical Composition of Petroleum from Borneo: H. O. Jones and H. A. Wootton.—(1) The Synthesis of Phenonaphthacridines. Trimethylphenonaphthacridines; (2) The Condensation of Aldehydes with Mixtures of α-Naphthol and α-Naphthylamine; Synthesis of 7-Aryl $\begin{matrix}\alpha-N-\alpha\\ |\\ \beta-CH-\beta\end{matrix}$ Dinaphthacridines: A. Senier and P. C. Austin.—(1) An Improved Form of Apparatus for the Rapid Estimation of Sulphates and Salts of Barium; (2) The Determination of Sugar by Fehling's Solution: W. R. Lang and T. B. Allen.

LINNEAN SOCIETY, at 8.—Distribution of Conifers of China: Dr. Maxwell T. Masters, F.R.S.—Pre-glacial Flora of Great Britain: Clement Reid, F.R.S., and Mrs. Reid.—Cruise of H.M.S. *Sealark*, Part ii.: Dr. J. Stanley Gardiner.—On Tubucellaria: A. W. Waters.—Cruise of the *Silver Belle*: Dr. N. Wolfenden.—Triassic Species of Zamiko and Pterophyllum: E. A. N. Arber.

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THURSDAY, JUNE 20, 1907.

PITT-RIVERS.

The Evolution of Culture and other Essays. By the late Lieut.-General A. Lane-Fox Pitt-Rivers. Edited by J. L. Myres, with an introduction by Henry Balfour. Pp. xx+232; twenty-one plates. (Oxford: The Clarendon Press, 1906.) Price 7s. 6d. net.

"IN language and in all ideas communicated by word of mouth there is a hiatus between the limits of our knowledge and the origin of culture which can never be bridged over, but we may hold in our hand the first tool ever created by the hand of man" (p. 31).

The great collection at Oxford needed this book, as a monument needs its inscription. These lectures, written during the actual collection and arrangement of the specimens, show the author's method of classification and explain the evolutionary principles which are concretely embodied in the objects themselves, from "the first tool ever created by the hand of man" to the highest effort of barbaric manufacture.

As every student of man knows, General Pitt-Rivers devoted a lifetime and a fortune to the application of the idea of evolution to the origin and development of the material arts. It was

"during his investigations, conducted with a view to ascertaining the best methods whereby the service firearms might be improved, at a time when the old Tower musket was being finally discarded, he was forcibly struck by the extremely gradual changes whereby improvements were effected. He observed that every noteworthy advancement in the efficiency, not only of the whole weapon, but also of every individual detail in its structure, was arrived at as a cumulative result of a succession of very slight modifications, each of which was but a trifling improvement upon the one immediately preceding it. Through noticing the unfailing regularity of this process of gradual *evolution* in the case of firearms, he was led to believe that the same principles must probably govern the development of the other arts, appliances, and ideas of mankind."

This extract, from Mr. Balfour's excellent introduction, puts on record a case of material inspiration very similar to that by which Darwin was led to his own great work. Colonel Lane-Fox began to put his ideas to a practical test in 1851. Evolution was in the air during the 'fifties, and it should not be forgotten that Pitt-Rivers, like E. B. Tylor in a parallel direction, worked out its principles independently of Darwin.

Taking what we may call *conscious* evolution at its first beginnings in the application of human hands and brains to the materials supplied by nature, he traces the development of utensils and weapons through savagery and barbarism into civilised culture. He takes as an axiom the principle that the earlier a weapon is the nearer it lies to some natural form. The consideration of these natural forms is extremely interesting, and the way in which, not only the form, but the material itself, flint, for instance, limited, or in some cases suggested, the use of a weapon or tool is an instructive psychological lesson. The author's analysis of variation, retardation, and other qualitative differences in the chain of continuity is full of interesting analogies with biological processes. Thus he can say that man "can no more be said to have *invented* the boomerang than he can be said to have *invented* the art of sustaining life by nourishment" (p. 124). Knowledge of the theory of projectiles renders the author's account of savage missiles scientific in the truest sense; there is nothing *a priori* about it. The evolution of the shield from the club will be strange news to the layman. A detail of development, which illustrates the interchange of use and ornament, is the following, from the lecture on "Early Modes of Navigation":—

"The *oculus*, which, on the sacred boats of the Egyptians, represented the eye of Osiris guiding the mummy of the departed across the sacred lake, is still seen eastward—in India and China—*converted* into an ornamental device, while westward it lived through the period of the Roman and Grecian *biremes* and *triremes* and has survived to this day on the Maltese rowing-boats and the *Xebecque* of Calabria, or has been *converted* into a hawser-hole in modern European craft."

The italics are not the author's, and serve to point out his tendency at times to make coincidence into causal connection. The bow of a boat is, of course, the obvious place for various gear to be put, failing which it is no less the obvious place for ornament, imaginative, as in the case of the "eye," or purely decorative. But the author did not mean that the hawser-hole of a modern ship is *sans phrase* a development from the Egyptian "eye."

The lectures deal generally with principles of classification (as applied to the Pitt-Rivers collection), the evolution of culture, primitive warfare and weapons (the largest section of the book), and early modes of navigation, and are filled with abundance of detail. Mr. Balfour in his introduction does full justice to his author's achievement and his inspiring of other workers on the same lines. A luminous example of the principles set forth in the book is given in a sketch of his own history of the origin of stringed instruments from the bow of the archer (*cf.* "The Natural History of the Musical Bow," by H. Balfour). He holds that some have taken exception to the use of the term "evolution" in connection with the development of implements and weapons, and adequately vindicates such use. So at least it seems to me; and a study of the earliest facts of "invention," so-called, would be most instructive to those who are inclined to draw too sharp a line between biological change and mental adjustments to environment. Psychologists and students of invention will find this a masterly book, and of unusual value in directing attention to many a fruitful series of facts and many examples of what Mr. Balfour well calls "hybridisation of ideas." There is no index. Many would prefer photographic process-work for the plates instead of woodcuts. Why should there not be some typical photographs of the Pitt-Rivers collection?

A. E. CRAWLEY.

THE VOICE.

La Voix, sa Culture physiologique: Théorie nouvelle de la Phonation. Conférences faites au Conservatoire de Musique de Paris en 1906. By Pierre Bonnier. Pp. 299. (Paris: Félix Alcan, 1907.) Price 3.50 francs.

THIS is an excellent work on the physiology of the voice. Nowhere have we met with a clearer exposition of the anatomical structure of the larynx, the mode of voice production, and the mechanism of breathing. The diagrammatic figures showing the action of the muscles are specially to be commended. The author rightly discredits the old-fashioned view that a vocal tone is produced by the vibrations of the margins of the true vocal cords. In a sense this is true, but it is an incomplete statement of the truth, and M. Bonnier lays stress on the variations of pressure that occur in the laryngeal cavity. The vocal cords are brought close together, and then, by an expiratory effort, the pressure below the cords becomes much greater than in the ventricles of Morgagni above the cords and in the upper part of the larynx. This increased pressure opens the chink of the glottis, and the cords are slightly stretched upwards. The air escapes, the cords again approximate, and there is a fall of pressure below the cords whilst the pressure rises in the ventricles and in the upper part of the larynx. There is thus a puff of air. This is repeated again and again according to the period of the vocal tone produced.

M. Bonnier associates the old view with the name of Helmholtz, and he so far claims the newer view as his own. This is scarcely correct. Undoubtedly Helmholtz expounded the mechanism of tone production on the "puff" theory, and he likened the acoustic action of the larynx to that of a syren. The view so ably dealt with by M. Bonnier is now almost universally taught. M. Bonnier gives an admirable account of the action of the resonating cavities in modifying quality of tone. He illustrates this by an analysis of the bass, tenor, alto, and soprano voice, and he indicates the physiological mechanism which brings out the best quality in each of these voices, a mechanism which can be trained under a competent teacher. He shows that there is a constant interplay between the muscular mechanisms and the air pressures in the larynx, so that under favourable conditions the best qualities of the voice may be produced. Accent in singing, as the effort of the singer to give emotional expression, is brought about by the action of the nervous arrangements on the muscular mechanism.

There are many excellent remarks on articulation, on the trill, on the means for, as it were, "flinging out" the voice so as to make it effective, and on the vocal registers. There is a brief account of some of the mistakes by which the voice may be injured, and the volume closes with a description of the results obtained by a clinical examination (by laryngoscope and otherwise) of forty-four voices of persons who desired to become professional singers. Of the forty-four, eight were chosen, and thirty-six were rejected as having such qualities that no amount of training could efficiently fit them for following a *carrière lyrique*. This book places voice production on a scientific basis. Many teachers have taught empirically, and with remarkable success, but they may have made mistakes. M. Bonnier conveys the scientific knowledge that is always the surest guide.

J. G. M.

THREE BOOKS ON ELEMENTARY CHEMISTRY.

A Method of Teaching Chemistry in Schools. By A. M. Hughes and R. Stern. Pp. xii+120. (Cambridge: University Press, 1906.) Price 3s. net.

Elementary Science of Common Life (Chemistry). By W. T. Boone. Pp. 252. (London: W. B. Clive, University Tutorial Press, Ltd., 1906.) Price 2s.

An Elementary Study of Chemistry. By Dr. W. McPherson and Dr. W. E. Henderson. Revised edition. Pp. viii+434. (Boston and London: Ginn and Co., n.d.) Price 6s.

THE authors of the "Method of Teaching Chemistry in Schools" claim to have discovered a new method of teaching elementary chemistry, based on the principle of working from the known to the unknown. Although one may be inclined to question the novelty of the discovery, there is no doubt of the efficacy of the principle. The book is written in the form of suggestions to the teacher. The directions are clear and concise, the illustrations are excellent, and the book is embellished by photographs of the pioneers of chemistry. But it is not the method of treatment, which is scarcely new, or the arrangement of the subject, which might conceivably be improved, which commends the book. What impresses one favourably is its manner rather than its matter. It is written by thoughtful teachers, who have striven in an attractive way to get as much out of each simple problem as it can be made to yield. For the beginner in science, the imparting of many facts or the elucidation of general theories is not wanted; what is required is the cultivation of intelligent observation and of common-sense explanations of phenomena, and if this is the aim of the little book, as we take it to be, it undoubtedly fulfils its purpose.

The modest volume on "Elementary Science of Common Life," by Mr. Boone, is one of the "Organised Science Series," and is well up to the standard of the companion volumes. There is really very little that demands anything but favourable criticism. The subject is handled in a simple fashion, the examples are well chosen, and there is wealth of verbal and graphic illustration drawn from "common life." One is inclined to ask oneself in reading a book of this type whether anything is gained by formal definitions of well-known phenomena such as heat and light. Heat and light are first realised as sensations. Later, they are recognised by certain objective effects, such as expansion in one case and chemical change in the other, and this is, of course, pointed out. But does the definition of temperature "as indicating a particular physical condition of that body while heat is the agency to which this condition is due," which is true enough, though it applies just as well to colour and light, convey information worthy of being recorded in formal language?

The "Elementary Study of Chemistry" is intended for much older students than either of the foregoing, and is an introduction to the serious study of chemistry as a separate science. The authors do not lay claim to any great originality in the treatment of their subject, and in this we must concur. At the same time, the fact that it resembles other elementary text-books does not detract from its merits. The authors have done their work thoughtfully and well. The matter is well arranged, the style is simple and concise, the paper and printing are good, and the illustrations are numerous and well executed.

As in the volume just referred to, we are soon confronted with definitions. "Physical changes," we are told, "are those which do not involve a change in the composition of the matter," but we are not told what "composition" means. "Chemical changes involve a change in the composition of matter." How would isomeric change be classified say the conversion of ammonium cyanate into urea—according to this definition? Why attempt to define where there is no clear boundary, for it is not always easy to say where physical change ends and chemical change begins?

Apart from this we have nothing but praise for the book. The information is well up to date. There are suggestive chapters on "solutions," "chemical equilibrium," and the new learning; and if the teaching is a little didactic in places and leaves many obvious questions unanswered, it must be ascribed to the highly condensed treatment of the subject.

J. B. C.

MEDICAL SCIENCE.

(1) *The Control of a Scourge, or How Cancer is Curable.* By Charles P. Childe. Pp. ix+299. (London: Methuen and Co., n.d.) Price 7*s*. 6*d*. net.

(2) *The Essential Similarity of Innocent and Malignant Tumours. A Study of Tumour Growth.* By Charles W. Cathcart. Pp. xii+79; thirty-eight plates. (Bristol: John Wright and Co.; London: Simpkin Marshall, Hamilton, Kent and Co., Ltd., 1907.) Price 9*s*. 6*d*. net.

(3) *Guy's Hospital Reports.* Edited by F. J. Steward and Herbert French. Vol. lx., being vol. xlv. of the third series. Pp. 373. (London: J. and A. Churchill, 1906.)

(1) IN "The Control of a Scourge," Mr. Childe deals with the cancer problem particularly in relation to prevention and cure. Whether the subject could not have been dealt with in a quarter of the space with equally satisfactory results as regards the general public is a question, many of the details introduced being quite unnecessary for the average man or woman to know. What is really wanted is the broadest issue of a leaflet indicating the "danger signals" warning of the development of a cancerous growth. The medical profession has naturally shrunk from doing this, savouring, as it might seem, of unprofessional advertising; but the importance of the subject warrants this being done, and there is a good precedent in the case of tuberculosis. Mr. Childe's main theme is that cancer usually indicates itself at an early stage by certain signs—"danger signals"—a lump, a sore, an abnormal discharge, &c., and that the public should be educated to understand the importance of these, so that they may seek advice at the earliest possible moment; and, this being so, cure would be possible in a much larger proportion of cases than at present. For cancer is at first a *local* disease; in four-fifths of the cases, at least, it is situated in regions eminently accessible for surgical operation, and complete removal while in the local stage would mean cure.

To the layman who wants to know all about cancer, and to the general practitioner who desires to be in a position to discuss the cancer problem with laymen, the book can be thoroughly recommended.

(2) The second work is for the professional reader, and is illustrated with some beautiful plates. It is, of course, admitted that there is no sharp line of demarcation between innocent and malignant growths, but we should take exception to the unqualified statement (p. 71) that "the same tumour may be at one time innocent and at another time malignant." Even now the minuter characters of the structure of neoplasms are by no means completely worked out, and it is surely previous to assert that tumours having an identity of structure may at one time be innocent and at another malignant. In the case of some of the infectious warts, &c., they should be regarded as infective granulomata rather than as true neoplasms. If not, it would be quite as logical to classify the granulomatous new formations of tubercule, syphilis, &c., as neoplasms.

(3) This volume of the Guy's Hospital reports contains a number (sixteen) of interesting papers, many of which have, however, been published elsewhere. Among others, Dr. F. Taylor discusses the chronic relapsing pyrexia of Hodgkin's disease, Drs. Bainbridge and Beddard discuss the mechanism of secretion by the renal tubules in the frog, and Dr. Buzzard and Mr. Allen describe observations on the effects produced by choline upon animals. The volume contains much matter of scientific value, and to old Guy's men the "school" news which is included will add to its interest.

R. T. H.

OUR BOOK SHELF.

Ightham; the Story of a Kentish Village and its Surroundings. By F. J. Bennett. Pp. viii+158; illustrated. (London: The Homeland Association, Ltd., 1907.) Price 7*s*. 6*d*. net.

THE area described lucidly in this volume is one of the most interesting in the country to the archæologist, the geologist, and the general student of nature. It comprises some sixteen square miles north of Tonbridge, lying between Maidstone and Sevenoaks, and under the unremitting observation of Mr. Benjamin Harrison, the White of Ightham, has probably been surveyed in greater detail than any other similar rural area. Much of Mr. Harrison's material is embodied in the present volume, having been personally communicated to the author and the associated contributors.

The earlier chapters deal with the physical and geological features of the area, and in them the student will find ample material for extended surveys, made easier by the careful descriptions and directions given. Debatable points are at times introduced, but where the author's conclusions run counter to those of other authorities, the actual field evidence in support thereof is submitted.

The development of flint implements, with illustrations drawn from those found by Mr. Harrison, and others, in this area, and the several epochs of the Stone age are next discussed, the seventh chapter being devoted to a description of the megalithic monuments which are to be found in the district. It is to be regretted that, in regard to the latter, more definite results have not been educed. Stone circles, dolmens, and the remains of *viae sacrae* are mentioned in a general way as being possible sites of prehistoric worship, but although the district teems with objects which may prove of the greatest value to the student of early Britain, and is situated in a home county, no one appears to have yet succeeded in discovering and elucidating alignments such as the labours of Sir Norman Lockyer have established for somewhat similar monuments in Cornwall, Devon, &c. Yet we read on p. 47 of recent vandalism which bids fair to obliterate for ever these unique traces of the early inhabitants of the district. Surely the time has now arrived when a Government which carefully preserves records of ancient Babylon and Egypt should take effective steps to protect the only records we have of prehistoric Britain.

The remainder of the book deals with the general history of the Ightham district, and is pregnant with interest both for the historian and the general reader. The illustrations are from excellent photographs taken especially for this work, and one puts the book down with a deep feeling of regret that similar records for the scores of other interesting areas in which rural England abounds are as yet unwritten.

W. E. R.

The Wit of the Wild. By E. Ingersoll. Pp. xi+288; illustrated. (London: Unwin, 1907.) Price 6s. 6d. net.

As Mr. Ingersoll is always interesting and generally accurate, his writings may be commended to the attention of the reader in a manner which would not be safe in the case of all works on popular natural history. To recapitulate the titles of the two dozen articles which go to form the present volume will be unnecessary—more especially as some of them are of a rather cryptic nature—and it must accordingly suffice to mention that they cover a wide field, ranging from an account of the jelly-fish picturesquely named the "Portuguese man-of-war" to an inquiry whether animals can rightly be charged with suicidal propensities. All have appeared in the form of periodical literature, but they are none the worse for this, especially as many were first published in America. The article in which we have been most interested is one on the death-feigning instinct in the opossum—an instinct which in this particular case the author suggests has been inherited from long dead ancestors to the animal's own disadvantage. That the "collapse" which occurs when an opossum is suddenly seized is not due to some form of hysteria the author is firmly convinced; and if it be a death-feigning instinct designed for protection it certainly fails in its object, as the unhappy creature is mauled and done to death by quite a number of animals when in this condition. The reader should, however, peruse the chapter for himself, in order to form his own judgment, and having done this he will scarcely "skip" the remainder of a very interesting volume.

(1) *Technical Electricity.* By H. T. Davidge and R. W. Hutchinson. Pp. x+502. (London: University Tutorial Press, Ltd.) Price 4s. 6d.

(2) *Elementary Electrical Engineering.* By John H. Shaxby. Pp. vii+192. (London: Blackie and Son, Ltd.) Price 3s. net.

(1) This book is intended chiefly for the use of students of electrical engineering, and covers the London City and Guilds preliminary examination in electric lighting and power, and also the necessary technical work for stage ii. of the Board of Education examination in magnetism and electricity.

The question of the various units and systems of units has been given very careful attention, and the absolute and practical units are taken side by side so as to enable the student thoroughly to understand the relationships between them, and should help to mitigate the difficulties which generally arise when dealing with these units. The same idea is applied in the description of the construction of laboratory and practical measuring instruments, all the most modern forms which are in present-day use being carefully described, both as to their construction and action.

Examples of calibration and testing are fully given, but perhaps chapter xxiv., on "indoor wiring and jointing," is one of the best. This subject is so fully dealt with and clearly explained by diagrams showing the various systems of wiring that it is one of the chief chapters in the book, although it need not be taken up for either of the examinations mentioned above.

(2) Mr. Shaxby has written a book which he hopes will assist the home reader and evening-class student. The latter mostly consist of men who during the day are employed on electrical machinery, the theory of which is little known to them. Consequently, Mr. Shaxby has written his book in the simplest and clearest manner, and mathematics are avoided as much as possible. The first part of the book deals chiefly with the theoretical side of electrical work, and the question of primary batteries is very fully gone into.

Alternating-current machinery is so very largely employed in works and mills at the present day that it does not surprise us to find the author devoting three chapters to the subject of alternating currents and alternating-current machinery. The author gives an adequate but simple explanation of their chief properties, and also supplies illustrations of modern generators and motors.

J. L. M.

Neinia, Denkversuche. By O. K. Kremer. Pp. 420. (Vienna and Leipzig: E. Beyers, 1907.)

This book is not likely to appeal to many readers of Nature. "Neinia," or Nein-Ja, represents the wish of the author to recognise any and every point of view as equally legitimate, although he personally professes to be an enemy of mystic metaphysics and a friend of materialism. He belongs to no particular philosophical school, but desires to think merely for the sake of thinking, without intending to prove any more or less unconsciously preconceived notions. This thinking cannot lead to any positive conclusion, and the book ends, characteristically enough, first with the sentence, "I believe nothing and therefore I believe everything," and then with the colophon, "U.S.W. *ad infin.*" The author claims for his book the advantage that one may begin to read it in the middle or from the end. This is no empty boast, for without wishing to depreciate a thinker who is evidently an earnest man, we cannot call his book anything but a collection of aphorisms.

Some Pages of Levantine History. By the Rev. H. T. F. Duckworth. Pp. iv+149. (London: Alexander Moring, Ltd., n.d.) Price 3*s*. 6*d*. net.

PROF. DUCKWORTH commends his book "to those of his countrymen who have either made, or intend to make, a pilgrimage to the holy places of Christian and Classical Antiquity," and it should certainly be of service to them. As he was formerly assistant chaplain representing the Eastern Church Association in Cyprus, he writes from first-hand knowledge in many of his chapters. The text is illustrated with several good plates.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Root Action and Bacteria.

MR. SPENCER PICKERING'S letter on the effect of soil sterilisation on the growth of apple trees (June 6, p. 126) is of interest in connection with experiments which have been made by Dr. Francis V. Darbishire and myself, and described in a paper read last year before the chemical section of the British Association. We find that most plants grow much better in heated than in unheated soils.

That the productiveness of a soil can be increased by heating was shown in 1888 by Frank, and has since been confirmed by other investigators besides ourselves. We have not yet been able completely to account for it. There is, beyond question, an increase in the total activity of the soil microorganisms; this is shown by the increased absorption of oxygen. There is also evidence that some chemical change takes place. Mustard grown in heated soil takes up a larger amount of nitrogen and of phosphorus, indicating an increased "availability" of some of the compounds of these two elements. One of our experiments gave the following results:—

		Yield of mustard in grams		Percentage composition of dry matter		
		Fresh weight	Dry weight	N	P_2O_5	K_2O
Heated soil	(*a*)	229·59	26·14	4·26	2·39	4·34
	(*b*)	226·15	24·04	4·80	2·01	5·07
Unheated soil	(*a*)	84·60	15·70	2·53	1·07	4·11
	(*b*)	88·70	16·05	2·09	0·92	4·29

Further, it is easy to show that heating increases the solubility both of the organic and of the inorganic matter in the soil. The actual change that takes place can only be ascertained when something more is known of the proximate constituents of the soil, and especially of the ill-defined colloidal bodies collectively known as humus.

The case is somewhat more complicated if the plant depends for part of its food on the activity of organisms which have been killed during the heating process. The increased "availability" of the plant food in the soil may or may not counteract the loss of the special organism; leguminous plants, and trees dependent on mycorrhiza, may therefore be expected to give irregular results.

A further complication may arise if the amount of calcium carbonate in the soil is insufficient. In certain circumstances humus is known to decompose and form bodies which, in absence of calcium carbonate, are injurious to plants. There is no evidence that a similar change does not take place on heating; on the contrary, one of Schulze's experiments (*Landw. Versuchs. Stat.*, 1906, lxv., 137) seems to show that it does. He found that heated pasture soil deficient in calcium carbonate gave a poorer crop of mustard than did the unheated soil, but on adding calcium carbonate the difference in crop disappeared. So far we have always worked with soils containing 3 per cent. or more of this substance, and no depressing effect has been observed, but it would be interesting to know how much was present in Mr. Pickering's soil. Unless there happened to be sufficient, the retardation in growth which he observed may well be due to some injurious body formed by heating the soil rather than to the absence of particular organisms.

EDWARD J. RUSSELL.

South-Eastern Agricultural College, Wye.

Unscientific Administration.

MAY I be allowed to offer a few words of comment on one point raised by Prof. Ronald Ross in his article appearing in this week's NATURE? No one can read his indictment of the Indian official attitude towards science without feeling that another voice crying in the wilderness is warning our administrators and governing classes of the dangers that await an unscientific nation that persists in the error of its ways. In explaining the cause of the present state of affairs, Prof. Ronald Ross says:—". . . Lastly, it is due to our defective public education." May I amend the phrase by interpolating the words "school and university" between the last two words quoted? For surely it is not the mass of the people who are to blame, but rather those who are directing the affairs of the country. Our governing classes have up till now been mostly educated at public schools and the universities of Oxford and Cambridge. To the latter institutions I will not refer. The Editor of NATURE, Prof. Turner, and Prof. Perry, not to mention the council of the Royal Society and others, have done sterling service to the cause of scientific education in their attempts to stir up public opinion; but, notwithstanding a special memorial from the Royal Society, neither university has as yet, by altering its entrance examination, acknowledged that science forms an integral part in a liberal education.

But with regard to science teaching in public schools, of which I may claim several years' experience, it is not too much to say that the outlook is far from promising. Notwithstanding the fact that governing bodies have voted money, built laboratories, and insisted on a minimum at least of science teaching, not one single public school, using the term in its usual application, has for its headmaster a man scientifically trained. The Naval College at Dartmouth and one or two grammar schools are the exceptions which prove the rule.

As a result of this, no science master can ever hope to get a headmastership, and the best men, therefore, do not enter the teaching profession. I should be far from wishing to assert that headmasters are not, as a rule, anxious to do the best they can for science, although their sympathies are with literary subjects, but they cannot do more than allow facilities for boys to learn science. The great clog to progress lies at the door of the assistant masters, who are as a body decidedly anti-scientific. What science master has not heard the opinion confidently asserted that science is only suited to the minds of a small minority of boys? They cannot and will not admit that it can be made an educational instrument of any moment. Who could not mention cases of clever boys being warned not to "waste their time" over science? Was not Darwin himself publicly rebuked for the same offence when a youth at Shrewsbury School? But if chemistry and physics are useless, biology is positively harmful. I have been told that biology should never be taught to boys, since it must turn their minds towards questions of sex about which they should be kept in perfect ignorance! Finally, it is said that the introduction of "modern" subjects such as science has only brought about mental confusion and stagnation, and the sooner we go back to the old exclusively classical curricula the better.

It is not hard to imagine what will be the attitude of mind towards science if the present generation of officials, against whom Prof. Ronald Ross brings his complaints, are succeeded by those who are now at our public schools and ancient universities. Surely it is not asking too much of some of our most distinguished men of science that they will follow in Huxley's footsteps, and once more bring home to our schools and universities the responsibility they are incurring by their attitude towards science in the education of the well-to-do classes.

Eton, June 13. M. D. HILL.

The Rainbow.

IN "Poems by Two Brothers," written by the Tennysons, and published in 1827, is a poem called "Phrenology." The following lines occur:—

> "Shall we, with Glasgow's learned Watt, maintain
> That yon bright bow is not produced by rain?
> Or deem the theory but ill surmised,
> And call it light (as Brewster) polarised?"

Can any of your readers kindly tell me (1) what view was held by James Watt about the rainbow? (2) If Brewster was the first to point out that its light is polarised? Brewster states that he observed the fact in 1812. (3) Having regard to the date (1827), what were the most probable sources of information to which the writer of the poem was indebted?

Lord Tennyson kindly informs me that the poem was probably written by Charles Tennyson.

CHAS. T. WHITMELL.

Invermay, Hyde Park, Leeds, June 5.

The Mass of the α Particle.

JUST too late to prevent the publication of my letter of last week, I perceived that the arguments contained in it are valueless. Rutherford's estimation of the number of α particles is based on the assumption that the charge on each of them is ε, and cannot be used to prove that proposition. The numbers given only show that the heat energy radiated by radium is approximately equal to the kinetic energy of the α rays, as has been pointed out by Rutherford. I regret that this foolish mistake should have led me to trespass needlessly upon your valuable space.

NORMAN R. CAMPBELL.

Trinity College, Cambridge, June 14.

Animal Messmates.

WHILE searching for marine animals on January 14, I came across some large specimens of *Ciona intestinalis*, which I kept for some time in a large bottle. After a while I noticed a small worm emerging from the larger or exhalent siphon, which, on examination by a competent authority, proved to be a small example of the nemertine worm *Drepanophorus rubrostriatus* = *Amphiporus spectabilis*, Qtrf. Other worms of the same species afterwards emerged, about ten being observed altogether. The Ciona betrayed no apparent annoyance at the egress or return of the creatures, though it withdrew its siphons at the slightest touch of any foreign objects. This observation seems to be a new instance of "animal messmates," or at any rate of the use of an ascidian's test for purposes of shelter by an active creature.

This has been confirmed on several subsequent occasions by myself and others; in one instance, a small Ciona, from which not fewer, but possibly more, than fifteen worms issued, the creature was so transparent that the worms could be observed moving about in its interior.

FRANK S. WRIGHT.

Guernsey, June 10.

Decomposition of Radium Bromide.

WITH reference to Prof. Porter's note in NATURE of June 13 (p. 151) on the odour of bromine detected on opening a sealed tube of radium bromide, it appears that the minimum quantity of bromine that is detectable by smell is between the orders 10^{-8} to 10^{-10} grams per cubic centimetre of air. This result has been obtained by the progressive dilution of a definite volume of bromine vapour. It may be mentioned that the vapour of bromine is just detectable by its odour at the temperature of liquid air.

ALFRED C. G. EGERTON.

University College, London, June 17.

THE DESTINY OF MAN.[1]

THE present volume contains three essays reprinted from two recent addresses and one article by the author. They have been slightly modified and freely illustrated for the present purpose. The first essay, "Nature's Insurgent Son," was delivered as the Romanes lecture at Oxford in 1905. It traces the history of man and his rebellion against nature, shows that his inevitable destiny is to transform rebellion into conquest, points to the causes of delay and the special responsibility for their removal which belongs to our universities.

The second essay, "The Advance of Science," served as the presidential address to the British Association at York in 1906. It gives an account of man's campaign against nature during the last twenty-five years. It is triumphantly successful in the difficult feat of rendering supremely interesting a brief general account of advance in all the great departments of science.

The third essay, "The Sleeping Sickness," reprinted from the *Quarterly Review*, gives an account of this recent terrible scourge of tropical Africa, and the attempts which have been made to deal with it. This essay is the other side of the picture presented in the second. The latter told of splendid successes in the warfare with nature; the present essay gives a startling example of those haphazard, unintelligent methods which bring terrible disaster upon man.

In attempting to give some account of this arresting and important work in the brief limits of the allotted space, I have thought it best to confine my attention to the central argument founded on man's history, rebellion and destiny. This argument, developed in the first essay, appeals strongly to the imagination, and supplies a powerful motive force which has been wanting in the case of earlier appeals for reform.

"Man is held to be a part of Nature, a product of the definite and orderly evolution which is universal; a being resulting from and driven by the one great nexus which we call Nature. He stands alone, face to face with that relentless mechanism. It is his destiny to understand and to control it."

This statement of man's origin is rightly held to contain no implied degradation—rather the reverse. It is only a superficial and ignorant view which sees in evolution the dominion of "chance." "The conclusion that Man is a part of Nature . . . is in fact a specific assertion that he is the predestined outcome of an orderly—and to a large extent 'perceptible'—mechanism." It was of importance to urge this conclusion again, a conclusion set forth, as the author states, by Tyndall in his presidential address to the British Association at Belfast in 1874, and again stated and admirably illustrated by Huxley in 1887.[2] But the error refuted in 1874 and 1887 was still alive and vigorous in 1905, and there is reason to fear that even now it is not wholly extinct.

The emergence of man—perhaps in Lower Miocene times—is shown to be the grand example of an evolution also witnessed in other animals. In many of the early Tertiary Mammalia, as well as in the ancestors of man, it is probable that mechanical form and function had reached a climax. From this point the struggle was conducted and evolution proceeded on a higher plane, and led to progressive increase in the size and powers of the brain. The author suggests the convincing hypothesis[3] that this sudden growth

1 "The Kingdom of Man." By E. Ray Lankester, F.R.S. Pp. xii+191. (London: Archibald Constable and Co., Ltd., 1907.) Price 3s. 6d. net.

2 "The Life and Letters of Charles Darwin." Edited by Francis Darwin. Vol. ii., Chapter v., Prof. Huxley on the reception of the "Origin of Species," pp. 179-201.

3 First published in "Cinquantenaire de la Société de Biologie." Pp. 43-51. (Paris, 1877.)

in the bulk of brain-substance—in animals as well as in ancestral man—signifies the substitution in large part of "educability" for a life controlled by inborn hereditary nervous mechanisms. An increased power of storing up and profiting by individual experience takes the place of all but the most fundamental and essential instinctive actions which are the inevitable outcome of inherited brain-structure. "The result is that the creature called Man emerged with an educable brain of some five or six times the bulk (in proportion to his size and weight) of that of any other surviving Simian." One of the most astonishing facts in this history is that so much of it was accomplished by early Palæolithic times, so that from this period to the present day "the bulk of his brain does not appear to have continued to increase in any very marked degree." We must, however, remember, as indeed the author reminds us, that Palæolithic man was probably not much more monkey-like than some of the existing savage races. The best implements of that age "are manufactured with great skill and artistic feeling"; they certainly go beyond the bare necessities of use as weapons or tools, and imply a life of immense complexity as compared with that of the highest animal. Although the subsequent increase in cranial capacity is surprisingly small, it is admirably shown, by two pairs of figures, to be very significant. By the courtesy of the publishers these illustrations are here reproduced. The first pair of figures, together forming the frontispiece of the work, represent above the cranial dome of Pithecanthropus, below the skull of a Greek, both seen from the left side. The former differs from the latter in the same features, but even more remarkably than do the Spey and the Neanderthal skulls.

"The three great features of difference are: (1) the great size of the eyebrow ridges (the part below and in front of A in the figures) in the Java skull; (2) the much greater relative height of the middle and back part of the cranial dome (lines *e* and *f*) in the Greek skull; (3) the much greater prominence in the Greek skull of the front part of the cranial dome—the prefrontal area or frontal 'boss' (the part in front of the line AC, the depth of which is shown by the line *d*)."

"The parts of the cranial cavity thus obviously more capacious in the Greek skull are precisely those which are small in the Apes and overlie those convolutions of the brain which have been specially developed in Man as compared with the highest Apes."

It is necessary to add a few sentences in explanation of the simple but extremely efficient set of lines by which the important differences between the skulls are indicated and can be assigned a quantitative value. The line A–B, in both skulls, is drawn from ophryon (the median point of a line drawn across the narrowest part of the frontal bone) to the extra-tentorial point between the occipital ridges. A–B thus practically represents the base-line of the cerebrum. Lines *e* and *f* are perpendiculars drawn respectively from the median point of A–B and the junction of the third with the posterior fourth of the same line.

The development of the frontal boss is clearly shown by the line A–C drawn from ophryon to bregma—the point of contact of frontal with both parietal bones. Line *d* is a perpendicular drawn from A–C to the most prominent point of the frontal boss.

The line A–B may be divided into units, and the lines *d*, *e*, *f*, indicating the depth of the brain-cavity at these three important points, expressed numerically as percentages of the ophryo-tentorial length.

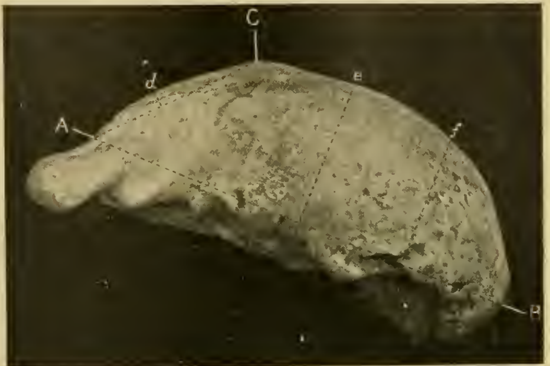


FIG. 1.—Cranial Dome of *Pithecanthropus erectus* from river gravel in Java. From "The Kingdom of Man."

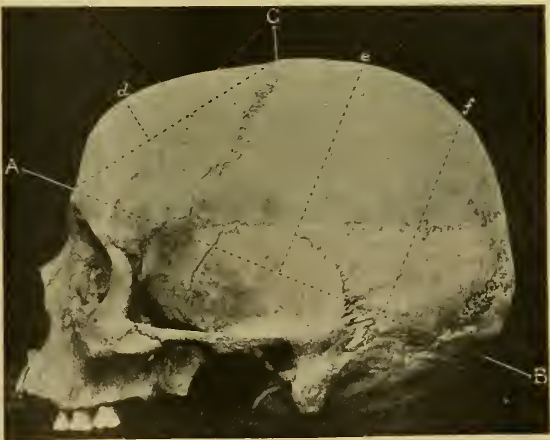


FIG. 2.—Skull of a Greek from an Ancient Cemetery. From "The Kingdom of Man."

The full significance of this method of comparison is only realised when the figures already described are considered in relation to those reproduced on the next page, Fig. 3, of course, corresponding to the upper, Fig. 4 to the lower of the preceding pair. It is here shown that line A–C—appearing as a straight line when the skulls were looked at from a little distance and placed so as to give an accurate side view—becomes when seen in front view the ovoid outline of the base of the frontal boss—the line where the frontal bone is cut by a plane at right angles to the sagittal plane, and passing through both ophryon and bregma. Similarly the line *d*, straight in the previous figures, becomes in front view the (white) line across the greatest breadth of the frontal boss. The astonishing difference between the size of this boss or prefrontal area in Pithecanthropus and that of the Greek skull is perhaps even more evident in these than it was in the former figures.

It should be mentioned that the Greek skull was selected because it happened to be a favourable example suitable for photographic reproduction, and not because of any special superiority in the crania from south-eastern Europe. Were it otherwise the author's illustrations might perhaps be called as evidence in favour of compulsory Greek!

We have directed special attention to these four figures because by their means the essential differences between the earliest known and the latest human crania are so clearly expressed; but, after all, the most striking fact that emerges is the immense size of the ancient brain and the relatively small increase which has since occurred. "The cranial capacity of many savage races and of some of the most ancient human skulls is only a little less than that of the average man of highly-civilised race. The value of the mental activities in which primitive man differs from the highest apes may be measured in some degree by the difference in the size of the man's and the ape's brain; but the difference in the size of the brain of Isaac Newton and an Australian black-fellow is not in the remotest degree proportionate to the difference in their mental qualities. Man, it would seem, at a very remote period attained the extraordinary development of brain which marked him off from the rest of the animal world, but has ever since been developing the powers and qualities of this organ without increasing its size, or materially altering in other bodily features."

It must, however, be again pointed out that, as the author states, these earliest human crania are probably Palæolithic, and thus belong to an advanced stage of human evolution with conditions not very different from those of certain savage races both existing and extinct within recent years.

The rise of the mind of man has finally led to a new "power in Nature, an *imperium in imperio*, which has profoundly modified not only man's own history but that of the whole living world and the face of the planet on which he exists." He has become "Nature's rebel," and "where Nature says 'Die!' Man says 'I will live.'" Finally, "he has advanced so far and become so unfitted to the earlier rule, that to suppose Man can 'return to Nature' is as unreasonable as to suppose that an adult animal can return to its mother's womb." But if man cannot go back he can go forward, and the author urges "the conscious and deliberate assumption of his kingdom by Man not as a matter of markets and of increased opportunity for the cosmopolitan dealers in finance—but as an absolute duty, the fulfilment of Man's destiny, a necessity the incidence of which can only be deferred and not avoided."

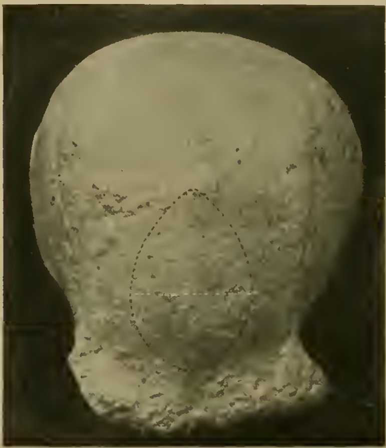


FIG. 3.—Pithecanthropus from Java.

FIG. 4.—Greek Skull.

From "The Kingdom of Man."

After tracing some of the chief lines in the past and urging the necessity for determined and active progress, the author proceeds to consider the causes of man's delay. These are found to spring from ignorance of the situation on the part of the masses of the people; and it is rightly argued that when the inevitable light shall have dawned the democracy will insist on very different qualifications in its public servants. The essay concludes by calling on the University of Oxford not to wait for the pressure that will surely come, but to take a foremost part in equipping mankind for further victories and a speedy entrance into the kingdom; and in order to play this splendid part, our ancient university is reminded that no new attitude towards learning is required, but a return to the old academic spirit which laid in Oxford the foundation of the Royal Society—this, together with some relaxation of the grip of the "present curriculum, . . . a mere mushroom growth of the last century."

It is astonishingly difficult to induce mankind to adopt fundamental changes in the methods of education. The results of education, although of boundless practical importance, are not immediately recognisable by those whose imagination has been stunted by the methods employed in their own youth. An inadequate cramping education tends to prolong itself; for youth, with all its hidden powers calling for development, must submit to the methods imposed by age. It is probable that no branch of the human race is more difficult to move than our own. The thought sometimes arises that salvation can only be found, if at all, by national disaster; and then, under modern conditions, the remedy may be too late and recovery impossible. About forty years ago Huxley delivered the powerful and eloquent addresses on education reprinted in "Lay Sermons, Addresses, and Reviews," and yet the same subject is felt to be still the paramount question of the hour when one of our foremost scientific men is invited to deliver the Romanes lecture in 1905. It is disheartening to read Huxley's admirable and convincing essays and to realise how small has been the effect. But a reformer who would achieve anything must not give way to despondency: it is only by hope and confidence in the future that mankind can be moved. And this latest appeal has one great advantage over the old. The history of man could not have been spoken of forty years ago as it can to-day; his interference with nature is also far more evident. In this latest appeal, the imagination of the author aroused by these considerations has originated the splendid argument founded on the deeds, the delay, and yet, in spite of delay, the inevitable triumphant destiny of man. It is not too much to hope that the power and the onward sweep of this great argument will carry away many an old but not time-honoured barrier, and many an obstacle built up, alas, in modern times, intervening between man and the race that is set before him. E. B. P.

INTERNATIONAL ASSOCIATION OF ACADEMIES.

A BRIEF note on the third triennial general assembly appeared in NATURE for May 30. The following academies were represented:—Amsterdam, Berlin, Brussels, Budapest, Christiania, Göttingen, Copenhagen, Leipzig, London (R.Soc.), London (B.Acad.), Madrid, Munich, Paris (Belles-Lettres), Paris (Sciences), Paris (Morales et Politiques), St. Petersburg, Rome, Stockholm, Tokio, Washington, Vienna. The English representatives mentioned in NATURE for May 30 were all present with the exception of Sir Norman Lockyer.

The proceedings opened on the morning of May 29 with a brief address from Prof. Suess, the president. Dr. Böhm-Bawerk (Vienna) was nominated vice-president, and the following as secretaries:—German, Gomperz (Vienna), von Lang (Vienna); French, de Lapparent (Paris), Senart (Paris); English, Turner (London), Gollancz (London).

M. Darboux (Paris) then announced that a medal had been struck by the French Government in honour of the first meeting at Paris. He presented the first copy to the Vienna Academy, and said that a copy would be sent to each constituent academy. The assembled representatives of science had been pictured on the medal as young girls, and, though scarcely in accord with the appearances round him at the moment, this representation had at least the merit of suggesting that science was always young.

It was decided by small majorities not to place on the agenda paper either the selection of an auxiliary language or the proposal for a symbolic nomenclature for machinery. Other questions dealt with at this meeting related to statutes and procedure.

On Thursday, May 30, the association met in two sections. In the section of science the report of the Brain Commission was received and placed on the minutes, no vote of approval being necessary since this commission has autonomous powers. A committee appointed in 1904 by the association to "consider the best method of bringing existing organisations into relation with the association" reported that they had made certain suggestions to the International Seismological Association which had been adopted, and that in consequence it had become possible for the United States, Austria, and England to join that association, while the adhesion of France was confidently expected.

Sir George Darwin presented a report on the possible cooperation of the International Geodetic Association in geological researches, by means of the study of anomalies in the value of gravity. There were difficulties (especially from lack of funds) in organising such cooperation; but the apparatus of Baron Eötvös seemed likely to give just the information desired, and it was to be hoped that the Hungarian Government would encourage experiments with this apparatus.

Prof. von Than announced that the Hungarian Government had promised a sum of 60,000 kronen annually for three years for work with the apparatus of Baron Eötvös. This announcement was naturally received with acclamation, and it was resolved to tender cordial thanks to the Hungarian Government. It was also decided to represent to the Italian Government the great importance of similar researches in the neighbourhood of active volcanoes such as Vesuvius.

A report by M. Ch. Lallemand on levelling operations urged the desirability of repeating precise levellings two or three times per century in all countries, in order to determine possible changes.

As bearing on the general importance of the work of the Geodetic Association, M. Darboux referred to the work of Prof. Milne in directing attention to the possible connection between variation of latitude and seismic phenomena.

With regard to the survey of the 30th meridian of longitude, Sir G. Darwin was able to report, on the authority of Sir David Gill, that the survey was now approaching the northern limits of British territory, where it was hoped that it would be taken over by Germany and carried through German territory. Further, that there was a good prospect that certain R.E. officers would be able to survey 2° of the meridian, in the neighbourhood of the Equator, and that Captain Lyons, F.R.S., the director of the Egyptian Survey, was hoping to begin the triangulation of the Nile Valley in the coming winter.

An interesting report of the Marey Institute was received, including the announcement of munificent assistance from the French Government and the city of Paris. Here again the Association hastened to tender cordial thanks for generous Government aid to science.

The proposal of the Royal Society for a committee on lunar nomenclature was adopted without opposition; and the following were nominated to serve on the committee, with power to add to their number:—Lœwy (chairman), Newcomb, Weiss, Franz, Saunder, and Turner.

The International Union for Solar Research successfully solicited the patronage of the association, in token whereof they were to report to it every three years, and to reserve one place on the executive committee (of three members) for a member to be nominated by the leading academy for the time being. It was unanimously decided, on the motion of Prof. Hale (Washington), respectfully to invite the Austrian

Government to consider whether, in view of the number of favourable stations existing in the neighbourhood of Vienna, they could encourage and assist solar observations.

An important resolution concerning the organisation of meteorological stations was moved by Dr. W. N. Shaw (London), and unanimously carried, as follows:—

Consideration of the distribution of meteorological stations over the globe shows that stations in the far north and on islands in the various oceans are of special importance; the International Association of Academies desires therefore to express the hope that the Governments concerned will take any necessary steps for securing the continuance of observations where they already exist; for the modification of their form, if necessary, to bring them into conformity with meteorological usage; for establishing stations where they do not yet exist; and for placing the observations at the service of science by suitable publication. As regards the far north, observations are desired from two or three stations, at least, in the north of Siberia and of the Continent of America respectively, and as regards the islands, the following list is suggested:—Greenland, Færöe Islands, Azores, Madeira, Canaries, Cape Verde, Ascension, St. Helena, Falklands, Fernando Naronha, Staten Island, Fernando Po, West Indies, Bermudas, Sandwich Islands, Carolines, Guam, Bismarck Archipelago, Samoa, Fiji, New Caledonia, Tahiti, Java, Borneo, Seychelles, Maurice, Réunion, Madagascar, Zanzibar, Socotra, Chagos Archipelago, Christmas Island, Karmaluki.

The Association reassembled in the afternoon, for a sitting which it was ultimately found necessary to adjourn until Sunday morning, June 2. The report on the publication of the works of Leibniz was received; already a catalogue of the Leibniz MSS. had been prepared and printed. The Association expressed the hope that the three academies which had prepared this catalogue (the Paris Academies of Science and of Moral and Political Science, and the Berlin Academy) would proceed to undertake and carry through a scientifically complete edition of the works of Leibniz, and that the necessary Government aid would be forthcoming.

The proceedings of the two sections were then approved in detail by the general assembly, including reports from the letters section on the international loan of MSS., on the Greek Thesaurus, and on the Corpus Medicorum Antiquorum.

It was decided to accept the invitation to hold the next meeting in Rome (1910), probably at Easter.

There were, of course, many hospitable entertainments. The Vienna Academy invited the delegates to the annual meeting on May 28; the president entertained them at dinner on May 29; there were delightful expeditions to the Semmering on June 1, and to the Schloss Kreuzenstein on June 2, which the Graf von Wilczek (the organiser of the Polar expedition which discovered Franz Josef land) has rebuilt on the old model, and filled with all the beautiful old pictures and pieces of furniture which can be collected. Finally, the delegates had the honour of being received by the Emperor in person on the evening of June 2, and of being present at the Opera on his invitation.

The success of the whole meeting was attested by the cordial words spoken at its conclusion by MM. Darboux (Paris), Schuster (London), and Kikuchi (Tokio), who joined in congratulating Prof. Suess and the Vienna Academy on the able manner in which the duties of the "leading academy" had been discharged during the last three years.

H. H. TURNER.

THE LEICESTER MEETING OF THE BRITISH ASSOCIATION.

LEICESTER people evidently intend doing their utmost to make the first visit of the British Association to their town as successful as it will be welcome, and the meeting itself promises to be both largely and influentially attended. Many foreign visitors will be entertained as guests by the local committee, the list already including representatives of science from the Cape, Canada, the United States, France, Germany, Austria, Russia, Switzerland, Holland, Prussia, Italy, Norway, Denmark, Sweden, and Greece.

The opening meeting is to be held in the Royal Opera House on Wednesday, July 31, at 8.30 p.m., when Prof. Ray Lankester, the retiring president, will vacate the chair, and Sir David Gill, K.C.B., F.R.S., assume the presidency and deliver his inaugural address. On Friday, August 2, a discourse on "The Arc and Spark in Radio-telegraphy" is to be delivered by Mr. W. Duddell in the same building, and on Monday, August 5, Dr. F. A. Dixey will discourse on "Recent Developments in the Theory of Mimicry" in the Temperance Hall. A lecture to the operative classes will be given on Saturday, August 3, also in the Temperance Hall, by Prof. H. A. Miers, F.R.S., on "The Growth of a Crystal."

Excursions are being arranged to Belvoir Castle, the seat of the Duke of Rutland; Chatsworth, the Duke of Devonshire's Midland home; Haddon Hall, and to Peterborough Cathedral, with an invitation to tea in the Palace grounds from the Bishop. In addition to a general excursion to the Charnwood Forest, there will be a special one both there and to the district of Belvoir for geologists, whilst the botanical section is also planning walks in the same district.

An interesting trip will be that over the Leicester and Swannington railway now forming part of the Midland Railway system. This is one of the earliest railways in the kingdom, and the honoured names of George and Robert Stephenson are closely associated with it. Opened for traffic in 1832, the first object of this railway was the provision of a cheap supply of coal from the district it tapped to Leicester, and there is no doubt its formation greatly influenced the prosperity of the town. From the West Bridge Station, Leicester, the line enters the Glenfield Tunnel, which is 1796 yards long, cut straight and level, 14ft. high, 12ft. 6in. wide, and built of 18in. brickwork. On the opening day a special train conveying the directors left Leicester for Bagworth. In entering the tunnel referred to the chimney of the engine, *The Comet*, was knocked down, with the result that the passengers travelled to the Glenfield end through thick smoke and dust. The train was stopped at the Glenfield Brook to permit of a general washing of faces and hands. At Bagworth an incline of 1 in 29 was originally worked by a rope 1000 yards long, 5 inches circumference, the full wagons of coal pulling up the empties. The Swannington incline, 1 in 17, has since 1833 been worked by a fixed winding engine and rope. The original engine, one of the first to be fitted with a piston-valve, is still in use. From the commencement, three passenger trains ran daily from the West Bridge Station, Leicester, and these still continue to be run, to almost the original times. It was owing to a collision at this station between an engine and a country cart, and the consequent smashing of a lot of eggs, that the engine whistle was invented for the purpose of sounding warnings. The chief boot and shoe and hosiery works in the town are to be visited, as well as the works of the water and gas and electric lighting undertakings of the Corporation. The principal Council schools will also be open for inspection.

Sectional meetings will be held on four or five days of the meeting at carefully chosen centres. The presidents of the various sections are as follows:—A (Mathematical and Physical Science), Prof. A. E. H. Love, F.R.S.; B (Chemistry), Prof. A. Smithells, F.R.S.; C (Geology), Prof. J. W. Gregory, F.R.S.; D (Zoology), Dr. W. E. Hoyle; E (Geography), Mr. G. G. Chisholm; F (Economic Science and Statistics), Prof. W. J. Ashley; G (Engineering), Prof. S. P. Thompson, F.R.S.; H (Anthropology), Mr. D. G. Hogarth; I (Physiology), Dr. A. D. Waller, F.R.S.; K (Botany), Prof. J. B. Farmer, F.R.S.; L (Educational Science), Sir Philip Magnus, M.P.

Every care is being taken in order to ensure the comfort and convenience of all attending the various meetings, and when the arrangements are completed it is anticipated that the accommodation generally will compare most favourably with that provided elsewhere. The various local secretaries are enthusiastically working with headquarters in the endeavour to make the Leicester meeting one to be long remembered for real usefulness and importance. The ladies of the town have formed a special hospitality committee, and are working to make, as they hope, ample provision for the large number of expected guests.

THE ASWAN RESERVOIR.

THE Egyptian Government has lost no time in arranging for the archæological survey of that portion of the Nile Valley which will be submerged by the Aswan reservoir when the dam has been raised seven metres above its present height.

The archæology of Nubia has not so far been very thoroughly studied, so that a comprehensive scheme of work must include:—(1) The consolidation of the foundations of ancient structures; (2) such repairs as are necessary to ensure their safety; (3) the copying of all inscriptions, and a complete photographic record of these buildings; (4) complete plans of each building, showing all structural details; (5) systematic excavation, together with the preparation of plans and photographs of all ancient sites, cemeteries, &c., which will be damaged by the increased level of the reservoir; (6) a complete topographical survey of the valley, which will also indicate all sites, buildings, &c., of archæological interest.

Under the arrangements which have been made by Sir William Garstin, G.C.M.G., Adviser of the Ministry of Public Works, the first three of these will be carried out by the Department of Antiquities; the last three sections, which constitute a survey, both topographical and archæological, will be carried out by the Egyptian Survey Department.

As the dam in its present condition admits of the water-level being raised 1·5 metres if necessary, the investigation of the area which would be affected by this will be undertaken at once, and preparations have been made to commence work in the early autumn of this year.

The recent cadastral survey of Nubia, 1:2500 reduced to the scale of 1:5000, will be utilised as the basis of the topographical survey in order to record the position of all ancient settlements, cemeteries, and structures as they are taken in hand, while the slopes of the valley will be surveyed and contoured.

The Egyptian Government has secured the services of Dr. G. Reisner, who will commence the systematic excavation of ancient sites at the end of September next at the southern limit of the area now submerged. From this point work will be carried on southwards so as thoroughly to examine the valley floor on either bank up to the future level of the reservoir (113 metres above sea-level), and as much above that as may be necessary on account of the water soaking the ground for some distance above it.

The Egyptian Government has included in the estimates for raising the dam a sum of 60,000*l.* for this work, which should suffice both for a thoroughly scientific study of the reach which is to be submerged, and for the necessary work of consolidating the foundations of temples. Facilities will be given to any archæological institutions which may wish to undertake the study of any site, and will thus facilitate the work. All other parts which have not been systematically explored by such institutions will be examined in due course by Dr. Reisner and his staff, and the results will be published so as to form a complete archæological record of this reach of the river.

PROF. ALFRED NEWTON, F.R.S.

WHILE zoological, and more especially ornithological, science has been deprived of one of its most illustrious students and exponents by the death of Alfred Newton, Cambridge has sustained an even more severe blow, both scientifically and socially. For not only has she lost in the late occupant of the chair of zoology a distinguished professor and working zoologist, and a great benefactor to her zoological museum, but likewise a social figure, whose place can never be exactly filled. For the past forty years or so the informal receptions held in term-time by Newton on Sunday evenings at his well-known rooms in Magdalene formed a unique feature in the scientific life of the university. To these gatherings not only were resident zoologists and the more advanced scientific students from all the colleges in Cambridge constant and welcome visitors, but older *alumni* re-visiting their *alma mater*, as well as zoologists educated at other seats of learning, were received and greeted by their host in that genial manner peculiarly his own. Reunions such as these must, unhappily, die with the man to whom they were due; but those in the smoky atmosphere of the old rooms at Magdalene will linger long in the memories of all the kindly old professor's former pupils and friends.

Born in Geneva on June 11, 1829, Alfred Newton belonged to an old East Anglian family, being the fifth son of William Newton, of Elveden, Suffolk, sometime M.P. for Ipswich, by Elizabeth, daughter of R. S. Milnes, of Fryston, Yorkshire, who represented his county town in Parliament. As a boy he was educated privately, but in due course he entered Magdalene College, Cambridge, as an undergraduate, and took his B.A. degree in 1853. In that year, as well as in 1852, he gained the English essay prize at Cambridge; and in 1854 he was elected to a travelling fellowship at his college, which he held until 1863. During the time that he held the travelling fellowship, Newton visited Lapland, Iceland, the West Indies, and North America, while in 1864 he accompanied Sir (then Mr.) Edward Birkbeck to Spitsbergen, then but little known zoologically. To these travels may in all probability be attributed a large proportion of his unrivalled knowledge of the distribution and habits of European birds. At a later period, during a visit to Heligoland, Newton sustained an injury in landing from a boat, which seriously increased a lameness due, we believe, to an accident in childhood. Ornithological observations were, however, continued for many years subsequently during summer yachting cruises, undertaken in company with the late Henry Evans, on the west coast of Scotland and elsewhere.

The most important and far-reaching event in the life of Newton occurred in the year 1866, when he was elected to the then newly-established professorship of zoology and comparative anatomy, a somewhat poorly paid office, which he held until his death on the 7th day of the present month, although he had for some years given up lecturing. The active part which he (in conjunction with his old friend Mr. J. W. Clark) took in the development of the Zoological and Anatomical Museum, and the energy with which he did all in his power to promote the study of zoology in the university, are known to all Cambridge biologists. As to his lectures, these, despite the fact that he was to a great extent a specialist in ornithology, covered a very wide field, in which, however, the systematic and distributional aspects of his subject loomed large.

So long ago as 1859 Newton was elected a Fellow of the Zoological Society of London; and two years later commenced a long, although, of course, interrupted, service on the council of that body, of which he was also for many years a vice-president. In 1870 he received the Fellowship of the Royal Society, and served on the council from 1879 to 1881, and again from 1889 to 1891, being also a vice-president during the latter period. From the same body he received in 1900 one of the Royal gold medals, while he was also the recipient in the same year of a gold medal from the Linnean Society, of which he was for many years a fellow. It should be added that in 1877 he was re-elected to a fellowship at his old college, which thus remained his home until the end of his days. Needless to say, the Cambridge Philosophical Society claimed him for a long period as a fellow, and subsequently as president.

Two years after his election to the professorial chair, that is to say, in 1868, Newton brought before the British Association the subject of the protection of birds; and he was subsequently for several years chairman of the close-time committee, during which period the first three Acts devoted to bird-protection were passed by Parliament. As the British Government was the first to move in this matter, Newton may be regarded as the father of bird-protection throughout the world, and, indeed, of all legislation of this nature, which had its origin in his early efforts. His endeavours to check the hideous cruelties connected with the collecting of so-called osprey plumes form another of his many claims to the gratitude of posterity. The establishment and maintenance of stations for observing the migration of birds also claimed a large share of his time and attention, and he was for many years chairman of the British Association Migration of Birds Committee. The important results which have accrued (and are still accruing) from these observations are familiar to all naturalists.

The scientific writings of Newton, which relate chiefly to ornithology, are remarkable for their finished and scholarly style, as well as for their extreme accuracy. To ensure both these attributes the author would, in the first place, defer sending his MS. to press as long as possible, and when it was in type he would go on correcting and refining until both printers and publishers must in many cases have been driven to the verge of insanity. As he was also a slow writer, the production of such of his works as were issued in parts extended over unconscionably long periods. Although, as already mentioned, characterised by the excellence of their literary style, Newton's writings in not a few instances were marked, more especially in footnotes, by criticisms of perhaps rather more caustic character than the occasion demanded.

Newton's earliest recorded paper appears to be one on the cedar-bird, published in the *Zoologist* for 1852, this being followed in the next year's issue of the same journal by one on the habits of the kiwi. His visit to the West Indies was marked by the appearance in 1859, in the first volume of the *Ibis*, of a paper on the birds of those islands. This reference to the *Ibis* affords a convenient opportunity of mentioning that Newton took a prominent part in founding that invaluable journal, of which he edited the second series (1865–70). He also took an active share in founding the *Record of Zoological Literature* (now the *Zoological Record*) a publication without which the study of zoology would now be practically impossible. To the first six volumes Newton contributed the annual record of the class Aves, while he acted as editor from 1871 to 1874 (vols. vii.–ix.). It may be added that his exertions and influence were no less important at a later period in bringing about the establishment of the British Ornithologists' Union.

The fact that during the 'sixties his brother Edward held the post of auditor-general of Mauritius (subsequently becoming governor) seems to have directed the attention of Alfred Newton to the birds, both living and extinct, of the Mascarene Islands. In 1861 and 1863 we find him, for instance, describing certain new birds from Madagascar and Mauritius; while in 1868 he and his brother communicated to the Royal Society a most important paper on the remains of the dodo-like bird from Rodriguez commonly known as the solitaire (*Pezophaps solitaria*), this paper being published in the Phil. Trans. for the following year. The same subject was continued at a later period, when Newton and Mr. J. W. Clark communicated a joint paper, published in the "Zoology of the Transit of Venus Expedition of 1874," a second paper, on the extinct birds of Rodriguez, other than the solitaire, being contributed by Dr. A. Günther and Newton to the same volume. The dodo was also a bird in which Newton was greatly interested, although the description of its remains from the Mare aux Songes was undertaken by his brother, Sir Edward Newton.

At an early period in his career Newton contributed to the *Ibis* (vol. iii., 1861) an epitome of John Wolley's investigations into the history of the extermination of the great auk, or gare-fowl; and from that time to his death the story of that bird was a subject to which his attention was constantly devoted. Indeed, we believe that at the very end of his active career he was engaged on a monograph which should comprise all that is known of that remarkable species.

One of Newton's earliest papers was "Suggestions for forming Collections of Birds' Eggs," published in London in 1860, and from that time onward the study of eggs attracted a large share of his attention. About this time he appears to have come into possession of the magnificent collection made by the late John Wolley—on condition, we believe, that he would write a descriptive catalogue embodying the collector's notes. The first part of "Ootheca Wolleyana" appeared in 1864, while the last was issued only a few months before the author's death. For a long period Newton believed that eggs might afford important clues to many vexed questions connected with avian relations; but this hope he was reluctantly compelled, in the main, to abandon. The Wolley collection of eggs, largely augmented by its late owner, is, we believe, to pass to the University of Cambridge, as is also Newton's valuable ornithological library.

To the general public the late professor is perhaps best known as editor of the first two volumes of the revised and enlarged fourth edition of "Yarrell's British Birds," the first part of which appeared in 1871, although the second volume was not completed until 1882. On the value of this work (completed by Mr. Howard Saunders) it is unnecessary to dilate.

Not less important were the contributions of Newton to the ninth edition of the "Encyclopædia Britannica," these comprising not only a large series of articles on different groups and species of birds, but likewise the article "Ornithology"; the article "Birds," it should be added, being the joint work of Newton and the late Prof. W. K. Parker. With the assistance of Prof. H. Gadow, these articles were subsequently combined by their author to form the well-known "Dictionary of Birds" (1893–1896), which forms a perfect mine of information on ornithological subjects. To this work a few articles were contributed by Dr. R. W. Shufeldt, Mr. C. S. Roy, and the present writer (by whom it was deemed a special honour to be thus associated with his former teacher). The article "Ornithology," which forms the introduction to this volume, is a perfect model of a classically written essay, and includes practically everything that there is to be said regarding the history of the subject of which it treats; while the one on "Migration" is no less important and philosophical.

As regards the other ornithological work of Newton, it must suffice to refer to a chapter on the ornithology of Iceland, issued as an appendix to S. Baring-Gould's "Iceland" (1863), to one on the birds of Greenland in the "Arctic Manual" (1875), and to a list of the birds of Jamaica in a handbook to that island, published in 1881.

To assume that Newton confined his attention to ornithology would, however, give but an inadequate idea of the scope of his knowledge. From the first he was an enthusiastic student of zoological distribution, and in 1862 he read before the Cambridge Philosophical Society a paper "On the Zoology of Ancient Europe," published the same year as a pamphlet by Messrs. Macmillan. In this he directed attention, for the first time, we believe, in this country, to the fact that the name "aurochs" belongs by right to the extinct wild ox (*Bos primigenius*), and not to the bison. His studies had also convinced him that the separation of the northern portions of the two hemispheres as distinct primary zoological regions—the Palæarctic and the Nearctic—is not supported by the facts; and at his suggestion Prof. A. Heilprin in 1882 proposed to unite them under the name of the Holarctic. That this is the true view (especially if the southern portions of the eastern and western divisions be severally cut off as the Sonoran and Mediterranean transitional regions) scarcely admits of argument. A small zoological text-book, of which the first edition appeared in 1874, likewise bears witness to the breadth of Newton's knowledge.

Although essentially conservative in all matters connected with natural history, Newton could not be termed a bigoted Tory in these matters; and when he saw occasion to change or modify his views, he had no compunction in doing so. He was an early convert to evolution, and in 1888 published a pamphlet entitled "Early Days of Darwinism"; and as evidence of the elasticity of his mind in regard to lines of investigation with which he was personally out of touch, reference may be made to his earnest support of the morphological and embryological investigations of the late F. M. Balfour, and of the Mendelian researches of the present day. As regards ornithological classification, he maintained to the last the advisability of employing generic terms in a wide sense. Whether he would ever have given his approval to modern views on nomenclature and the subdivision of species are questions which need not here be discussed.

The late professor, to quote from the obituary notice in the *Times* of June 8, "was gifted with an affectionate nature, which was not the less real because it found little verbal expression, and, possessed of old-fashioned courtesy of manner, he had the best characteristics of the race of English country gentlemen to which by birth he belonged. Stanch in his friendships, firm in his opinions, and following what he held to be right with dogged perseverance, he was a man of whom anyone might well be proud to be the friend, and one whom a very wide circle is now most genuinely mourning."

To the present writer, if he may be allowed to say so, the loss is a very real one—more so than he cares to state fully in public. R. L.

NOTES.

We regret to announce that Prof. A. S. Herschel, F.R.S., died on Tuesday, June 18, at his residence, Observatory House, Slough.

The French section of the Alliance Franco-Britannique will pay a visit to London from June 30 to July 5, and will be entertained at dinner by the British section on July 1.

The third Prehistoric Congress of France will be opened at Autun on August 12 by the president, Prof. Adrien Guébhard, and will close on August 18. Particulars may be obtained from M. Marcel Baudoin, 21 rue Linné, Paris.

Four lectures on plague are being delivered by Dr. W. J. R. Simpson as the Croonian lectures of the Royal College of Physicians. The first lecture was delivered on Tuesday, and the second is to be given to-day. The two remaining lectures will be delivered on June 25 and 27.

Science announces that at the recent session of the Pennsylvania Legislature the Senate voted 60,000*l.* to enable the American Philosophical Society to erect a memorial to Franklin, but the house did not agree to the Bill.

Mr. W. T. Hornaday has presented to the New York Zoological Society his collections of heads, horns, and tusks, comprising 131 specimens, representing 108 species. These are to form the nucleus of a collection to be exhibited at the New York Zoological Park.

A report from Santiago de Chile states that a severe shock of earthquake occurred at Valdivia on June 13. A violent earthquake was also felt at Kingston, Jamaica, on the same date, at 1.20 a.m. The earthquake was especially severe at Port Royal. A curious turbulence of the sea was noticed. An earthquake was felt at Gibraltar at 5 a.m. on June 16.

Through the generosity of several members of the Pillsbury family, of Minneapolis, Dr. Thomas G. Lee has secured, says *Science*, for the department of histology and embryology, University of Minnesota, the working library of the late Prof. W. His, of Leipzig. This collection comprises more than 8400 monographs and other papers contributed by over 2500 different authors.

An exhibition of engineering models, optical, electrical, and scientific instruments, technical education appliances, and tools, is to be held at the Royal Horticultural Hall, Vincent Square, Westminster, S.W., on October 22–26. In addition to exhibits by leading makers, there will be a loan collection of experimental and exhibition models and apparatus, and also lectures and demonstrations in various branches of applied science.

The Victoria and Albert Museum has been opened to the public exactly fifty years to-day. On June 20, 1857, Queen Victoria and Prince Albert, accompanied by the Princess Royal (afterwards the Empress Frederick), the Archduke Maximilian of Austria (afterwards Emperor of Mexico), Prince Frederick William of Prussia (afterwards German Emperor), and a numerous suite, attended in the evening the opening of the South Kensington Museum, as it was at that time styled. In it there were exhibited several miscellaneous collections of a scientific character, mainly acquired from the Exhibition of 1851. The whole of the fine art collections which had been exhibited at Marlborough House since 1852 were also removed to South Kensington, and these were supplemented by valuable loans from H.M. Queen Victoria and others. Immediately after the opening of the temporary museum the erection of permanent buildings was commenced, and various portions were completed and opened in successive years. The greater part of the original iron building was taken down in 1868, and re-erected as a branch museum at Bethnal Green. The foundation stone of the new buildings was laid by H.M. Queen Victoria on May 17, 1899, and by her late Majesty's command the name of the institution was changed to that of the Victoria and Albert Museum.

The Engineering Conference of the Institution of Civil Engineers, which began on June 18, will conclude to-morrow. On Tuesday, June 18, Dr. Francis Elgar, F.R.S., delivered the fifteenth James Forrest lecture, taking for his subject "Unsolved Problems in the Design and Propulsion of Ships." The conference was opened formally on June 19, when the president of the institution, Sir Alexander Kennedy, F.R.S., delivered his inaugural address. This evening a conversazione is to be held at the Albert Hall. The business part of the conference is being carried on in the sections, in connection with which meetings are taking place daily until 1 p.m. There are in all seven sections, which, with their chairmen, are as follows:—Section i., railways, Mr. William R. Galbraith; Section ii., harbours, docks, and canals, Sir William Matthews, K.C.M.G., who is also president-elect of the institution; Section iii., machinery, Prof. W. C. Unwin, F.R.S.; Section iv., mining and metallurgy, Mr. John Strain; Section v., shipbuilding, Dr. F. Elgar, F.R.S.; Section vi., water works, sewerage, and gas works, Sir George T. Livesey; Section vii., applications of electricity, R. E. B. Crompton, C.B. We hope to publish an article on the conference in a future issue.

Two important additions to the collection in the Natural History Museum were put on exhibition for the first time at the conversazione of the Royal Geographical Society, held in the hall of the museum on Friday last. The first is the mounted skin of a male okapi, obtained during the late Alexander-Gosling expedition on the River Welle, near Angu, in the northern part of the Congo Free State, and presented by Mr. Boyd Alexander. The second is a model of the complete skeleton of the marsupial Diprotodon, based on material obtained by Mr. E. C. Stirling in the Lake Cadibona district of south central Australia. In this skeleton some portions of the limbs and feet are represented by the original bones. Diprotodon, it will be recalled, was named many years ago on the evidence of a lower jaw described by Sir R. Owen. Now that the complete skeleton is known, there is little doubt that the creature was a gigantic relative of the wombats, retaining, perhaps, in its foot-structure evidence of arboreal ancestry. In one of the recesses on the right side of the central hall were also exhibited portraits and relics of Linnæus. The portraits of the great naturalist, represented by small woodcuts, were ten in number. Several Linnæan manuscripts sent from Bloomsbury were shown, as well as several books from the library of Linnæus (the property of the Linnean Society), and certain plants from his herbarium.

In accordance with previous announcements, the autumn meeting of the Iron and Steel Institute will be held in Vienna on September 23–25. An influential reception committee has been formed, with an executive consisting of Mr. W. Kestranek, central director of the "Prager Eisen Industrie Gesellschaft" as chairman, Max Ritter von Gutmann as vice-chairman, Mr. Richard von Schoeller as treasurer, Baron von Jüptner, A. Ritter von Kerpely, Mr. F. Schuster, and Mr. Hugo von Noot as members, and Dr. Eugen Herz and Mr. H. von Noot, jun., as honorary secretaries. The provisional programme of the meeting is as follows:—On Monday, September 23, the president, council, and members will be welcomed by the reception committee, by the Government and civic authorities, and by the president of the Society of Engineers and Architects, at the headquarters of which the meeting will be held. A selection of papers will subsequently be read and discussed. In the afternoon, members and the ladies accompanying them will be taken for a drive through Vienna and in the Prater, visiting the Municipal Museum and the Town Hall, where they will be received by the Lord Mayor of Vienna, and in the evening a special performance at the Imperial Opera House will be arranged. On Tuesday, September 24, the morning will be devoted to the reading and discussion of papers, and the afternoon to a visit to the Imperial Palace at Schönbrunn. On Wednesday, September 25, the whole day will be devoted to an excursion to the Hoch-Schneeberg. In the evening the members and ladies will be invited to a banquet at the Hall of the Musical Society. At this and at all the other functions, including the visit to the opera, the members and ladies will be the guests of the Austrian Iron Works. On Thursday, September 26, will begin the excursions to the works to be visited in (1) Bohemia; (2) Styria; and (3) Moravia and Silesia.

It is reported in the daily Press that Prof. von Leyden has arrived at the conclusion that the development of cancer is due to the diminution or absence of certain chemical substances in the liver. Further details will be awaited with interest.

In the *Bio-chemical Journal* for May (ii., Nos. 5 and 6) Drs. Garrod and Clarke describe a new case of alcaptonuria, Drs. Little and Harris discuss the metabolism in a healthy vegetarian, Dr. Barger and Mr. Dale describe the physiological action of some of the constituents of ergot, Dr. Drabble, Hilda Drabble, and Daisy Scott discuss the influence of neutral salts on the size of the cells of pleurococcus and saccharomyces, and Prof. Moore and Drs. Nierenstein and Todd publish experiments on the treatment of trypanosomiasis with atoxyl, an organic arsenical compound, followed by a mercuric salt, showing that this combination is much more successful than atoxyl alone.

At a meeting of the Pathological Society of London on June 4, Drs. Sambon and Seligman described a number of hæmogregarine parasites obtained from snakes. Dr. Pye-Smith, the president, gave a valedictory address, for the society as such ceases to exist, being merged (as the pathological section) into the new Royal Society of Medicine.

By the amalgamation of fifteen out of the twenty or twenty-five medical societies of London, the Royal Society of Medicine has been constituted, the incorporated societies forming the sections of the new society. A meeting was held on June 14 for the purpose of receiving and adopting a Royal charter. The meeting was presided over by Mr. Warrington Hayward, the president of the Royal Medical and Chirurgical Society, the wealthiest and principal society of the amalgamation, when Sir William Church was elected the first president. Each society (now a section) will carry on its special work as before. The Royal Society of Medicine will commence with a membership of 4000, an annual income of nearly 8000*l*., and possesses a library of 80,000 volumes.

A list of the palæontological type specimens in the collection of the Boston (U.S.A.) Society of Natural History, by Mr. J. A. Cushman, has been published as No. 6 of vol. xxxiii. of the Proceedings of that body.

Bulletin No. 4 of the Division of Entomology, Honolulu, is devoted to a further account of the parasites of leaf-hoppers, by Mr. R. C. L. Perkins, together with descriptions of certain new Hemiptera, by Mr. C. W. Kirkaldy, the material having been almost entirely collected in Arizona.

A paper on the ants of Saxony, by Mr. H. Viekmeyer, and one on change of function in various animal organs, by Mr. A. Jacobi, form the most important zoological contributions to the *Abhandlungen* of the Dresden Isis for the second half of 1906 (1907).

In the May number of *Naturen* Mr. O. J. Lie-Pettersen concludes his account of Scandinavian thrushes, in which special attention is directed to the dates of arrival of the migratory species. "F. V. H." figures a horse with a supplemental front toe, which was successfully removed in the Copenhagen Veterinary Institution.

"Dwellers in our Rock-pools" is the title of a small illustrated booklet describing the common littoral fauna of Folkestone. The author is Mr. F. Rutt, and the pamphlet is published by Messrs. A. Stace and Sons, of Folkestone, at the price of threepence. We have also to welcome a cheap re-issue of Mr. E. W. Wade's "Birds of Bempton Cliffs," published by Messrs. A. Brown and Sons, Ltd., of London, Hull, and York, at one shilling.

The functions of the "spiracles" in skates form the subject of an interesting article, by Mr. H. W. Rand, in the May number of the *American Naturalist*. Some time ago the author received about half a dozen skates which had been out of the water for nearly an hour, and were consequently presumed to be dead. When salt water was discharged on them from a hose, they gradually, however, showed signs of returning life, and eventually spouted copious jets of water from their spiracles. As such a phenomenon had not been previously noted by the author, he set himself to study the functions of the spiracles generally. Owing to the habit of lying flat on the sand, the spiracle, of which the primary function is to take in water, appears of much more importance to skates than to sharks. In addition to serving as an intake, it also acts as an exhalent orifice, soft substances, such as fragments of seaweed, which have gained an entrance into the gill-chamber, being expelled by spouting through the spiracles. Spouting also appears to be employed as a means of keeping the eyes clean.

In the May number of the *Zoologist* Mr. C. M. D. Stewart discusses a somewhat mythical snake known to the Zulus as "ndhlondhlo." It was reported to be of huge size, poisonous, very fierce, and furnished with a feather-like crest, while it was also asserted to utter a whistling cry. Its name forms one of the titles of the Zulu king. The main question appears to be whether the creature was a distinct species or whether we have to do with overgrown individuals of the one locally known as the black mamba (*Dendraspis angusticeps*, var.). A snake shot by the Commissioner of Zululand about 1874, measuring about 16 feet in length, and regarded by that gentleman as a black mamba, was declared by the Zulus to be a ndhlondhlo. Certainly naturalists have no knowledge of black mambas of that length, but this by no means proves that such may not have existed. The argument used by the author, that as no such giants are now known the ndhlondhlo must have been a distinct species, does not seem to us to carry much weight.

In his Huxley memorial lecture for 1903 (Nature, vol. lxviii., p. 607), Prof. Karl Pearson showed that the mental and moral characters of man are inherited in much the same manner as the physical characters. "We inherit," he said, "our parents' tempers, our parents' conscientiousness, shyness and ability, even as we inherit their stature, forearm and span." This conclusion was arrived at as the result of a prolonged investigation of fraternal resemblance between children, based on the estimates of school teachers. At the Francis Galton Laboratory for National Eugenics, University of London, the inquiry has been extended to material derived from class lists of the University of Oxford and the school lists of Harrow and Charterhouse, and the results are given in a memoir—"The Inheritance of Ability," by Edgar Schuster and Ethel M. Elderton—just published (London: Dulau and Co., price 4*s*.). The definite object of the investigation was to determine as exactly as possible the resemblance between father and son and brother and brother, as indicated by successes or failures in passing the examination for the B.A. degree at Oxford, or by their positions in school at Harrow and Charterhouse at corresponding times. The results obtained from the Oxford material show that the correlation between father and son is represented by 0·312, and that between brother and brother by 0·405, on a scale by which complete resemblance would be indicated by 1 and no resemblance by 0. The public-school material gave the value 0·398, which is in close agreement with the Oxford value, for the correlation coefficient between brother and brother. The general result of the inquiry is therefore to confirm Prof. Pearson's conclusions as to the inheritance of psychical characters in man.

A reprint has been received of an account of the development of the common mushroom, *Agaricus campestris*, contributed by Prof. G. F. Atkinson to the *Botanical Gazette* (September, 1906). Examination of the very early stages indicated that, except for the universal veil, no differentiation was noticeable until the hymenium or spore-bearing layer develops and marks off the stem and the cap. The author states that he has found two spores only arising from the basidia in cultivated varieties, whereas he has often identified four spores in normal pasture forms.

In the *Trinidad Bulletin* (April) Mr. J. H. Hart, referring to the packing of seeds for the tropics, discriminates between seeds that can be fully dried without injury, such as the seeds of temperate plants, and the seeds of many tropical plants that lose their vitality if only a small percentage of water is removed. A botanical irregularity in the shape of a nutmeg-tree bearing both staminate and pistillate flowers is recorded from the island. Allusion is also made to a variety, *longipedunculata*, of the palm *Pritchardia pacifica*, distinguished by the length of the flower stalks, of which plants have been raised from seed originally supplied from British Guiana.

An irregular series of nuclear changes in the development of the embryo-sac of *Peperomia hispidula*, differing slightly from the development in *Peperomia pellucida*, is described by Prof. D. S. Johnson. Sixteen nuclei are formed in the embryo-sac, of which two become the nuclei of the ovum and one synergid respectively, while the remaining fourteen fuse to form the endosperm nucleus; also the divisions of the endosperm nuclei are at once followed by the formation of cell-walls, so that the endosperm is cellular from the start. A preliminary notice with illustrations is published in the Johns Hopkins University Circular (March), wherein Mr. W. D. Hoyt records the observation of crops of sexual cells of *Dictyota dichotoma* at monthly intervals at Beaufort, North Carolina, as compared with fortnightly crops observed by Mr. J. Lloyd Williams at Bangor.

We have received from the Engineering Standards Committee copies of the British standard specification for ingot steel forgings for marine purposes (No. 29, price 2*s*. 6*d*. net), and of the British standard specification for steel bars for use in automatic machines (No. 32, price 2*s*. 6*d*. net). The former is based on the present specifications of the Admiralty, the Board of Trade, and the three leading registry societies, whilst the latter is based upon evidence collected from users and manufacturers. The mechanical tests and chemical analyses of steel bars for use in automatic machines are also based on the evidence obtained, supplemented by the results of actual testing. Owing to the widely different results when bars of small diameter are subjected to mechanical tests, it has been decided not to include such tests for steel bars less than half an inch in diameter.

In 1903 the Canadian Government appointed a commission to investigate the different electrothermic processes for the smelting of iron ores and the making of steel in operation in Europe. Since that date experiments have been made by Dr. P. Héroult at Sault Sainte Marie, Ontario, under Government auspices, in the smelting of Canadian ores in a specially designed electric furnace. The superintendent of mines, Dr. E. Haanel, has now issued a detailed report (Ottawa: Department of the Interior, 1907) containing in 149 pages a statement of the work done and of the results obtained, with analyses of the pig iron and slag produced and of the iron ores employed. Illustrations of the furnace and machinery used are given. The results obtained were most gratifying, and were briefly as follows:—Canadian ores, chiefly magnetites, can be smelted as economically as hæmatites in the electric furnace. Ores high in sulphur can be converted into pig iron containing only a minute proportion of sulphur. The silicon content can be varied as required for the class of pig iron to be produced. Charcoal, which can be cheaply produced from waste material, and peat-coke can be substituted for coke. Nickeliferous pyrrhotite and titaniferous iron ores containing up to 5 per cent. of titanium can be successfully treated. The far-reaching consequences of these results will be apparent. Many magnetites are too high in sulphur to be dealt with in the blast-furnace, and consequently have hitherto been of no commercial value. The introduction of electric smelting, too, will render it possible to utilise water-power that cannot at present be profitably employed for any other purpose, and to utilise peat bogs and mill refuse or sawdust, for which there has hitherto been no use. An appendix contains an account of recent improvements in electric smelting made in Sweden and in Germany.

In the *Rendiconti* of the Lombardy Institution, xl., 8, Prof. Torquato Taramelli gives a short obituary notice of the work of Dr. Benedetto Corti. This work consists largely in the study of the fossil microzoa of the Tertiary and Quaternary deposits of Lombardy, and forms an important contribution to Italian geology.

Dr. Giovanni Zappa, writing in the *Atti* of the Lincei Academy, discusses the possibility of the instruments in the observatory at Padua being affected by tides in the Adriatic. The author makes calculations of the gravitational effects, based on tide tables, using a method of triangulation as a basis of rough computation, but the results appear to be too small to have any appreciable effect even on the seismographs at Padua.

In the Bulletin of the St. Petersburg Academy of Sciences, Prince B. Galitzin describes an experimental verification of Doppler's principle for light rays, conducted in collaboration with J. Wilip. Use was made of rotating mirrors, as in the experiments of Bielopolsky, but by means of the graduated spectroscope (Stufenspektroscope) described previously by Prince Galitzin, it was possible to photograph and measure the displacements of the spectral lines of a mercury arc lamp used as the source of light. In this way quantitative results were obtained within the limits of experimental error.

Mr. C. E. Benham, writing from Colchester, June 4, points out that it is a common practice in lantern demonstrations, when it is desired to minimise the heat radiation, to interpose a cell of alum solution, though distilled water is actually more athermanous than water with alum in solution. The common belief that an alum solution is very opaque to thermal rays was disproved many years ago, but evidently has not yet quite disappeared even at the present time.

The supplement to *Mitteilungen aus den deutschen Schutzgebieten* (vol. xx., part ii.) contains the observations made in the year ended June, 1906. Taking into account the results from all stations, the rainfall was favourable, but less in amount than in the two previous years. The annual falls vary, according to position, from 27·5 inches to 0·3 inch; May to August are practically rainless months. The largest amount recorded in one day was 4·5 inches, at Seeis, in the central district, on January 30, 1906. The stations now number seventy, against sixty-seven three years previously, notwithstanding that two-thirds of them were destroyed or necessarily abandoned after the outbreak of the war.

Owing to a slight accident, Mr. Francis Galton was unable personally to deliver his Herbert Spencer lecture at Oxford, referred to in last week's Nature (p. 158), but the lecture was read by his cousin, Mr. A. Galton.

An illustrated guide to holiday resorts in the United Kingdom has been published under the title of "The Holiday Whitaker" by Messrs. J. Whitaker and Sons, Ltd. The present edition is intended as a guide to resorts for the summer season, and it is proposed to issue another and different edition for the winter season.

Accurate and interesting "guides" greatly assist the intelligent visitor to examine and understand the objects exhibited in a museum. The trustees of the British Museum are rendering a great service to natural science in ordering the publication of the excellent series of handbooks to accompany the admirable collections exhibited at the Natural History Museum, South Kensington. The most recent of these volumes is the "Guide to the Fossil Invertebrate Animals in the Department of Geology and Palæontology," which, with its seven half-tone plates and ninety-six text figures, will enable the visitor to the galleries to appreciate the significance and importance of the various fossils on view. We learn from the director's preface that the book has been written by Dr. F. A. Bather, and that the formerly published "Guide to the Fossil Invertebrates and Plants" is partly replaced by the present volume, the price of which is one shilling.

Several new volumes belonging to the concise and comprehensive series of Hoepli manuals have recently been received from the publisher, Mr. U. Hoepli, Milan. Two volumes by Prof. P. E. Alessandri, entitled "Merceologia Technica," deal respectively with natural and chemical products of commercial and industrial use. Caoutchouc and gutta-percha is the subject of a volume by Dr. L. Settimj, and the preservation of foods of one by Drs. G. B. Franceschi and G. Venturoli. Other volumes are on taxidermy, by Dr. R. Gestro; radio-activity, by Dr. G. A. Blanc: and limnology, or the scientific study of lakes, by Dr. G. P. Magrini.

Many publications of deep scientific interest have been issued by the Carnegie Institution of Washington and described in the columns of Nature. A list has just been received of ninety-two works available now or shortly which the institution has published or has in the press. Applications for the list or for copies of the works not out of print should be sent to the Carnegie Institution of Washington, D.C., U.S.A.

The Proceedings of the Anglo-Russian Literary Society for February, March, and April have now been published in one small volume. The papers read at the monthly meetings of the society, one of the objects of which is to promote the study of the Russian language and literature, are here reprinted. We notice in an obituary of the great Russian chemist, Mendeléeff, the remark, "A prophet is not without honour, save in his own country; Mendeléeff was black-balled at the elections in the Imperial Academy of Sciences."

Messrs. West, Newman and Co. have published a fifth edition of the late Rev. Joseph Greene's "Insect Hunter's Companion." The little book, which runs to 120 pages, gives instructions for collecting and preserving butterflies, moths, beetles, bees, flies, &c., and has been revised by Mr. A. B. Farn. Its price is 1*s.* 6*d.* net.

OUR ASTRONOMICAL COLUMN.

Another New Comet, 1907*d*.—A telegram from the Kiel Centralstelle announces the discovery of the fourth comet of this year by Mr. Daniel, at Princeton, on June 14. The object was of the eleventh magnitude, and at 14h. 19·1m. (Princeton M.T.) on the day of discovery its position was

R.A. = 23h. 48·53 m., dec. = 1° 8′ S.,

which lies about half-way between λ and 29 Piscium. The daily motion is given as +34′ in R.A. and +14′ in declination.

A second telegram from Kiel states that this comet was observed by Prof. Aitken at the Lick Observatory on June 13, when its position at 15h. 7·2m. (Lick M.T.) was

R.A. = 23h. 59m. 44·4s., dec. = 0° 10′ 16″ S.,

which is about 22·5m. E. and $1\frac{1}{2}$° S. of λ Piscium. This object is apparently becoming brighter at a rapid rate, for Prof. Aitken gives its magnitude as 9·5.

Titanium Flutings in the Spectrum of α Orionis.—From the examination of the spectrum of α Orionis taken with the four-prism spectrograph, Mr. Newall believes that he has discovered the presence of three titanium flutings in the red end of the spectrum of that star. The wave-lengths determined for the heads of the flutings, viz. λλ 7053, 7087, and 7124, agree fairly well with those found by Messrs. Hale and Adams in the spectrum of the titanium-arc flame, whilst collateral evidence, based on the analogy between the spectra of sun-spots and third-type stars, suggests that these bands are to be expected in stellar spectra of the α Orionis type, because they have been found in sun-spot spectra. Two other flutings, with heads at λλ 5166·8 and 5447·1 respectively, were also found, and agree with the heads of the two strongest Ti flutings found by Prof. Fowler.

An inter-comparison of sun-spot spectra and the spectrum of α Orionis shows that numerous spot lines occur in the stellar spectrum (Monthly Notices R.A.S., vol. lxvii., p. 482, May).

Tin in Stellar Atmospheres. On examining some spectrograms of α Scorpii for radial-velocity determinations, Mr. Goatcher, of the Cape Observatory, found a persistent discrepancy occurring when measurements of the wave-length of a line at about λ 4525 were reduced, this line always giving a velocity about 6 km. per second too low. This discordance was examined by Mr. Lunt, who arrived at the conclusion that it is probably due to the hitherto unsuspected presence of a tin line, the wave-length of which, according to Exner and Haschek's tables, is λ 4525·00. In the region covered by the spectrum which was examined, the latter observers give only one other tin line, and as this, according to Sir Norman Lockyer's published tables, is an enhanced line, it is not to be expected in the spectrum of α Scorpii (Antarian type). Should Mr. Lunt's conclusion be confirmed, it will be the first occasion on which tin has been shown to exist in the atmosphere of a star (Monthly Notices R.A.S., vol. lxvii., p. 487).

Non-polarisation of the Light of Prominences.—In a note appearing in No. 21 (May 27) of the *Comptes rendus*, M. Salet states that, although he was able, during the total solar eclipse of 1905, to show that the coronal radiations down to the edge of the moon were polarised, he was unable to observe any trace of polarisation in the prominence radiations. M. Salet then points out that this result appears to introduce a contradiction to the theory of Prof Julius, that the monochromatic light of a point on a prominence comes in reality from a point on the photosphere, for, according to Schmidt, such a ray would be strongly deviated by the successive refractions of the solar envelopes, and should then become partially polarised, the quantity of polarisation depending, by Fresnel's theory, only on the value of the deviation. The absence of polarisation seems, therefore, to argue that the light is not deviated, and, consequently, that it does not have to pass through the solar atmospheres from the disc.

Nova T Coronæ of 1866.—Some interesting observations concerning Nova Coronæ are made by Prof. Barnard in vol. xxv., No. 4 (p. 279, May), of the *Astrophysical Journal*. Before its outburst this star was of magnitude 9·5, then it increased to the second magnitude, finally relapsing to 9·5. Novæ generally fade away to a much less brightness than this.

Prof. Barnard has repeatedly examined this star with the 40-inch refractor, but can find no difference of focus such as usually exists between the light from faded Novæ and the stars in general. Estimations of magnitude show that the star still has essentially the same magnitude that it had before 1866; there is no definite indication of motion in the Nova. Prof. Barnard found a faint nebula in the field with the Nova, the nebula being of magnitude 14·0 or 15·0, and having a diameter of 5″ to 10″ with no nucleus.

THE SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES.

THE twelfth annual congress of the South-Eastern Union of Scientific Societies, which opened at Woolwich on June 12 and closed on June 15, was in every way a very successful gathering. At the first evening meeting, held in the New Town Hall, Mr. Francis Darwin, F.R.S., the retiring president, introduced his successor, Prof. Silvanus P. Thompson, F.R.S., who delivered the inaugural address. This was an eloquent discourse, mainly on the value of voluntary work in science—such work as is carried on non-professionally by members of local scientific societies constituting the South-Eastern Union. These societies consist chiefly of persons who may be called, in the best sense of the word, amateurs. Exposing the fallacy of the popular saying that "a little knowledge is a dangerous thing," the president advocated the cultivation of scientific hobbies, enlarged on the value of acquiring a taste for studies outside the monotonous round of daily work, and showed how science had frequently been advanced by the work of amateurs. Among examples of famous amateurs, he pointed to William Herschel, originally a teacher of music; Gilbert, of Colchester, who was a medical man; and Joule, a Manchester brewer: nor were Spottiswoode, De la Rue, and Dr. Dallinger overlooked, whilst Sir Edward Fry's study of British mosses was cited as a contribution to science by an eminent lawyer. But to an audience at Woolwich the most telling example was that of William Sturgeon, the inventor of the electromagnet, who lived at one time as a shoemaker at Woolwich. Electricity has indeed been to a large extent a layman's science.

Prof. Thompson dwelt at some length on Goethe's researches on colour, and rather startled his hearers by affirming that in the famous controversy with Newton the poet-philosopher was in some sense right. Looking at natural science with the eye of a poet, Goethe failed to comprehend the value of Newton's work, and obstinately maintained that in the prismatic analysis of light the colour was derived from the prism itself, and not from the white light. But though it is generally held that the *Farbenlehre*, in which he published his views, embodies an elaborate optical heresy, it has, strangely enough, been recently shown by Lord Rayleigh's researches that there is, after all, some truth in Goethe's contention.

As Prof. Thompson proceeded, he rather surprised the naturalists by recalling his early rambles in Yorkshire, and showing himself to be an excellent botanical observer. The preservation of our wild flowers, which are really the property of the community, is an important subject which he commended to the consideration of local societies. It would be true patriotism, he held, to establish a New Primrose League for the protection of this flower, which in some places, as in Epping Forest, has become practically extinct. Another subject which he suggested might be advantageously taken up by the societies of the South-Eastern Union was that of constructing a map of the Weald, which should show the position of all the old furnaces, forges, hammer-ponds, cinder-heaps, and other relics of the iron-making industry for which the Weald was so long famous.

It is interesting to note that by the generous action of the local committee the presidential address of Prof. Thompson was open to the public. This innovation was one of several excellent features that characterised the Woolwich congress.

As it unfortunately happened that Prof. Thompson was unable to attend after the delivery of his address, the subsequent proceedings of the congress were presided over by a former president, the Rev. T. R. R. Stebbing, F.R.S. At one of the meetings an interesting lecture on an experiment in cooperative field-work in botany was given by Prof. F. W. Oliver, F.R.S. A few years ago a party of students acquired a salt-marsh with sand dunes at Erquay, in Brittany, where they have established a laboratory. The vegetation consists chiefly of suæda grass and salicornia, backed by a growth of juncus. The observations have been directed mostly to the study of the way in which the growth of halophytes is affected by variation in the salinity of the soil.

An evening lecture was given by Mr. W. Whitaker, F.R.S., entitled "Some Ideals for Local Geologists," in which he offered excellent advice to the societies in the union, urging upon their members the necessity of cultivating habits of observation and seizing the opportunity of describing every geological section that might be exposed within their area. At other meetings Dr. Treutler, of Brighton, read a paper on Goethe as a naturalist; Mr. Norman Gray brought forward some suggestions for making local scientific societies more efficient; Mr. W. H. Griffin discussed the antiquity of the horse, with special reference to remains found in Kent; and Mr. G. F. Chambers advocated the storage and use of rain-water for domestic purposes.

In the excursions to which the afternoons were devoted Mr. Whitaker was the principal guide when geology was concerned, whilst the archæological remains were described mostly by Mr. W. T. Vincent, the president of the Woolwich Antiquarian Society, who also read a paper at the congress on local archæology.

At a reception given in the Town Hall by the Mayor of Woolwich, two illustrated lecturettes were delivered, one by Dr. G. Abbott entitled "Life in Rocks and Minerals," dealing chiefly with the formation of concretions, followed by one on xerophytes by Mrs. W. Plomer Young, of the Battersea Polytechnic.

An interesting feature of the meeting was the temporary museum, which contained an exceptionally large collection of objects illustrating natural history, under the superintendence of Mr. W. H. Griffin, of Catford. Many of the exhibits showed the results of nature-study in the elementary schools of the London County Council, and by the thoughtfulness and generosity of the local committee the children of the neighbouring schools were brought in parties to visit the museum.

It had been intended to present the delegates of the constituent societies of the union with a local handbook, similar to that sometimes issued at meetings of the British Association. But so large a number of writers had contributed essays on special subjects of local interest that the printing was delayed, and the publication necessarily deferred.

It should be remarked that the conspicuous success of the Woolwich congress was mainly due to the fact that the work of the honorary secretary, the Rev. R. Ashington Bullen, was aided by a powerful local committee, which included such enthusiastic workers as the Rev. C. H. Grinling and Mr. W. T. Vincent.

THE INSTITUTION OF MINING ENGINEERS.

THE forty-sixth general meeting of the Institution of Mining Engineers, which now numbers more than 3000 members, was held in the rooms of the Geological Society, London, on June 13 and 14, and was attended by a large and representative gathering from the various coal-mining districts. Mr. Maurice Deacon gave an admirable presidential address, in which he reviewed the recent improvements in coal-mining practice, and indicated the directions in which further progress might be sought. Mr. H. R. de Salis discussed the improvements required in inland navigation, urging that the authorities controlling the canals should be re-organised. When the works of improvement have been carried out and efficient waterways provided, the problem of mechanical haulage will soon be solved. Mr. W. B. M. Jackson described the by-product coking plant at Clay Cross, a new plant of fifty Simplex ovens with all the mechanical appliances electrically driven. Mr. A. Victor Kochs also read a paper on by-product coking, in which he described the latest forms of the Koppers oven. Water supplies by means of artesian bored tube wells were dealt with at considerable length by Mr. H. F. Broadhurst; Mr. W. J. Kemp and Mr. G. A. Lewis described the occurrence and mining of gypsum in Sussex, in the beds discovered by the sub-Wealden exploration of 1872. The mine is undoubtedly a model of modern practice. The proceedings on Thursday concluded with a paper by the Rev. J. M. Capell, the inventor of the fan bearing his name, in which he urged that the application of duplicate fans on one upcast shaft would result in great economy.

On Friday Mr. Austin Hopkinson discussed the reform of British weights and measures. Mr. J. T. Brown described the methods of working the thick coal of Warwickshire, expressing, incidentally, the opinion that coal seams exist more or less continuously, but at great depth, under the large tract of country between the South Staffordshire and East Warwickshire collieries. Mr. D. M. Chambers gave an account of the mining of ozokerite at Boryslaw, in Galicia. Mr. C. Sandberg drew some general conclusions regarding the origin of the geological structure of South Africa. His conclusions are as follows:—The main directions of mountain-folding pressures have been north and south and east and west, the result of the former being predominantly evident in the central zone and that of the latter on the periphery of South Africa. These orogenic forces worked simultaneously, and together built up the tectonic structure of South Africa, which may thus no longer be regarded and studied as the outcome of many different and local, that is, comparatively insignificant, causes, that have worked independently of one another. These systems of forces acted on all the strata of the geological systems, from the Primary upwards, either at different periods, or possibly during one long period, when there was active deposition of the younger sediments in one place and denudation of the older in another. The origin of poorten (gaps in mountain ranges), river valleys, and pans is traceable to the same causes which produced anticlines and synclines, brachy-synclines, basins or domes, that is, to fold-producing pressures, the former set of phenomena being, in fact, only modifications or diminutives of the latter.

Another paper on South African geology was contributed by Mr. A. R. Sawyer, who gave some information regarding the general geological conditions obtaining in the New Rand goldfield in the Orange River Colony. The last paper was by Mr. H. W. G. Halbaum, who discussed the contradictory formulæ given by various authorities for the strength of cast-iron tubbing, and proposed a rational formula in which the action of corrosion as well as of the pressure to which the tubbing is subject is taken into account. In connection with the meeting, visits were arranged to the generating station of the Great Western Railway at Park Royal, and to the Portland cement works at Northfleet. The next meeting of the institution will be held at Sheffield on September 4, 5, and 6.

THE PLANET SATURN.

SATURN has now become well visible as a morning star. The rings being turned nearly edgeways to the earth, the belts in both hemispheres may be observed to advantage. The irregular markings can also be satisfactorily seen, as there will be practically no interference from the rings.

This planet is perhaps more utilised as a "show" object than as a subject for critical study by observers. There is no doubt, however, that it is well calculated to repay the most diligent attention. It is true that there is rarely an outbreak of such magnitude on the disc as that which affected the N. temperate region of Saturn in the summer of 1903. In fact, it would appear that really well-marked instances of irregular spots among the dark belts or bright zones are by no means frequent. Prof. Barnard said that the spots which he discovered in 1903 were the first he had ever distinguished upon the planet, and certainly these particular markings were the first that had been clearly and satisfactorily seen by the writer, though he had been observing Saturn for more than thirty-five years.

It is extremely probable that the real surface of Saturn, like that of Jupiter, is hidden from our view. We cannot therefore determine the rotation period of the planet's actual globe, but only of the dense vapours floating above it and forming its atmosphere. These vapours are obviously influenced by great differences in velocity, the period of the N. temperate latitude being twenty-three minutes longer in 1903 than the equatorial region in 1876–7. It is very desirable to ascertain the rates of velocity of the various latitudes, as has been done in the case of Jupiter. To this end the planet should be examined frequently at every opposition, so that, whenever any visible disturbances present themselves, a large number of their transits across the central meridian may be taken. In certain years, according to the best testimony, the belts are apparently smooth and even with no interruptions or irregularities due to dark and light spots. Visible atmospheric disturbances no doubt occur on Saturn more often than is supposed. Jupiter's envelope presents very frequent evidences of eruptions and irregularities capable of producing very conspicuous and in some cases long-enduring spots. To Saturn, therefore, the most beautiful planet of our system, we may naturally look to afford us fuller information as to his surface currents if observers will but keep a critical eye upon the physical aspect of the object as seen in good telescopes.

W. F. DENNING.

THE INTERNATIONAL COUNCIL FOR THE STUDY OF THE SEA.

THE sixth meeting of the International Council for the Study of the Sea was held at the Foreign Office in London on June 13 and 14, when delegates and experts representing Norway, Sweden, Finland, Russia, Germany, Denmark, Holland, Belgium, and Great Britain were present and took part in the discussions. The meeting was formally opened at noon on June 13 by Sir Edward Grey, Secretary of State for Foreign Affairs, who was accompanied by Lord Carrington, President of the Board of Agriculture and Fisheries. Prof. Otto Pettersson, of Stockholm, vice-president of the council, occupied the chair in the absence of the president, Dr. Herwig, of Hanover.

Sir Edward Grey said that from the necessities of our geographical situation and of our associations we have a natural interest in everything that concerns the sea. We have a great interest in the practical side of the labours of the Council, and are not deficient in interest in the scientific side as well. The British Government has shown the interest which it attaches to work of this kind by continuing for another year its subscription to the work of the Council. It must be a question of increasing interest as to whether the means of capture of fish in the sea, and the increase of the demand, are tending to overtake the natural supply. It is, of course, impossible to deal with this subject adequately simply by legislation within our own territorial waters, because the territorial limits of the sea have been arranged without any special regard to the habits of the fish, and the habits of the fish have been arranged by nature without any special regard to territorial limits. Therefore, whatever measures may be taken for ourselves, and whatever separate investigations other countries may make for themselves, if any question arises as to how the protection of fish in the North Sea can be controlled, encouraged, and preserved, it must form the subject of discussion between the different countries which are interested in the high seas.

Prof. Pettersson said that five years have passed since the commencement of the international investigation of the sea and eight years since the lines of the researches were laid down by the conference in Stockholm. The bounty of the Governments has supplied the means to carry on the work of investigation on a larger scale than has perhaps ever before been employed in scientific enterprise. The Council is convinced that the statesmen of Great Britain were well advised when they engaged their country to participate in this international work, of the ultimate success of which the Council feels assured. The British Government has taken the wise and just decision to devote a year to an inquiry in order to gain a sure ground for its future action. This work the Council leaves in the hands of the British Government with the utmost confidence.

Dr. Lewald (Germany) said that the German Government was of opinion that investigations must be continued, and that some form of international cooperation was required. M. Hamman (Belgium) and Commander Drechsel (Denmark) also spoke. The subsequent proceedings of the Council were conducted in private.

In connection with the meeting of the Council, Prof.

Otto Pettersson delivered a lecture on Monday, June 10, before the Royal Geographical Society, on "Oceanic Circulation," in which he elaborated his theory of the influence of melting ice in the polar regions upon the general circulation of the oceans. In the course of the discussion which followed, Dr. Nansen gave a short account of the Norwegian hydrographical results and the nature of the actual currents which had been found to exist in the Norwegian Sea. He directed special attention to the cyclonic nature of the currents, which had been found to exist in that area. Prof. Gilson (Belgium), Prof. Homen (Finland), and Dr. Hjort (Norway) also spoke.

From June 10 to June 13 the delegates and experts were engaged on the work of the various committees of the Council, when arrangements for the conduct of the investigations during the coming year were elaborated.

The very full programme of festivities in connection with the conference, which was referred to in our last week's issue, was most successfully carried out, and it was felt by all who took part in the proceedings that much benefit would result from the friendly intercourse which took place during the week between the representatives of science on the one hand and those of the official and fishing interests on the other.

On Friday, June 14, the delegates and experts were received at Buckingham Palace by the King, who expressed his sense of the importance of the work in which they were engaged.

INTERNATIONAL CONFERENCE ON SLEEPING SICKNESS.

REUTER'S Agency announces that, at the invitation of the Colonial Office, a conference of various African colonies and protectorates has been summoned to discuss concerted international measures for dealing with sleeping sickness. This conference met at the Foreign Office for the first time on Monday, Government delegates being present from Germany, Congo Free State, France, Great Britain, Portugal, and the Sudan. The delegates are as follows:—Germany, Herr von Jacobs, Dr. Ehrlich, and Dr. Fulleborn; Congo Free State, Colonel Lantonnais, Vice-Governor General, Commandant Tonneau, M. Rutten, and Dr. van Campenhout; France, Dr. Kermorgant, Dr. Paul Gouzion, Prof. Blanchard, and Dr. Laveran; Great Britain, Lord Fitzmaurice (president), Sir W. Foster, Mr. A. W. Clarke, Mr. H. J. Read, and Sir Patrick Manson; Portugal, Dr. Correa Pinto; Sudan, Colonel Hunter and Dr. Balfour, of the Gordon College, Khartoum. The work before the conference includes the question of the holding of regular conferences, the establishment of a central bureau of information, and the assignment of definite points for investigation to particular countries or individuals. Lord Fitzmaurice, president of the conference, made the following remarks at the opening meeting to describe the objects in view:—

We are met together in the hope that it may be possible to concert measures which will enable the Powers which we represent to wage a more effective warfare against that terrible epidemic of sleeping sickness, which has already devastated so great a part of Africa, and which appears to be assuming even greater and greater proportions. This disease, as you are aware, has decimated the natives in large areas of the Congo Free State; it has levied a heavy toll on the natives of Uganda, of whom 200,000 out of a total population of 300,000 in the infected area have fallen victims to it. It has invaded portions of the French Congo and the Portuguese possessions; it has appeared the Sudan, and is now threatening German East Africa, Rhodesia, and the British Central Africa Protectorate. Already not a few Europeans have died of the disease, and many of those still alive are known to be infected.

By a bitter irony the European administration of Africa, while producing a more settled state of affairs than formerly existed, has led to more frequent and more extended travel on the part of the natives, and so helped to diffuse and spread the infection. In view of this state of affairs, which is little less than a calamity for tropical Africa, His Majesty's Government has been endeavouring, by subsidising and otherwise encouraging investigation into the nature and cause of sleeping sickness, to acquire the necessary knowledge on which to base a scheme or schemes for the prevention, and possibly the cure, of this disease. Happily these efforts have met with considerable success. It has been definitely ascertained that *Trypanosoma gambiense* is the cause of the disease, and it is all but proved, both experimentally and by analogy, and also by considerations of distribution, that this parasite is conveyed from the infected to the uninfected by at least one species of tsetse-fly (*Glossina palpalis*), and that the distribution of this fly is strictly limited to the close neighbourhood of open water. It has further been ascertained experimentally in animals, and therapeutically in man, that the infection, once acquired, can be controlled to some extent by various substances—arsenic, certain colours, dyes, and combinations of arsenic and colour dyes—*e.g.* atoxyl—and by mercury. Lastly, though sometimes difficult to diagnose in its incipient stages, symptoms have been discovered which enable the expert to recognise the earlier, and, from the point of view of infection, equally dangerous stages of the disease. It may be that we are already, in these respects, in possession of the knowledge which, if energetically applied, would enable us to prevent the spread and possibly to exterminate sleeping sickness. It is by no means improbable that there are other factors at work determining the spread of the disease, of which we are at present in ignorance, and which, if ignored, might render futile any efforts, founded on a limited knowledge, we might take.

As our several countries are responsible for the good government and prosperity of tropical Africa, His Majesty's Government, feeling sure that they would be willing to cooperate in the struggle against sleeping sickness, has asked them to send you here to devise some scheme directed to this end, and by way of initiating discussion on the subject, I would submit for your consideration the following outline:—(1) Annual or biennial conferences of delegates from the several countries interested in sleeping sickness; (2) a central bureau to extract and circulate all new literature on the subject; (3) assignment of definite points for investigation to particular countries or individuals—*e.g.* (*a*) to determine whether *Glossina palpalis* is a direct or an indirect conveyer of the trypanosome; (*b*) if the trypanosome undergoes necessary developmental changes in the *Glossina palpalis*; (*c*) if such be the case, whether the developed germ be conveyed by the original Glossina or by its larva, when the latter arrives at its imago stage; (*d*) how long an infected Glossina continues infective; (*e*) whether other species of Glossina can convey the trypanosome; (*f*) the geographical distribution of the infecting species and their habits; (*g*) the *rôle* the vertebrate fauna other than man play in the spread of the infection; (*h*) the best methods for exterminating Glossina; (*i*) the best methods for preventing the introduction of the infection into virgin country; (*j*) the best methods of controlling the spread of the disease in an infected country, including segregation of the infected and removal from the infected area of those as yet uninfected; (*k*) the experimental study on animals of drugs which destroy the trypanosome; (*l*) the therapeutical application of these drugs to man.

Doubtless other points for consideration will occur to the delegates. The foregoing have been suggested merely to start discussion. In conclusion, His Majesty's Government feels sure that, unless cooperation is secured, not only will time and labour be lost by the superfluous overlapping of the uncoordinated studies of men of science, but that it will be impossible to carry out anything like a general plan in the nature of quarantine or the restriction of the movements of the native population more immediately interested in this important disease. Much money and effort are now being expended by the different European administrations, but as there is no common plan of action there must be a considerable waste of energy. It is in the hope of organising the forces of those administrations to the best advantage against the common enemy that His Majesty's Government has invited the Powers concerned to send their representatives to this conference.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following are the speeches delivered on June 12 by the Public Orator, Dr. Sandys, in presenting the three recipients of the degree of Doctor of Science *honoris causa* :—

(1) SIR CLEMENTS MARKHAM, K.C.B., F.R.S.

Sequitur deinceps Regiae Societatis Geographicae per annos quinquaginta quidem minister indefessus, per duodecim praeses praeclarus, cuius sub ductu Societas illa diu floruit, et non modo Britannorum in doctrinae sedibus honoris locum est adeptus, sed etiam terras remotissimas, et praesertim regionem polo Australi propinquam, exploravit. Idem quot iuuenes rei naualis peritos trans maria longinqua scientiarum finibus proferendis excitauit! Quam feliciter ipse ex intimis Peruuiae penetralibus arborem contra febrium impetus ui salutari praeditam, etiam in Indiam, populi totius cum magno commodo, transtulit! Quot regiones peragrauit, peragratas litterarum lumine illustrauit! Ergo, et sibi ipsi, et collegis suis orbem terrarum totum explorantibus, nemo melius poëtarum Latinorum uerba illa potest arrogare :—

"Quae regio in terris nostri non plena laboris!"
"Viximus insignes inter utrumque"—polum.[1]

(2) COLONEL SIR THOMAS HUNGERFORD HOLDICH, K.C.M.G., K.C.I.E., C.B.

Societatis Geographicae praesidi emerito nemo potest opportunius succedere quam praesidis ipsius uicarius, miles fortissimus, Indiae totius explorator audax, qui praesertim in tellure Russorum imperio contermina, montium arduorum inter ambages, gentium barbararum inter arma, animo intrepido regionis difficillimae, regionis prope inextricabilis, fines designauit. Idem in America Australi inter respublicas duas confines controuersiam magnam de limite communi exortam, populi utriusque non sine magno commodo, terminauit. Is autem qui scientiarum doctor hodie nominabitur, itinerum suorum libris stilo facili et facundo conscriptis, non immerito etiam laudem litterarum est adeptus.

(3) PROF. SIR THOMAS RICHARD FRASER, F.R.S.

In Uniuersitate Edinensi iam per annos triginta materiam medicam est professus uir in remediorum ui et usu inuestigando iamdudum exercitatus. Abhinc annos plus quam quadraginta de magica illa faba, physostigmate uenenoso, disputauit, et propterea Franco-gallorum ab Instituto laurea insigni est coronatus. Quid dicam de pestilentia illa per Indiam quondam grassante, ab hoc uiro per triennium audacter inuestigata? Quid de serpentium ueneno ab eodem fortiter explorato? Quid de atropia et strophantho? In medicina etiam uenena nonnumquam prodesse ne antiquis quidem prorsus ignotum. Talium autem uirorum auxilio disciplina illa, "quondam paucarum scientia herbarum," "in hanc peruenit tam multiplicem uarietatem."[2]

The election of a professor of zoology and comparative anatomy will take place on Tuesday, July 23, at the University Offices, St. Andrew's Street. Candidates for the said professorship are requested to communicate with the Vice-Chancellor on or before Tuesday, July 16.

Prof. Newton has bequeathed to the University his natural history collections and library, together with the cabinets, cases, and apparatus thereto belonging, including all his copyrights, books, pictures, prints, drawings, letters, and papers relating to natural history, to be attached, so far as is convenient, to the department of zoology. He has also left the sum of 1000*l.* to apply the annual income to the keeping up and adding to the library.

The Harkness scholarship in geology and palæontology has been awarded to L. J. Wills, scholar of King's College. The Wiltshire prize in geology and mineralogy is not awarded this year.

The general board recommends that, in place of the present lectureship in physiological and experimental psychology, a university lectureship in the physiology of the senses be established from Michaelmas, 1907, in connection with the special board for biology and geology, and that a university lectureship in experimental psychology be established in connection with the special board for moral science from the same date.

It is proposed to confer the degree of Doctor of Science *honoris causa* upon Prof. W. C. Brögger, University of Christiania; Prof. H. Credner, University of Leipzig; Prof. L. Dollo, Brussels; Prof. A. de Lapparent, Paris; Prof. A. G. Nathorst, Stockholm; and Prof. H. Rosenbusch, Heidelberg, in connection with the centenary of the Geological Society, London, in September next.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Prof. Paul Ehrlich for the degree of D.Sc. *honoris causa* on June 18 :—

Antiquis ea erat medendi ratio ut angores levarent vel varia molestiarum genera minuerent medicamentis usi quæ affectus contrarios excitarent: recentes id propositum habent ut abdita morborum semina iam inolescentia et in vivis medullis concreta deprehendant et exstinguant. Ita non solum morbo quo quisque laboret mederi sed ipsum corpus quasi præsidiis occupare et inexpugnabile facere conantur. In maximo hoc bello quod hodie geritur contra febres varias, velut διφθερίαν quam vocant, contra cancros, vel noxiis seminibus vel ipsius carnis corruptione ortos, nemo melius vel viam munivit vel in acie præliatus est quam Paulus Ehrlich. Victoria quidem nondum reportata est: quamvis multi hostes fusi sint, restant alii mox superandi: huic certe viro summa diligentia et prudentia prædito, salubritatis patrono et præsidi, si quid bene gestum est acceptum referre debemus: huius opera et eorum qui sub eius signis militant novos triumphos reportari posse speramus.

DR. R. K. MCCLUNG, who has been senior demonstrator in physics in McGill University, Montreal, for the past three years, has been appointed to the chair of physics in Mount Allison University in Sackville, New Brunswick, Canada.

THE following recent appointments are announced:— Dr. Kriemler, to be professor of applied mechanics at the Technical College, Stuttgart; Mr. H. Maschke, to be professor, and Mr. L. E. Dickson, to be associate professor, of mathematics at Chicago University; Mr. W. L. Reid, to be professor of mathematics at Haverford College; Dr. Philipp Furtwängler, to be professor of mathematics at the Technical College, Aachen; Dr. Wilhelm Bjerknes, to be professor of mechanics and mathematical physics at Christiania; Dr. Karl Wieghardt, to be professor of mathematics and mechanics at the Technical College, Hanover.

THE Berlin correspondent of the Times reports that the German Colonial Secretary, Herr Dernburg, recently visited Hamburg to inspect the Institute for Tropical Diseases, the Botanical Museum, and the Museum for Ethnology and Anthropology with a view to ascertain whether the city possessed facilities enough for the study of colonial and tropical questions to justify the foundation of a colonial training college. Herr Dernburg decided to recommend the establishment of such an institution, and the courses at the new college are to be open to those who desire to engage in private commercial or industrial enterprise in the German colonies, as well as to Government officials. The new institute will be modelled on the plan of existing German technical colleges. The promoters of the scheme hold that the intercourse between intending officials and young business men will contribute to the benefit of the German colonies. The State of Hamburg will for the present be responsible for the scheme, and, if the results prove satisfactory, the institution will receive official recognition in the form of an Imperial subsidy.

THE King and Queen will visit Bangor on July 9, when the King will lay the foundation stone of the new buildings of the University College of North Wales. The site of the new college, at Penrallt, is at present occupied by the residence of Principal Reichel, and this interesting feature of old Bangor will have to be demolished in order to make way for the buildings. The permanent build-

[1] Virgil, *Aeneid*, i. 460; Propertius, iv. 5 (11), 46.
[2] Seneca, *Ep.* 95, § 15.

ings fund has now reached a sum that will suffice for the erection of the arts and administrative portions, and this will enable the present college buildings (formerly the Penrhyn Arms Hotel) to be handed over entirely to the requirements of science. Thus, for a time, the college will be conducted on the lines of certain foreign universities, where the faculties of arts, science, law, and medicine are housed in separate buildings. It is hoped, however, that the completion of the new college by the erection of buildings for the faculty of science will not be long delayed. A considerable moral obligation rests on the Government to assist in this matter, more especially in view of the fact that the death duties arising out of the estate of the late Lord Penrhyn, while representing a heavy financial loss to the people of North Wales, would far more than suffice to build and equip the new college.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 23.—"Chemical Reaction between Salts in the Solid State." By E. P. **Perman.** Communicated by Principal E. H. Griffiths, F.R.S.

Experiments have been made on the following pairs of salts:—lead chloride and potassium iodide, mercuric chloride and potassium iodide, sodium carbonate and barium sulphate, sodium sulphate and barium carbonate. The chief points investigated were the effect on certain of these salts of (1) traces of moisture; (2) great pressure; (3) heat.

It was found that reaction always took place unless the salts were very carefully dried, and that the reaction was accelerated by shaking the mixture, and by the application of heat or great pressure; further, that the velocity of the reaction is much influenced by the solubility and volatility of the salts.

The effect of small quantities of some other solvents was also tried. It was found that methyl alcohol caused a reaction between lead chloride and potassium iodide in the same way as water, whilst benzene, chloroform, and ammonia were without result.

Finally, it would appear that reaction between solid salts is of essentially the same nature as that between salts in solution, and it is suggested that the water (or other solvent) present forms a film on the surface of the salts, and that in this film minute quantities of the salts dissolve, and there react. In the absence of an ionising solvent there is no chemical reaction, even when the substances are heated or subjected to great pressure.

Physical Society, May 24.—Prof. J. Perry, F.R.S., president, in the chair.—The measurement of mutual inductance by the aid of a vibration galvanometer: A. **Campbell.** Carey Foster's method of comparing a mutual inductance with a capacity is one of the most convenient. The advantage gained by the use of a *vibration galvanometer* in methods for measuring capacity or inductance led the author to apply it to the Carey Foster and the Hughes-Rayleigh methods. He found it was necessary with alternating currents to modify the Carey Foster method by adding a series resistance in the condenser branch; this gave an additional formula involving the ratio of a mutual and a self-inductance. This modification has been suggested by Rowland. The modified method is convenient, the two adjustments required for a balance being independent, and the result not involving a knowledge of the frequency; the use of the vibration galvanometer is an improvement, making the method independent of the wave-form of the current used. The author discussed vibration galvanometers. They belong to the class of tuned instruments. If the detecting instrument used in a null method (with alternating current) is adjusted so that its natural period is in tune with that of the applied voltage, it will be set into strong resonance and will be enormously increased in sensitivity for this particular frequency, practically ignoring in comparison all the other components of the wave-form. Thus in any method in which the tuned instrument is used, a sine wave-form may be assumed. The author exhibited a vibration galvanometer of another type, having a moving coil controlled by an adjustable bifilar suspension. By adjusting the tension of this the tuning is easily effected. For measuring the frequency to which a tuned instrument is responding, it is convenient to use the Hughes-Rayleigh method. The author showed such an arrangement in which the slide-wire was graduated directly in frequency. The author gave results of tests of a standard mutual inductance of 0·05 henry. The Kirchhoff method with direct deflection on a ballistic galvanometer, of measured time of swing, gave a mean of 0·05014 henry, while the Carey Foster method gave 0·05009 henry; the probable error of the latter was much smaller than that of the older method.—Note on the rate of decay of the active deposit from radium: W. **Wilson** and W. **Makower.** In some experiments in which the ionisation produced by the α rays from radium C was balanced against that produced by the more penetrating β and γ rays, it was found that after a short time these two ionisations were no longer exactly equal, however carefully they had been adjusted to equality at first. A similar effect had been noticed by Brousson, and was attributed to the slowly moving β rays emitted by radium B which is present with the radium C. Since these rays are emitted by radium B, whereas the α and more penetrating β rays are emitted by radium C, it is to be expected that the rate of decay as measured by these two types of radiation will be different. The authors' experiments confirm the view that the observed difference in the rate of decay as measured in the two vessels is due to the slowly moving β rays emitted by radium B.—Apparatus for relay working of long submarine telegraph cables: S. G. **Brown.** This relay system consists of three parts:—(1) the actual relaying device or drum relay; (2) an inductive shunt with closed iron circuit for use across the receiving coil to curb the signals and straighten out the zero; and (3) a method of applying a local current possessing suitable time-lag to the receiving coil to correct the tendency of signals made up of two or more impulses of the same polarity to fall away to zero due to the charging up of the receiving condenser itself.

Faraday Society, May 28.—Prof. A. K. Huntington in the chair.—Contributions to the chemistry of gold: F. H. **Campbell.** Aurous iodide, AuI, was prepared and found to decompose at 25°, according to the equation

$$2AuI \rightleftarrows 2Au + I_2.$$

Since this equation contains only one variable, namely, the iodine, there must be a particular pressure of iodine at which AuI, Au, and I_2 are in equilibrium. This was found to be 0·943 of that of pure iodine; any solution of iodine will therefore act on gold if more than 0·943 saturated, but not if below this strength. When gold is acted on by a solution of KI and iodine, part is converted into insoluble AuI and part dissolves. The experimental results with various solutions agree with the equilibrium equations only when the gold is assumed to enter the complex ion in the monovalent condition, *i.e.* to yield AuI_2 ions. The action $3AuCl = AuCl_3 + 2Au$ was found to occur at ordinary temperatures and in absence of moisture.—Reduction of some oxides and sulphides by means of metallic calcium: Dr. F. Mollwo **Perkin.** The author first referred to the well-known powerful reducing action of aluminium, as, for example, its use in the preparation of chromium, ferrosilicon, and other metals and alloys, and its use in the form of "thermite" for welding purposes. He finds that metallic calcium is a still more powerful reducing agent than aluminium. For example, when molecular proportions of aluminium and ferric oxide are mixed together and ignited by means of a fuse of aluminium and barium peroxide, intense reaction ensues, and continues until all the oxygen has been removed from the ferric oxide, and aluminium oxide and metallic iron produced in its stead. When metallic calcium in the form of fine turnings is mixed with ferric oxide and ignited in a similar manner, the reaction is so intense that the mixture is in large part ejected from the crucible. The reaction can be brought under control by mixing 30 per cent. to 40 per cent. of calcium fluoride or 10 per cent. to 20 per cent. of calcium oxide with the contents of the crucible. Boron can be obtained by igniting a mixture of boron trioxide with the calculated quantity of calcium and 5 per cent. to 10 per cent. of calcium oxide. Attention was directed to the difficulty experienced in causing silica in the form of fine sand to react with metallic aluminium which was in the form of a rough powder. A similar difficulty was met with in the case of boric anhydride and aluminium. Galena does not yield metallic lead and calcium sulphide, but a greyish mass which gives off sulphuretted hydrogen when acted upon with acids, lead in the form of a salt being left in solution. Red phosphorus and calcium unite with explosive violence. Sulphur and calcium also react with great vigour.

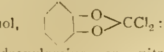
Society of Chemical Industry, June 3.—Mr. R. J. Friswell in the chair.—The nature of the changes involved in the production and setting of plaster of Paris: W. A. **Davis.** The contradictory character of the present knowledge of this problem is first discussed. Data are then adduced to show that the first change occurring in the dehydration of gypsum is the formation of a new, orthorhombic form of the dehydrate, $CaSO_4,2H_2O$, which by loss of water subsequently gives the half hydrate $CaSO_4,2H_2O$ (the essential constituent of ordinary plaster). The so-called "soluble anhydrite" is produced from gypsum, not directly as supposed by van 't Hoff, but as a product of the further dehydration of the half hydrate. The conditions under which this change occurs and the manner in which it may be reversed are dealt with in detail. In the setting of plaster, gypsum is not immediately regenerated, but the second form of the dehydrate referred to above is first produced; it undergoes change into gypsum subsequently.—Analysis of white lead: W. A. **Davis** and C. A. **Klein.** The authors have investigated the sources of error in the different methods used in the analysis of white lead. These errors are much smaller in the case of dry white lead than in that of white lead ground in oil.—Calorimeter for volatile liquid fuels. Specially adapted for petrol: W. Hansen **Rawles.** A development of the Darling calorimeter. The calorimeter, which was made for the author by Messrs. A. Gallenkamp and Co., is applicable to solid and liquid fuels.—The influence of temperature of dyeing on resolution: W. P. **Dreaper** and A. **Wilson.** Basic colours are absorbed by silk fibre in two ways. Above 40° a more permanent absorption of part of the dye takes place which increases up to 100°. A similar effect is noticed with acid dyes on silk. Preliminary boiling with water or acid does not influence subsequent dyeing at low temperatures. A similar result is obtained with direct colours on cotton, so the reaction is a general one. The effect is absent when dyeing in alcohol. Fastness against light does not follow the temperature in same way.—The loss of nitre in the chamber process, part iii.: J. K. H. **Inglis.** The author, in continuation of earlier papers, has again analysed samples of the exit gases from sulphuric acid chambers by means of fractional distillation at low temperatures. Indirect analyses were almost completely avoided, and the results show the presence of small quantities of nitrous oxide and of appreciable quantities of higher oxides, the quantity of nitric oxide being considerable when the sulphur escape is high. There is still a considerable quantity of nitre unaccounted for, its loss being either due to reduction to nitrogen or to the whole of the nitric acid not being collected in this method of analysis.

MANCHESTER.

Literary and Philosophical Society, April 23.—Sir William H. Bailey, president, in the chair.—Coal mines in Sutherlandshire: Dr. M. C. **Stopes.** The mines are of Mesozoic and not of Palæozoic age, as is the case with the vast majority of coal seams.—Science and poetry: C. L. **Barnes.** The author enumerated the principal poems handed down by antiquity, enshrining the scientific knowledge of the age which gave them birth. Among these were the "Phænomena" and "Prognostica" of Aratus, originally written in Greek, but made more familiar in Latin and French translations; Lucretius, "De Rerum Natura"; the "Georgics" and "Bucolics" of Virgil; the "Astronomicon" of Manilius; Marbodus, "De Gemmis"; Alexander Neckam, "De Laudibus Divinæ Sapientiæ"; and Philippe de Thaun, "Le Livre des Créatures." Allusion was also made to the "Canon's Yeoman's Tale," Milton's "Paradise Lost" and "Natura non pati senium"; Cowley's "Plantarum Libri Duo" and "Ode to the Royal Society"; Phineas Fletcher's "Purple Island"; Erasmus Darwin's "Botanic Garden" and "Loves of the Plants"; Rowbotham's "Human Epic," and other poems of less note.

May 7.—Prof. H. B. Dixon, F.R.S., president, in the chair.—A series of photographs illustrating the flora of Corsica, particularly the characteristic bush flora of the mountain slopes: Prof. F. E. **Weiss.** This "macchia" or "Magius" is made up largely of hard-leaved shrubs, such as the arbutus, rock-rose, tree-heath, and shrubby oaks. A comparison with the bush of Table Mountain shows certain similarities between the two floras, both in the manner of growth and in the constituent orders, such as Ericaceæ, &c.—Science and poetry: C. L. **Barnes.** Conclusion of paper read on April 23. Poems were read by Prof. J. C. Maxwell, Prof. Rankine, Archbishop Whately, and others.—The compression of gases by means of hydraulic apparatus: J. E. **Petavel.**

PARIS.

Academy of Sciences, June 10.—M. Henri Becquerel in the chair.—The petrographic constitution of the volcanic *massif* of Vesuvius and Somma: A. **Lacroix.** The petrographic constitution of these rocks has hitherto been considered as extremely simple. It is found, however, that the old volcano is not simply constituted by basic rocks and their projection products. Other rocks are present in abundance, a detailed study of which is given, showing their complex nature.—Observations made at the summit of Mont Blanc from August 31 to September 5, 1906: A. **Hansky** and M. **Stefánik.** Details are given of the atmospheric conditions, attempts at the determination of the rotation of Venus, observations on the sun, Mercury, and Jupiter.—Observations concerning the form of the satellite I. of Jupiter: José Comas **Sola.** The disc of this satellite appears distinctly elongated. This was confirmed by observations made on the night of February 28, when the conditions were exceptionally favourable. The shadows of both satellites I. and II. were seen close together on the planet. The shadow of II. was clearly circular, that of I. being elongated; the flattening is fixed provisionally at $\frac{1}{4}$.—A new Giacobini comet: M. **Giacobini.** This comet was first seen on the night of June 1 at Nice. It is badly defined, 1′·5 to 2′ extent.—A new class of surfaces: G. **Tzitzéica.**—The application of the formulæ relating to molecular volumes to the calculation of the variation of the maximum pressure of water vapour with temperature: A. **Leduc.**—The electric discharge in gases: P. **Villard.**—Some oxidising and decolorising properties of graphite: Henri Louis **Dejust.** A comparison of the decolorising powers of animal charcoal, natural graphite containing 79 per cent. of carbon, and purified graphite containing 93·1 per cent. of carbon, litmus being used as the colouring matter. The activity of the graphite is reduced by purification. Graphite shows an oxidising power analogous to that noted by M. Cazeneuve for animal charcoal.—Modified nickel acetate, a new type of excitor of oxidation for hydroquinone: André **Job.** Pure nickel acetate, heated for a long time at 100° C., loses some acetic acid, but remains completely soluble in cold water. This product acts as an oxydase towards hydroquinone, its activity in this respect being greater than that of manganese acetate. The cause of this remains unknown.—Contribution to the study of the ammonio-mercuric base: H. **Gaudechon.** This base is formed at once by the action of precipitated mercuric oxide upon aqueous ammonia solution, forming hydrates of $(NHg_2)_2O$. The hydrate with one molecule of water is stable at the ordinary temperature in a dry atmosphere, that with four molecules of water stable in a moist atmosphere at 15° C. The hydrate with $5H_2O$ can only exist in the presence of water.—The combinations of hypovanadic acid with some acids containing oxygen: Gustave **Gain.**—The relation between the diagram of the binary alloys and their malleability: Léon **Guillet.**—The mechanism of the synthesis of quinoline derivatives (Döhner's reaction): L. J. **Simon** and Ch. **Manguin.**—The ether function of diphenol,  : R. **Delange.**—The action of hydroxylamine on nitriles, amides, and acetylenic esters, and on the corresponding β-ketonic compounds: Ch. **Moureu** and J. **Lazennec.**—The hydrolysis of salts: A. **Rosenstiehl.** From a consideration of the phenomena of the hydrolysis of esters and salts, the author concludes that the hypothesis of ionisation is unnecessary.—The existence of a tyrosinase in wheaten bran: Gabriel **Bertrand** and M. **Muttermilch.** Wheaten bran is shown to contain at least two ferments, tyrosinase and peroxydiastase.—The basic rocks of the Tschissapa range, northern Ural: L. **Duparc** and F. **Pearce.**—The pleural cavity in the elephant: Guillaume **Vasse.** A fully grown elephant killed in the province of Gorongoza showed on dissection lungs easily detached. There was no point of adherence.—An improved apparatus permitting of staying and working for a long time in irrespirable atmospheres: J. **Tissot.** In a previous note the author has detailed the conditions which should be realised in an apparatus of this kind. The present paper gives an account of an apparatus fulfilling these conditions, together with an account of its actual use in practice.—The digestion of chlorophyll and the stomachic excretion in rotifers: P. **de Beauchamp.**—The hypertensive action of the cortical layer of the supra-renal capsules: O. **Josué** and Louis **Bloch.** The cortical layer has been found to contain substances strongly hypertensive which are chemically different from adrenaline. It is possible that these substances are destined to form adrenaline later, and researches are being carried on to determine this point.—Radioscopy and radiography applied to the inspection of tuberculous meat: H. **Martel.** It is shown that the Röntgen rays may serve to detect tuberculous lesions in meat. The cutting into sections necessitated by the ordinary method of examinations is avoided, thus saving time and preventing the depreciation of the meat. Fat does not interfere.—The geosynclinal Miocene of southern Tell (departments of Algiers and Constantine): J. **Savornin.**—The Dinosauria of the Jurassic in Madagascar: Armand **Trévenin.**—The characteristics of the leaf trace of *Ankyropteris Bibractensis*: Paul **Bertrand.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 20.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture, On the Atomic Weight of Radium: Dr. T. E. Thorpe, C.B., F.R.S.—On the Origin of the Gases Evolved by Mineral Springs: Hon. R. J. Strutt, F.R.S.—On the Presence of Sulphur in Some of the Hotter Stars: Sir J. Norman Lockyer, K.C.B., F.R.S.—The Fluted Spectrum of Titanium Oxide: A. Fowler.—Preliminary Note on a New Method of Measuring Directly Double Refraction in Strained Glass: Dr. L. N. G. Filon.—Studies of the Processes Operative in Solutions, II., The Displacement of Chlorides from Solution by Alcohol and by Hydrogen Chloride, III., The Sucroclastic Action of Nitric Acid as Influenced by Nitrates; IV., The Hydrolysis of Methylic Acetate in Presence of Salts; V., The Discrimination of Hydrates in Solution: Prof. H. E. Armstrong, F.R.S., and others.

CHEMICAL SOCIETY, at 8.30.—Some Properties of Radium Emanation: A. T. Cameron and Sir W. Ramsay.—The Affinity Constants of Aminosulphonic Acids as Determined by the Aid of Methyl Orange: V. H. Veley.—Azo-derivatives of 1:3-Diphenylbarbituric Acid. Dynamic Isomerism among the Coloured Hydrazones of 1:3-Diphenylalloxan: M. A. Whiteley.—A Series of Coloured Diazo-salts Derived from p-Aminoaceto-α-naphthalide: G. T. Morgan and W. O. Wootton.—(1) Colour and Constitution of Azo-compounds, Part I.; (2) Colour and Constitution of Azo-compounds, Part II.: J. T. Hewitt and H. V. Mitchell.—The Oxidation of Hydrazines by Free Oxygen: F. D. Chattaway.—Calmatambin, a new Glucoside: F. L. Pyman.—The Decomposition of Hyponitrous Acid in Presence of Mineral Acids: P. C. Rây and A. C. Ganguli.—The Chemical Composition of Petroleum from Borneo: H. O. Jones and H. A. Wootton.—(1) The Synthesis of Phenonaphthacridines, Trimethylphenonaphthacridines; (2) The Condensation of Aldehydes with Mixtures of α-Naphthol and α-Naphthylamine; Synthesis of 7-Aryl $\begin{matrix} \alpha\text{—N—}\alpha \\ | \\ \beta\text{—CH—}\beta \end{matrix}$ Dinaphthacridines: A. Senier and P. C. Austin.—(1) An Improved Form of Apparatus for the Rapid Estimation of Sulphates and Salts of Barium; (2) The Determination of Sugar by Fehling's Solution: W. R. Lang and T. B. Allen.

LINNEAN SOCIETY, at 8.—On the Distribution of Conifers in China and Neighbouring Countries: the late Dr. M. T. Masters, F.R.S.—Lithothamnia of the *Sealark* Expedition: M. Foslie.—The Pre-Glacial Flora of Britain: Clement Reid, F.R.S., and Mrs. Reid.—Report on the Results obtained during the Cruise of the *Silver Belle*: Dr. R. Norris Wolfenden.—On a Small Collection of Amphipoda, and Two New Species: W. M. Tattersall.—On *Pyrosoma spinosum*: G. P. Farran.—Rare or Little-known Fishes taken by the *Silver Belle*: E. W. L. Holt and L. Byrne.—*Sealark* Coccidæ: E. Ernest Green.—Species and Ovicells of Tubucellaria: A. W. Waters.—Doridoeides, a New Genus of Nudibranchs, from the *Sealark*: Sir C. Eliot and T. J. Evans.—Stomatopoda of the *Sealark*: L. A. Borradaile.—On Triassic Species of Zamites and Pterophyllum: E. A. N. Arber.—Introduction to the Voyage of H.M.S. *Sealark*, Part ii.: J. Stanley Gardiner.—Cephalopoda of the Sudan: Dr. W. E. Hoyle.—Descriptions of Plants from Ruwenzori: E. G. Baker, S. Moore, and A. B. Rendle.—The Anatomy of the Julianiaceæ: Dr. E. F. Fritsch.—On Critical Freshwater Algæ: Prof. G. S. West.

TUESDAY, JUNE 25.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Kanaka Skull: Dr. D. Waterston.—Instruments employed to obtain Contour Tracings of Different Aspects of the Skull: Prof. D. J. Cunningham, F.R.S.—Notes on Australian Aboriginal Paintings: F. S. Brockman.

FARADAY SOCIETY, at 8.—The Thermo-chemistry of Electrolysis in Relation to the Hydrate Theory of Ionisation: W. R. Bousfield and Dr. T. Martin Lowry.—The Influence of Non-Electrolytes and Electrolytes in the Solubility of Gases in Water. The Question of Hydrates in Solution: J. C. Philip.—The Dissociation of Hydrates as indicated by their Equilibrium Curves: Dr. A. Findlay.—Hydrates in Solution: Discussion of Methods proposed for determining Degree of Hydration: Dr. George Senter.—The Reading of the Papers will be followed by a General Discussion on "Hydrates in Solution."

PHYSICAL SOCIETY, at 8.

WEDNESDAY, JUNE 26.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, JUNE 27.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Dynamical Theory of Gratings: The Lord Rayleigh, O.M., P.R.S.—On the Surface Tension of Liquids investigated by the Method of Jet Vibration: S. D. Pedersen.—Cases of Colour Blindness, No. VI. to No. XVIII., together with Eleven Selected Examples of Normal Colour Sensations: G. J. Burch, F.R.S.—On the Occurrence of Post-tetanic Tremor in Several Types of Muscles: Dr. D. F. Harris.—On the Pressure of Bile Secretion and the Mechanism of Bile Absorption in Obstruction of the Bile Duct: P. T. Herring and S. Simpson.—Further Studies of Gastrotoxic Serum (Progress Report): Dr. C. Bolton.—And other Papers.

FRIDAY, JUNE 28.

PHYSICAL SOCIETY, at 5.—Demonstration of the Uses of his Hot Wire Oscillographs and Hot Wire Wattmeters: I. T. Irwin.—(1) A Cosine Flicker Photometer; (2) Some Phenomena in Colour Vision: J. S. Dow.—Description and Exhibition of Students' Apparatus for Measuring Permeability and Hysteresis: Prof. W. E. Ayrton and T. Mather.—Design of Chokers: Prof. W. E. Ayrton and T. Mather.

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THURSDAY, JUNE 27, 1907.

RESINS.

Die Harze und die Harzbehälter mit Einschluss der Milchsäfte. By A. Tschirch. Zweite stark erweiterte Auflage. Erster und zweiter Band. Pp. xxii+1268. (Leipzig: Gebrüder Bornträger, 1906.) Price 32 marks.

The Distillation of Resins. By Victor Schweizer. Pp. viii+183. (London: Maclaren and Sons; New York: Van Nostrand and Company, n.d.) Price 10*s.* 6*d.*

THE chemistry of resins has been very much neglected by investigators, so much so that even now the empirical formula of the best known of their constituents—abietic acid, which was isolated from ordinary rosin more than eighty years ago—is still a matter of dispute. It is difficult to account for this neglect, since many of the naturally occurring resins are readily resolved into crystalline or otherwise well-defined substances, so that the subject does not present the initial difficulties encountered by the investigators who have studied the terpenes, proteids, and similar intractable natural products. Resins should now be particularly attractive to chemical workers, since Prof. Tschirch and his collaborators have surveyed almost the whole field in a preliminary manner, and from their results it is possible to select the most promising materials for detailed investigation.

Perhaps the most important result which has accrued from this work is the possibility of classifying the constituents of the natural resins into a comparatively small number of groups of similarly reacting—and probably similarly constituted—substances.

Looked at from this general point of view, the chemical work done by Prof. Tschirch and his coadjutors can be regarded as a very satisfactory contribution to our knowledge of resin chemistry.

The publication of the second edition of this monograph affords an opportunity for a review of this work as a whole, since the book is largely a reprint, with additions and corrections, of papers published in the *Archiv der Pharmazie.*

Prof. Tschirch's usual method of investigation consists in dissolving the resin under examination in an indifferent solvent, and extracting this successively with solutions of alkali carbonates and hydroxides.

The products so isolated, and perhaps subjected to a more or less satisfactory process of purification, are in general regarded as definite substances, and though they are in the majority of cases amorphous coloured products having no constants which may be regarded safely as criteria of purity, they are analysed and have names and formulæ assigned to them. The qualifying statement that such substances may be impure is no adequate defence for such a proceeding, since the names and formulæ are liable to be copied into the literature of the subject without the disclaimer which originally accompanied them.

Similarly, when Prof. Tschirch in the course of an investigation meets with a substance resembling one already known, he does not in general ascertain definitely whether the two substances are identical, but, assuming that they are probably distinct, makes a denominator for his supposed new substance by attaching a descriptive prefix to the name of the older compound; thus *palabietic acid*, from the resin of *Pinus palustris*, has the same elementary composition and melting point as abietic acid, with which, so far as one can see, it may be identical.

The application of the terms "resinolic acid" and "resene" is also objectionable. The first of these would, under any system of nomenclature now in use among chemists, imply the presence of a hydroxyl in addition to a carboxyl group in each of the substances included in the class so designated, and similarly the termination -ene is usually reserved for hydrocarbons. Prof. Tschirch's "resinolic acids" are simple carboxylic acids, typified by abietic acid, and his "resenes" are oxygenated substances.

The book is not only a record of the results of chemical investigations, but deals with the botany and habitats of the plants from which resins are obtained, and to these branches of knowledge the author and his collaborators have made many and important contributions. Much of the information given is the result of personal observations made by Prof. Tschirch during travels in the East Indies and elsewhere, and probably no previous investigator of plant products has devoted more care to securing authentic material for investigation. The botanical part of the subject is dealt with in the second and smaller volume, which gives a *résumé* of our present knowledge of the mode of origin and distribution of resins in plants. Reference should also be made to the important section dealing with latices and the resins and rubbers obtained from them, matters which are at the present moment of great economic importance.

There are a few resinous products which have been the subject of investigation, and which, in spite of Prof. Tschirch's desire to make his monograph as complete as possible, have escaped his notice, but these are for the most part of little importance.

In spite of those unfortunate tendencies to add unduly to nomenclature and to be somewhat lax in awarding the character of a definite substance to ill-defined amorphous products, to which attention has been directed, this book is a welcome addition to the rather scanty literature dealing with the chemistry and botany of vegetable products.

Mr. Schweizer's book is intended primarily for the "practical man," and is consequently of little interest from the purely scientific point of view. The descriptions of processes and plant for the distillation of rosin and the rectification of the products obtained are lucid, and their value is enhanced by the well-printed illustrations of distilling and other apparatus, made in several instances from the author's designs.

The chapters dealing with the manufacture and uses of resinates, the preparation of lampblack, and the methods of making printing and other lampblack inks are of special interest, since much of the information given was not accessible previously.

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In the first line of p. 22 "position" is obviously a misprint for "composition," and there are a considerable number of such slips throughout the work. A fairly full "contents list" is given, but the book would have been more useful if a comprehensive index had been provided. T. A. H.

THE WORKS OF C. F. GAUSS.

Carl Friedrich Gauss Werke. Siebenter Band. Herausgegeben von der Kön. Gesellschaft der Wissenschaften zu Göttingen. Pp. 650. (Leipzig: B. G. Teubner, 1906.) Price 30 marks.

THIS volume contains a reprint of Gauss's principal astronomical work, the "Theoria Motus Corporum Cœlestium," and his unpublished researches on planetary perturbations and on the lunar theory. In 1871 the late Prof. Schering brought out a "volume vii." without the cooperation of the Göttingen Academy of Science, containing the "Theoria Motus" and some notes from Gauss's papers; but for the sake of uniformity the academy considered it desirable to include the "Theoria" in the present volume, which has been edited by Prof. Brendel, of Göttingen.

A careful revision of the original edition of 1809 brought a few corrections to light, and a re-computation of the examples with modern tables of logarithms revealed a number of errors of one or two units of the seventh decimal (caused probably by the absence of decimals in the proportional parts of the old tables) which sometimes gave rise to greater errors in the course of the computation. A list of these corrections is given. Some notes found in Gauss's own copy of the book are added in footnotes. Next follow various notes on elliptic and parabolic motion, partly already published, partly extracted from letters and note-books. Of these the most important is a table for computing the true anomaly in a parabolic orbit; it was to have formed part of a supplement to the "Theoria Motus," dealing with the orbits of comets, which never was written.

The discovery of the first of the minor planets, Ceres, had obliged Gauss to work out a general method of computing an elliptic orbit. The next step was to determine the perturbations of the motion of Ceres and Pallas, which, particularly in the case of the latter, necessitated new methods owing to the great eccentricity and inclination; and on this work Gauss spent a great deal of time in the years 1802 to 1817. In 1805 he worked out a new method of computing the general perturbations by the variation of the elements, but he never published anything on the subject. The method is essentially the same as that proposed by Hansen in 1843 in his paper on absolute perturbations in orbits of any eccentricity and inclination.

The present volume first gives letters and computations on Ceres, after which follow 200 pages devoted to Pallas. Special perturbations by Jupiter for the years 1803–1811 were computed in 1810 and 1811, first for intervals of fifty days, after which the work was repeated with periods of 500 days, the elements for each period being taken from the first computation. The memoir on the theory of general perturbations was written in French, about the year 1815, apparently in answer to a prize question of the Paris Academy, but never finished. In 1811 Gauss began the immense labour of computing the action of Jupiter on Pallas, and finally, with the aid of Encke and Westphal, completed the work by the preparation of tables. The perturbations by Saturn were computed by Nicolai, and this work is preserved at the Heidelberg Observatory; it has naturally not been included in the present volume, but hopes are held out that it may be published elsewhere. Finally, the last part of the whole work, the action of Mars, was taken in hand, but owing to the press of other work it was never completed. It is much to be regretted that this fine piece of work, involving an enormous amount of computation, has been unknown until now, and that not even so interesting a result as the increase of the assumed mass of Jupiter was published. Already in 1814 Gauss found from the first nine oppositions of Pallas that Laplace's value, 1 : 1067·09, should be increased to 1 : 1042·86, a result which differs but little from the most recent determinations. If known to Encke, this correction of the mass would have prevented the errors of 5′ in the computed geocentric places in 1834, caused by the near approach to Jupiter in 1832 (*Astr. Nachr.*, No. 332). Needless to say, the remarkable commensurability of the mean motions of Jupiter and Pallas was noticed by Gauss at an early date.

It appears from letters written to Hansen and Bessel in 1843 that Gauss bitterly regretted having laid this great work aside. Thanks to the skilful editorship of Prof. Brendel, whose task of arranging and interpreting a vast mass of papers must have been a very difficult one, the work is now accessible in a clear and convenient form, and it is to be hoped that some competent hand will complete it.

Lastly, the volume contains the beginning of a lunar theory, dating from the second half of 1801, but soon abandoned, probably because vol. iii. of Laplace's "Mécanique Céleste" came out in the following year, and seemed to make work on the motion of the moon unnecessary at that moment. The form in which the perturbations are given is similar to that of Plana (1832).

Vols. viii. and ix. of the collected works of Gauss have already appeared. A tenth and concluding volume is announced, which is to include a general index. J. L. E. D.

NATURE AND FLORAL DESIGN.

Flowers and Plants for Designers and Schools. By Henry Irving and E. F. Strange. Pp. 95. (London: Hodder and Stoughton, 1907.) Price 10*s*. 6*d*. net.

IF designers could be produced by the study of books upon plant form there ought to be a large and flourishing crop of them, since so many elaborate works have appeared on this subject addressed to the supposed needs of such artists.

Every designer of any originality, however, feels the necessity of providing his own raw material, and what is suggestive and valuable to one may by no means prove equally so to another. The designer's best reference library is, of course, Nature; but Nature is always changing her dress, and her wealth of floral pattern is transformed with each season, so that unless we presuppose good opportunities combined with immense industry on the part of the artist, he must occasionally run short of working notes, and may be glad of the help of a herbal or a book which will give him the essential facts of the form, growth, general appearance, and structure of particular plants and flowers with which he is not familiar.

Such a practical aid and friend in need may be found in the admirable series of photographs from nature by Mr. Henry Irving and the valuable notes by Mr. E. F. Strange which constitute the volume before us.

The latter contributes a well-informed and interesting introduction to the book, as well as a series of notes upon the plants figured, which show his historic knowledge as well as his artistic sympathies.

While quite of the opinion he expresses as to the value of the study of the human form for *all* designers, it appears to be quite possible to attain great skill in purely floral draughtsmanship and design without any corresponding power over the human figure. Mr. Strange, too, hardly seems to appreciate, perhaps, the value of practice with a *firm point*—the severest test of draughtsmanship—the power of clear definition and definite expression being most necessary in all kinds of working designs intended to be carried out by some process of handicraft or manufacture. He is also a little severe upon what he describes as "brush-work"—the power of clear definition of form in the mass by means of brush and colour being also essential to a floral-designer's work, and needing much practice to gain facility and sureness of touch. The dexterity and directness of the method of Japanese artists have taught us much in this way.

Mr. Strange gives an admirable *résumé* of the treatment of plant form in the history of decorative art, and in speaking of the utility of such examples of plant form as are given in Mr. Irving's plates, he very pertinently remarks upon the beneficial effect upon a student or designer having to make their notes and drawings direct from nature or from photographs such as these, "uninfluenced by the versions, however admirable, of others."

If a designer cannot refer directly to nature, photographs are next best for most purposes, that is to say, for all superficial facts about a plant which can be disclosed without colour.

Mr. Henry Irving has made an interesting and judicious selection of plants and flowers likely to be useful to designers of all kinds, and he has been successful in presenting them by photography in a clear and tasteful way, often usefully silhouetting the stems and leaves against a light plain background, and giving the scale, and in some cases showing the seed vessels and the root. The plate of the tulip tree gives a singularly complete exposition of the characteristics of the tree—stem, leaf, bud, and full flower being given, and, moreover, quite decoratively spaced. Among the most successful plates, perhaps, may be named the wild rose, the yellow iris, the wood sorrel, the lily of the valley, the thistle, the teasle, and the catkins of the hazel.

More of the lily tribe might have been given perhaps with advantage, seeing that the structure is so beautiful and well defined, and it is the structure of plants and flowers above all that a designer needs to understand. Altogether the book may be heartily recommended to students and practical designers, and, indeed, to all interested in the beauty of plants and flowers.

WALTER CRANE.

SOME RECENT PHILOSOPHICAL WORKS.

(1) *Proceedings of the Aristotelian Society*. New Series. Vol. vi. Pp. 402. (London: Williams and Norgate, 1906.) Price 10s. 6d. net.

(2) *René Descartes' Philosophische Werke*. Erste Abteilung (Fortsetzung). Übersetzt und herausgegeben von Dr. Artur Buchenau. Pp. xviii+149. (Leipzig: Dürr'schen Buchhandlung, 1906.) Price 1.80 marks.

(3) *Herders Philosophie*. Herausgegeben von Horst Stephan. Pp. xliv+309. (Leipzig: Dürr'schen Buchhandlung, 1906.) Price 3.60 marks.

(4) *The International Scientific Series. The Mind and the Brain*. By Alfred Binet. (The authorised translation of "L'Âme et le Corps.") Pp. xii+280. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1907.) Price 5s.

(5) *Essay on the Creative Imagination*. By Th. Ribot. (Translated from the French by A. H. N. Baron.) Pp. xix+370. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1906.) Price 7s. 6d. net.

(6) *Structure and Growth of the Mind*. By W. Mitchell. Pp. xxxv+512. (London: Macmillan and Co., Ltd., 1907.) Price 10s. net.

(1) THE sixth volume (new series) of the Proceedings of the Aristotelian Society contains the papers read before the society during its twenty-seventh session, 1905–6, and is unusually bulky, as publication has now become a much more important part than formerly of the society's work. Among other articles, it contains one on teleology by Dr. Shadworth H. Hodgson, the veteran ex-president of the society; a symposium "Can Logic abstract from the Psychological Conditions of Thinking?" to which contributions are made by Messrs. Schiller, Bosanquet, and Rashdall; and the records of a controversy (on Kantian and anti-Kantian lines) between Dr. G. Dawes Hicks and Prof. Stout. Scientific readers will turn with interest and profit to a paper by Mr. T. Percy Nunn, entitled "The Aims and Achievements of Scientific Method." Mr. Nunn defines the aim of the scientific process as an endeavour to render the Objective in its actual determinations intelligible. He points out the stages of Animism and Hylozoism through which pre-scientific thought

has passed, and examines more particularly, in the case of Kepler, the struggle between the non-scientific (and commonly theological) prepossession and the purely scientific spirit—so well illustrated, for example, in Kepler's demonstration that the orbit of Mars is an ellipse, and not a circle as his "prepossession of perfection" had originally compelled him to suppose. But in all attempts at explanation, whether "the divine" is invoked or not, the primary facts are qualified by an hypothesis—in other words, they are made to form part of an apperceptive system. In this way the non-scientific attempts to render the Objective intelligible do not differ formally from the scientific, and Mr. Nunn argues that it is, in fact, difficult to declare *any* concept essentially incapable of mediating a scientific interpretation of the Objective to some thinker: he instances the use made by some scientific men of the concept of cause in the sense of transeunt action, or again the preference shown by Weber and the Continental school for the concept of action at a distance, as contrasted with the equally marked preference of the British school for the concept of an intervening medium. Finally, as for the close connection between mathematics and science, it is due simply to the fact that primary facts present themselves for the most part in series, and so "the most useful method of determining the Objective consists in correlating terms of these series with the members of the number series."

(2) and (3) These two books form part of the excellent "Philosophische Bibliothek." The Descartes volume contains (in a German translation) the "Regulae ad Directionem Ingenii" and the "Inquisitio Veritatis per Lumen Naturale." The editor, in a well-written introduction, discusses the question of dates, and reaches the conclusion that the "Regulae" were composed about the year 1628, and in Latin, as Descartes at that early age still employed the language of his instructors. The "Inquisitio," on the other hand, was probably written in French between 1644 and 1647, and translated into Latin by the unknown editor of the posthumous works published in 1701. Dr. Buchenau concludes that its fragmentary condition is due to the fact that Descartes, in 1645, had an opportunity of comparing the French translation of the "Meditations" with his own new French work, and on finding a great similarity between the two thought it unnecessary to proceed with his later effort.—Herder's works readily lend themselves to selection, and it would be a pity that we decadents should forget one who, though overshadowed by the gigantic figures of Kant and Goethe, is by no means negligible in the history of thought. The excerpts are chosen with discrimination, and include the most suggestive passages of the "Ideen." The introduction gives a good account of Herder's relation to Kant, and a useful index is provided.

(4) The title of this work is rather misleading. The International Scientific Series already contained a book entitled "Mind and Body," by Prof. Bain, and it has therefore seemed to the translator or publishers desirable, and to M. Binet tolerable, that this work in its English dress should be called "The Mind and the Brain," and not "Soul and Body" or "Mind and Body." But, for that matter, the well-known series in which it appears also contains works entitled "The Brain as an Organ of Mind," and "The Brain and its Functions," so that he who would avoid Scylla must reckon with Charybdis. And certainly, when one finds that the table of contents is boldly divided into three parts, "The Definition of Matter," "The Definition of Mind," "The Union of the Soul and the Body," it argues a certain lack of insight and imagination to fix upon a name so inappropriate as "The Mind and the Brain."

M. Binet writes in an interesting and generally a clear style, with a French lightness of touch which occasionally borders on superficiality. The subject could, in our judgment, have been better treated. The reader is often irritated by one-sided statements which are apparently, a few pages later, contradicted by one-sided statements in precisely the opposite sense. One yearns for the synoptic view, for the *cacoethes explicandi*, which will compel the writer, even at the risk of being tiresome, to burrow to the very roots of his problem. Thus, for example, on p. 25 we are told that our nervous system, which enables us to communicate with objects, prevents us from knowing their nature. Sensation has, as its unknown cause, the great X of matter. On p. 38 we find objection taken to the physicist's attempt to explain sensations of sound:—"outside our ears there exists something we do not know which excites them; this something cannot be the vibratory movement of the tuning fork, for this vibratory movement which we can see is likewise [as much as the sensation of sound] a subjective sensation"; and the airy reference on p. 39 to the hegemony of certain of our senses over others still avoids much of the difficulty. But in the light of all these statements the conclusions reached on p. 109 are little short of astonishing; they are these, that (1) there remains no reason for refusing to admit that we perceive things as they are, and that the consciousness, by adding itself to objects, does not modify them; (2) the statement that we only know our sensations, and not the excitants which produce them, is to be understood in this way that these sensations are matter—they are matter modified by other matter, viz. our nervous centres. This is perhaps skilful, but is it convincing?

(5) M. Ribot's "Essay on the Creative Imagination," which appeared in French about six or seven years ago, has now been translated into English. Like all its author's work, it is suggestive and thorough. The translation is usually well done; but is it author or translator who is responsible for the statement on p. 58 ("The Unconscious Factor") that inspiration is the result of an *underhand* process existing in men? Chatterton is said, on p. 145, to have died at the age of sixteen, some emphasis being attached to that precise number; the usual statement is that "the marvellous boy" had almost reached his eighteenth year when he died.

(6) Mr. Mitchell's work will compare very favour-

ably with the best philosophical books of recent years. At its best the exposition of the subject is very clear and engaging, and gives evidence of much reading and sound study. If it errs at all, it is perhaps in occasional over-subtlety. An excellent running analysis is given in the table of contents.

Where all is so excellent and thorough, a short notice can do little more than indicate the point of view. The first part of the volume deals with the direct explanation of the mind, *i.e.* the explanation of experience in terms of itself. The second considers Sympathetic and Æsthetic Intelligence, and contains valuable chapters on Imitation, Fellow-feeling and Individuation (with a good note on *Einfühlung* on p. 149), and Absorption in the Object. The Growth of Intelligence in its two forms, Perceptual and Conceptual, is the subject of the third part, and in the last we return to an extension of the direct explanation of experience, and to the indirect explanation or explanation in physical terms.

We note one or two small points. (i) Mr. Mitchell rounds on the materialist position thus:—

"The capacity of the brain has to be inferred from the capacity to experience. . . . Whatever is possible to the mind is possible to the brain."

(ii) While not accepting the ordinary man's use of the term "mental faculty," and not accepting the division into faculties as though they were physical, the author has a refreshing bluntness and honesty in dealing with the term faculty itself. He has no objection to its use as properly defined, and complains that too often writers on psychology have thought that, so long as they avoided the *term* faculty, they could ask any number of indefinite questions—as to whether feelings depend on thoughts, or whether reason is the slave of passion—and could, in fact, substitute for faculties "a miscellaneous collection of experiences in every kind, of processes conscious and unconscious, and even of laws, as combining to make experience or causing it somehow." "I think it a needless penance," he adds, "to use the word 'disposition' in the sense that everyone would be willing to give to 'faculty' if he understood."

THE IMPERIAL GAZETTEER OF INDIA.

The Imperial Gazetteer of India. The Indian Empire, Vol. i., Descriptive. New edition. Pp. xxxi+568. (Oxford: The Clarendon Press, 1907.) Price 6s. net.

THE completion of the census in 1901 necessitated a revised issue of "The Imperial Gazetteer of India," of which two editions had already appeared, both compiled by the late Sir W. Hunter. Hunter, while in charge of the statistical department, had gained considerable knowledge of the country and its people, and in one subject, the history of the British occupation, was a competent authority. It is true that he inclined to overestimate the importance of his labours, and that he failed to give due credit to the district authorities who provided the raw material on which his compilation was based. At the same time he performed an invaluable service in popularising India for European readers. It became clear, however, that the Gazetteer was beyond the capacity of any single man, and that it was necessary to divide the subjects among a body of specialists. In the present issue, which will be nearly double the size of the last edition, little remains of Hunter's work except the final historical chapter.

During the quarter of a century which has passed since the last edition appeared, much has been done to extend our knowledge of the country. It is significant that in its physical aspects it is now officially assumed to include those outlying territories over which the Government has extended its control, even to the southern limits of Persia, Russia, Tibet, and China. The progress in the natural sciences is marked by Sir G. Watt's unwieldy "Economic Dictionary," Sir J. Hooker's "Flora," the "Manual of the Geology of India," the series of monographs on the fauna edited by Mr. Blanford, and a great mass of special literature. Scientific anthropology was in its infancy in Hunter's day; Dr. Grierson's linguistic survey was not even dreamed of; meteorology had not begun to gather its materials from beyond the Indian Ocean; hygiene had not yet been confronted with the problem of Oriental plague. Lastly, in the domain of religion, the translation of the sacred books had only just begun, and little attention had been given to the not less important subject of the beliefs and superstitions of the peasantry.

In the present edition of this great work these stores of new learning have been summarised and interpreted. Four introductory volumes are devoted to a series of lucid articles on the various scientific and administrative questions to which reference is made in the body of the work. The first volume contains ten articles. It opens with a chapter on the physical aspects of the country by Sir T. Holdich. The natural sciences are represented by a chapter on geology by Mr. T. Holland, one on meteorology prepared from materials supplied by Sir J. Eliot, while the veteran Sir J. D. Hooker deals with botany and Mr. W. T. Blanford with zoology. The chapter on ethnology and caste is a summary of the views expressed by Sir H. Risley in his last census report; that on language is the work of Dr. Grierson. Mr. W. Crooke is responsible for religions, Mr. E. A. Gait for sociology, and Dr. A. E. Roberts for public health and vital statistics.

The volume is thus made up out of a series of essays, each the work of an expert, and each provided with an adequate bibliography. In some cases, as that of geology, the treatment is more technical than will suit the general reader, but the review within narrow limits of space of a wide and intricate subject rendered this inevitable, and the serious student is the gainer. Many of the articles, however, are eminently readable; in particular, Sir T. Holdich, dealing with Mr. Holland's materials, has so interpreted the story of rock, mountain, and river that he has produced a fresh and graphic picture of the physical aspects of the country and of the environment of its people.

The gazetteer, which is issued in excellent form and at a most moderate price, should be in the hands of all who are interested in the fortunes of India. It should remain for many years the most authoritative source of information regarding our great eastern empire. The Government of India and its official editors and contributors are to be congratulated on the completion of a work of national importance.

OUR BOOK SHELF.

The Laboratory Book of Mineral Oil Testing. By James A. Hicks, with introduction by Sir Boverton Redwood. Pp. xii+76. (London: C. Griffin and Co., Ltd., 1906.) Price 2*s*. 6*d*. net.

EMPIRIC methods of testing, however simple in principle, are just those which require exact procedure in practice; otherwise two equally skilful analysts, by slight and apparently insignificant modifications, may arrive at different results. As the flash-point and viscosity methods, applied to the testing of mineral oils, depend on specially designed apparatus used under special conditions, it is essential that every chemist should work under the same conditions, and for this reason Mr. Hicks's little book will be gratefully appreciated by those who have to do with mineral oil testing. In addition to a careful description of various flash-point and viscosity apparatus and their application, the book contains an account of colour-testing and the use of sundry apparatus for estimating pressure of naphtha vapour, detection of petroleum vapour, capillarity testing, methods for estimating melting points of paraffin, wax, and scale, and for determining the calorific value of mineral oils. There is also a table (which should be unnecessary) for converting centigrade into Fahrenheit degrees, and a list of all the apparatus required for oil testing, including the name of the firm which undertakes to supply it. The book is evidently designed to meet every requirement, and its appearance under the auspices of Sir B. Redwood should be a guarantee of its practical value and utility. J. B. C.

Theories of Chemistry. Being Lectures Delivered at the University of California in Berkeley. By Svante Arrhenius. Edited by T. Slater Price. Pp. xii+212. (London: Longmans, Green and Co., 1907.) Price 5*s*. 6*d*. net.

THE nature and aim of this work are clearly stated by the author in his preface. He writes:—"The present lectures were delivered at the University of California during the summer of 1904. I have for a long time wished to give a coherent account of the development of theories in general chemistry. This seemed to me the more desirable because the latest extensions of this science are often, both by followers and opponents, regarded as something wholly new and quite independent of the progress in the past. Many seem to hold the opinion that the new developments are the more to be admired, the less dependent they are on the older chemical theories. In my opinion, nothing could be less correct. It is just the circumstance that the new theoretical discoveries have developed organically from the old generally accepted ideas, that is to me their most promising feature."

This is a somewhat unexpected view to be held by perhaps the greatest innovator in modern chemical theory, but there is no question that it has led to the production of a most unusual and stimulating book, the perusal of which no scientific chemist can afford to neglect. A detailed enumeration of the chapters would do little to indicate their contents. The subject-matter is familiar to all chemists—it is the treatment which is of special value. The various theories and hypotheses are critically examined and exhibited in their proper relationship and subordination. The whole work bears the stamp of a mind of uncommon power applied to the matter in hand with a balance and sobriety of judgment no less rare.

Life and Flowers. By M. Maeterlinck. Translated by A. T. de Mattos. Pp. xii+312. (London: George Allen, 1907.) Price 5*s*. net.

THIS volume contains a collection of essays of which some have appeared in periodicals, others are published in English for the first time. They are all more or less directly concerned with life, from the phantasy on the sun-dial to the eulogy on the boxer's fist, but only the two last, on the intelligence of flowers and perfumes, are relevant to the subject of flowers. In the former of these, M. Maeterlinck describes in his perspicuous language some of the striking phenomena connected with fruit dispersal, flower pollination, and movement in plants. The accuracy of the word-painting bears witness to the author's first-hand observation of many of the phenomena, although, as he points out, except for his original experiments with the species of Salvia, the results of which are not sufficiently advanced to publish, the facts are taken from well-known sources. The attribution of arithmetical powers to the Rue and other such hyperboles may be regarded as the expression of a strong imaginative temperament. The account of the pollination in *Orchis pyramidalis* furnishes one of the best examples of the author's faculty of description.

LETTER 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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Unscientific Administration.

IN his letter of June 20, Mr. M. D. Hill refers to the defective education of our schools and universities, and seems to suggest that it is not the mass of the people who are to blame for England's isolated position in her national neglect for science. May I point out that in the education of our future working classes equally unscientific ideals still prevail?

The recent review of Mr. Mair's book in NATURE of June 13 (p. 147) under the title "Realistic School Mathematics" shows that there is one Government department which is striving to introduce thoroughly sound and practical, and therefore scientific, methods of teaching into this country. But the training colleges in which teachers for elementary schools are educated at the expense of the State are tied down, by examination requirements, to courses which cannot be described otherwise than as useless mechanical drudgery, with the result that the student who obtains the highest class certificate of competency to teach becomes thoroughly unfitted to appreciate or even understand such a stimulating book as "A School Course of Mathematics." The children who are taught by such a teacher will in time become the electors in whose hands lies the duty of returning a Conservative or Liberal Government to power. Unless the teachers are trained on more scientific and practical lines, there is little prospect of any Government being administered scientifically.

One further point may be mentioned. In Germany and Austria the Government confers titles of honour—Geheimrat and Hofrat—on professors who have distinguished themselves by their researches. In Great Britain it is the universities which confer honorary degrees on prominent politicians. G. H. BRYAN.

LONDON BOTANIC GARDENS.[1]

THIS little work comprises in book form a series of articles contributed to the *American Journal of Pharmacy* by Mr. P. E. F. Perrédès in 1905 and 1906. Written by a pharmaceutical chemist to a pharmaceutical journal, these papers naturally devote attention primarily to the relationship of the London botanic gardens to the art of pharmacy. In tracing the origin of botanic gardens to the private gardens of the herbalists of the sixteenth and seventeenth centuries, the author shows that the cultivation of medicinal and officinal plants was the fundamental object kept steadily in view. But recognising that the modern botanic garden, while not departing from this original function, has developed other and equally important features, he has not confined himself exclusively to the pharmaceutical aspect of the London botanic gardens, but has given in a concise but comprehensive manner a review of the work accomplished by them in the domain of pure botany and in the application of the science to technical affairs. The subject has been treated throughout with a breadth of view, an insight and a sense of proportion which have too often been lacking in sketches of this nature, and the absence of which may be held accountable in a great measure for the vague ideas prevalent as to the functions of a botanic garden.

The gardens dealt with are the Chelsea Physic Garden, the Royal Botanic Gardens, Kew, the Royal Botanic Society's Garden, and the garden of the Royal Horticultural Society. The last makes no claim to rank as a botanical establishment, but in view of the close association with it of such men as Lindley, Bentham, and Fortune, and of the services rendered to botanical science by the collectors of the society, such as Don and Douglas, the author rightly feels that in a comprehensive review the Royal Horticultural Society cannot be ignored. In dealing with the three London botanic gardens proper, Mr. Perédès judiciously leaves the reader to form his own idea of their relative importance. Each is dealt with separately, from three points of view—historical, functional, and administrative.

From the historical standpoint it may almost be said that the history of these gardens is the history of systematic botany in England. In dealing with their functions, as already remarked, there has been no attempt at comparison. But the conclusion one arrives at is that, in inception at least, these respective botanic gardens were complementary rather than antagonistic or competitive. While founded on a common basis, they differed widely in scope, and though perhaps not dovetailing perfectly, there was no material overlapping. Thus the deed conveying the Chelsea Physic Garden to the Society of Apothecaries in 1722 stated that the conveyance was made "that their apprentices and others might better distinguish good and useful plants from those that bore resemblance to them, and yet were hurtful, and other the like good purposes."

The Royal Botanic Society was established, in 1839, on a somewhat wider footing "for the promotion of botany in all its branches, and its application to medicine, arts and manufactures, and also for the formation of extensive botanical and ornamental

Chelsea Physic Garden (*circa* 1850) from the river, before the construction of the Chelsea Embankment. From "London Botanic Gardens."

[1] "London Botanic Gardens." No. 62 of the Publications of the Wellcome Chemical Research Laboratories, Snow Hill, E.C. Pp. 99, with 31 plates.

gardens within the immediate vicinity of the metropolis." Both were strictly metropolitan institutions, and both were essentially educational establishments, differing only in scope. Various exigencies have at times modified, and even obscured, their primary object, but each has, so far as circumstances permitted, devoted itself to educational work. The extent and value of the services they have rendered, and continue to render, in this direction are fully detailed in the work under review.

Kew, on the other hand, can only be termed a *London* botanic garden in a strictly limited sense. As a national institution it has a much wider field, and its activities are on a correspondingly broader basis. Unlike the other gardens, it does practically no direct educational work, but "stands out prominently as a centre of botanical research, and as the cradle of botanical enterprise in India and the Colonies."

The principal aspects of Kew work are touched upon, but the limits of space have compelled the writer to treat them by way of illustration rather than exhaustively. No reference is made to the horticultural or ornamental side of Kew. While detracting in a measure from the completeness of the sketch, the omission is the less to be regretted because of the growing tendency on the part of the general public to regard this feature as fundamental rather than incidental, and to look upon botanic gardens as places of recreation rather than as scientific institutions. Mr. Perrédès's work, by directing attention to the conspicuous part that the London botanic gardens have played in the scientific and material progress of the nation, should go far towards removing the reproach that our botanic gardens are better understood and more appreciated abroad than at home, a reproach which gains point from the fact that the papers under notice were contributed to an American journal, and are only available in this country at second-hand.

The work is well illustrated, and contains a copious bibliography.

THE NATIONAL PHYSICAL LABORATORY.[1]

THE recent discussion of the affairs of the National Physical Laboratory in Parliament, and the appointment of a departmental committee of the Treasury to inquire into the working of the laboratory, with special reference to its alleged "competition with private establishments," have tended to produce amongst the newspaper-reading public an impression that the institution was not being carried on satisfactorily. It may be useful, therefore, to state in a few words what is really the position of affairs.

The laboratory was established in 1899 to serve as an independent testing authority, and to carry out researches into the properties of materials which, while necessary for the advance of the industries of the country on scientific lines, are generally too extensive and laborious to be undertaken by private individuals. It was not anticipated that it would ever be necessary to compete with the existing private institutions in the testing of materials, but nothing in the Royal Society's scheme on which the laboratory was founded limited its testing powers. Once it was equipped and staffed, the desire of industrial firms to have their materials tested by men who had already made names for themselves in the scientific world appears to have led to much work of this kind being sent to the laboratory, and it is difficult to see on what grounds it could be refused. Whether it is to be undertaken in future or not the Treasury Committee must decide.

With regard to the research work of the laboratory, there can be no two opinions. A glance through the two works under notice is sufficient to show how well it is fulfilling its task. Dr. Stanton's work on the resistance of iron and steel to reversals of stress is supplying information urgently needed, and with Dr. Carpenter's work on the structure of high-speed tool steel and on the properties of iron-nickel-manganese-carbon alloys is constituting the laboratory *the* authority in this country on the properties of the materials used by mechanical engineers. Mr. Paterson's investigations on light standards and glow lamps, communicated to the Institution of Electrical Engineers in January, supply gas and electrical engineers with information of the greatest value as to the relative merits, or rather demerits, of the various standards of light. Mr. Campbell's researches on the properties of the paper and cellulose used in telephone cables, on insulating materials suitable for high temperatures, and his hysteresis research, all bear intimately on the electrical engineering industry, as does Dr. Caspari's work on gutta-percha and balata. Dr. Harker's new bench-mark 1710° C. for the melting of platinum will serve as a starting point for a revision of all our high temperature melting points, and will introduce precision into a region in which uncertainty has been the prevailing feature. His interesting work on the Kew temperature scale may lead to Kew methods becoming international.

The testing work of the observatory department has increased, and the department appears now to turn out "hall-marked" men, *e.g.* Wood, Simpson, and Gold, as well as "hall-marked" instruments. Two important discussions, by Dr. Chree, of terrestrial magnetism and of atmospheric electricity records, and their relation to meteorological phenomena, show that there is no likelihood of the reputation of Kew as a place of research suffering now it has lost its independence.

The few investigations mentioned above serve as examples of the work that is being done in the laboratory, but they tell nothing of the good influences exerted by the laboratory through the members of its staff on the councils and at the meetings of scientific and technical societies throughout the kingdom.

Although there will always be members of the public, and even Members of Parliament, who are unable to understand why any of the nation's money should be invested outside the circle of "small profits and quick returns," no one who is anxious that our country should stand shoulder to shoulder with its neighbours in the march of scientific and industrial progress can feel other than gratified that in establishing the National Physical Laboratory we have taken a step in the right direction.

C. H. L.

[1] The National Physical Laboratory Report for the Year 1906. Pp. 61. (Teddington: Parrott and Ashfield, 1907.)
The National Physical Laboratory—Collected Researches, vol. ii. Pp. ii+310. (N.D.)

DR. EDWARD JOHN ROUTH, F.R.S.

BY the death of Dr. Routh on June 7, after a period of gradually failing health, a commanding figure in the recent history of English mathematics has been removed. Born at Quebec in 1831, the son of a distinguished British officer, he was educated in London at University College School, and subsequently studied mathematics under de Morgan at University College. He matriculated at Peterhouse in 1850, but did not drop his London connection, obtaining the gold medal in mathematics with the degree of Master of Arts in 1853, then a somewhat rare distinction. At Peterhouse he had Clerk Maxwell, who soon after migrated to Trinity, as his rival in the same year; while Tait and Steele were undergraduates of the College, and Lord Kelvin (already Prof. W. Thomson, of Glasgow) was a junior Fellow.

Not long after taking his degree, in January, 1854, being senior wrangler, and bracketed with Clerk Maxwell for the Smith's prizes, he began the career of tuition of advanced honour men in mathematics, which was soon to lead to a unique reputation as a successful teacher. From 1858 to 1888 he had, in all, between 600 and 650 pupils, of whom the great majority graduated as wranglers, twenty-seven being seniors, while forty-one were Smith's prizemen; between 1861 and 1885, when he retired from this strenuous work at the age of fifty-four, he had all the senior wranglers as pupils, with but one exception near the end of the time.[1] The number of his pupils, which was for many years about 100, was not at all unprecedented; what was unique was the fact that for all this time he directed, almost without challenge, most of the intellectual activity of the *élite* of the undergraduate mathematical side of the University. This herculean task naturally demanded methodical arrangements, and the husbanding of his resources to the utmost. What he aimed at was to impart thorough mastery of the main principles of ascertained knowledge over the field of mathematics then cultivated at Cambridge; it was clearly out of the question to stray very far into the regions of nascent science in which ordered theory gradually evolves itself in response to concentrated and specialised effort. He was in the habit of claiming that this would follow spontaneously in the case of the mathematician born, once he had learnt mastery of the resources of the science; while even when it did not follow, the record in the legal and other professions of persons who had done well in youth in mathematical studies proved their supreme value as a deductive mental discipline.

His plan was to take small classes, each of about ten men selected to run together, and to maintain an average by catechetical methods. Those who could go faster than the average had extra material provided in the form of manuscript digests for study, and especially in the institution of a weekly paper of about a dozen problems, selected from recent examination papers, or abstracted from memoirs in the home and foreign mathematical journals. An element of competition formed a stimulus in answering these papers, while written solutions were afterwards at hand for study in cases of failure to unravel them. Looking back on those times, it might be thought that there was too much problem and too little sustained theory; but no one ever accused the standard of the problems selected of being lower than it ought to be, while, on the other hand, absence of some such rigid procedure would have rendered quite impossible that focussing of undergraduate mathematical activity and ambition in one place which was a main feature of the system. Men with further ambitions would struggle with Thomson and Tait's "Natural Philosophy" or with Maxwell's "Electricity," or with brilliant and stimulating courses of lectures given on growing special subjects by the more eminent mathematical physicists, and thus learn that though in youth mastery may be rapid, yet at all times invention must be slow. It was, moreover, thus possible for the abler men to have time to spare to expand their outlook by taking up some other branch of knowledge as a relaxation from mathematics, or for joining in other activities of the University. Nowadays the field covered by the mathematical instruction offered at Cambridge is vastly wider than would have been conceived as practicable twenty years ago; but the question is still unsettled how far it is expedient to extend the preliminary undergraduate course into complex special theories.

[1] These and other facts have been taken from a valuable notice in the *Cambridge Review* signed W. W. R. B.

Whatever may be thought as regards Dr. Routh's views on postponing special research in favour of thorough preparation, it could not be urged that he did not himself, notwithstanding his other absorbing work, set an example of what research might be. Many of his earlier papers, mainly in the *Quarterly Journal of Mathematics*, related to the dynamics of rigid solids, spinning tops, rolling globes, precession and nutation, and such like, and were distinguished by the development of methods relating to moving systems of coordinate axes, and to the differentiation of vectors such as velocity and momentum with regard to them. In another connection he applied the kinematics of special systems of coordinate axes moving along a curve to problems of curvature and torsion. The advantages of these methods in differential geometry have come again into recognition, as may be seen in such works as Darboux's "Théorie des Surfaces." Afterwards, arising out of his researches on dynamical stability, which will be referred to presently in more detail, there came a series of papers in the Proceedings of the London Mathematical Society on the propagation of waves and the analysis of complex vibrations in networks of interlacing threads and in other such laminar systems, leading up to a mechanical treatment or illustration of the broad general theory of harmonic analysis, principal periods, and related topics.

In the early 'seventies, the question of the possible explanation of steady, including apparently statical, relations of material systems by the existence of latent steady motions, such as the rotations of concealed flywheels or gyrostats attached to the system, was much to the fore. The fundamental problem as regards such representations is their degree of permanence; for a state of motion which falls away, however slowly, cannot be appealed to in elucidation of secular steadiness of relations. At a later stage the ideas of the subject were crystallised by Lord Kelvin in his British Association address, Montreal, 1884, entitled "Steps towards a Kinetic Theory of Matter," and in later addresses on cognate topics, mainly reprinted in vol. i. (Constitution of Matter) of his "Popular Lectures and Addresses," culminating in a way in 1897 in his gyrostatic model of a rotationally elastic optical æther.

It is thus not surprising that the Adams prize subject at Cambridge for the period 1875–7, announced over the signatures of Challis, Clerk Maxwell, and Stokes, should have been the search for "The Criterion of Dynamical Stability." This subject suited Routh's predilections exactly; and his classical essay, "A Treatise on the Stability of a Given State of Motion, particularly Steady Motion," composed, as he states in the preface, almost entirely during the year 1876, was the result. The greater part of the work in the essay is analytical, and is concerned with the discussion of the nature of the roots of the algebraic equation determining the free period of slight vibration of the dynamical system; but where it enters upon the discussion of dynamical principles, such as the criteria connected with the Energy and the Action, the essay moves in a high plane. In particular, the burning question of how adequately to represent latent, and, therefore, unknown steady motions, such as those of concealed flywheels or gyrostats attached to the system, is solved at a stroke by the famous theorem of the "modified Lagrangian function." It was established, in fact, that the presence of concealed steady motions does not fundamentally alter the standard mode of analytical specification of dynamical interaction developed originally by Lagrange, except in the one respect that the effective Lagrangian function now involves terms linear in the velocity-components as well as quadratic terms. The procedure of Lagrange, evolved originally from the side of the Principle of Action, constituted the science of general dynamics by eliminating from the problem all variables the values of which are prescribed in terms of the remaining ones by relations of permanent constraint, thus reducing the dynamical analysis to the discussion of just as many quantities as are required to specify the state of the system. It gives cause for some surprise that nearly a century elapsed before the correlative step was taken, namely, the elimination from the analytical specification of the system of permanently steady or cyclic motions, as well as the permanent geometrical constraints above mentioned. In the hands of the analysts who treated the subject meanwhile, the requirements of the actual planetary and lunar theories were perhaps the main aim; it is only recently, and largely in the hands of the English school, notably Lord Kelvin and Clerk Maxwell, in later conjunction with Helmholtz, and building largely on the earlier work of W. Rowan Hamilton, that the subject of general dynamics has been welded into an instrument for the inductive, and in many cases speculative, exploration of physical processes in general. Anyhow, it will be evident how fundamental an advance in the principles of the dynamical interpretation of nature was involved in Routh's formulation of what he called the "modified Lagrangian function."

The problem thus solved by Routh with remarkable simplicity had already been some time in evidence. In the first edition of Thomson and Tait's "Natural Philosophy" in 1868, the equations of Lagrange had been applied in most effective manner to problems of motions of solids in fluid media, the energy function involved being determined in terms of the motions of the solids alone, and the fluid thus being *ignored* in the subsequent work. This procedure was soon challenged by Kirchhoff, as going beyond the existing conditions of validity of general dynamical theory; and a special justification for the case of motion in fluids was given by him on the basis of a Least Action analysis. Soon afterwards the same difficulty was pressed on Lord Kelvin independently by J. Purser, who also published a justification on more physical lines. This was, not unlikely, the origin of Lord Kelvin's general theory of "ignoration of coordinates," first published in 1879 in the second edition of Thomson and Tait's work, but which probably existed in manuscript anterior to Routh's essay. A report was once current that most of it was worked out in the harbour of Cherbourg, while his yacht was refitting, and the carpenters were all the time hammering overhead. This form of the theory, though more expressly suggested by the needs of physical dynamics, was less complete in one respect than Routh's, in that it did not bring the matter into direct relation with a single characteristic function (Lagrangian function of Routh, kinetic potential of Helmholtz), but simply obtained and illustrated the equations of motion that arose from the elimination of the cyclic coordinates that could be thus ignored.

Later still, Helmholtz, in his studies on monocyclic and polycyclic kinetic systems, which began in 1884 and culminated in the important memoir on the physical meaning of the Principle of Least Action in vol. c. (1886) of *Crelle's Journal*, developed the same theory more in Routh's manner, and built round it an extensive discussion of physical phenomena, so that on the Continent the whole subject is usually coupled with his name. Shortly before, the work of Routh and Kelvin had already been coordinated with the Principle of Action by more than one writer in England.

The most elaborate published result of Dr. Routh's scientific activity was the "Treatise on the Dynamics of a System of Rigid Bodies," which began as a thorough, though rather difficult, handbook in one octavo volume, but expanded in successive editions in a manner of which other classical instances readily occur to mind, until it became a sort of cyclopedia of the dynamical section of theoretical physics. In the course of an inquiry some ten years ago as to the reason why English mathematical physicists had so much practical command over the application of their knowledge, the mode of teaching in Cambridge came under review; and in particular this book was discovered by Prof. F. Klein, of Göttingen, who made arrangements for its introduction to the Continental public in a German translation, containing some brief valuable annotations such as the wide analytical outlook at Göttingen suggested. Especially was emphasis given to the great extension of the scope of abstract dynamics above described, with which Routh's name was associated, it is to be hoped permanently. Somehow the book does not seem to have attracted even yet much sustained attention in France.

Until lately, Dr. Routh's presence was a familiar and welcome one to residents in Cambridge. Though he never sought public positions, his services were in requisition in many ways, as Senator and Fellow of the University of London, as member of the University Council at Cambridge, member of council of the Royal Society, and in other activities; while he declined more prominent offices more than once. In society he was bright and attractive though somewhat retiring, simple, and entirely free from any suggestion of superiority. The respect and affection which he inspired in a long succession of distinguished pupils found expression on the occasion of his partial withdrawal from work in 1888, when at a remarkable gathering of judges, engineers, and men of science, his portrait by Herkomer was presented to Mrs. Routh, with many expressions of warm appreciation. His leisure he employed mainly in mathematical research, and in the preparation of a series of treatises on subjects of mathematical physics, of which the only criticism to be made is that his wealth of valuable material tended to convert them into cyclopedias rather than text-books. His last public action was to take the lead in opposition to the proposals for change in the system of the mathematical tripos at Cambridge. It is possible that he did not fully realise the altered circumstances of the time, and the insistent claims of other studies; anyhow, it will be matter for congratulation if the new arrangements work as well and as smoothly as did the older mathematical tripos during the long period when the practical direction was mainly in his hands.

J. L.

PROF. A. S. HERSCHEL, F.R.S.

THE death of Prof. Alexander Stewart Herschel, F.R.S., on June 18 will be deplored by many astronomers. Prof. Herschel was born in 1836, and was the second son of Sir John Herschel. He was appointed professor of physics at the Durham College of Science, Newcastle-on-Tyne, in 1871, and was honorary professor and governor of the college at the time of his death, though he left Newcastle about twenty years ago, and resided with his brother, Col. John Herschel, F.R.S., at Observatory House, Slough, which was the home of his renowned grandfather, Sir William Herschel, and of his father. Prof. Herschel was elected a Fellow of the Royal Astronomical Society in 1867, and of the Royal Society in 1884.

Inheriting an illustrious name, Prof. Herschel also inherited the love for astronomy, the indomitable perseverance and capacity for work, and much of the ability which distinguished his father and grandfather. As a mathematician, physicist, and observer, Prof. Herschel was *facile princeps*, and it was fortunate for meteoric astronomy that he devoted himself to its practical and theoretical investigation. Sir John and Sir William Herschel had swept the heavens with large telescopes in quest of nebulæ, double stars, and other objects, but Prof. Alexander Herschel appears to have preferred naked-eye observation to instrumental work. For about half a century he watched diligently for meteors, and obtained numerous and valuable results, as past volumes of the Monthly Notices of the Royal Astronomical Society and Nature fully attest.

Apart from his observational results Prof. Herschel accomplished a large amount of important work in the summation, reduction, and discussion of various other observations. In conjunction with Mr. R. P. Greg he formed several extensive catalogues of the radiant points of shooting stars, and the most important of these were published in 1868, 1872, and 1874. One of his greatest successes, though it has been little commented upon, was the prediction made in the Monthly Notices, vol. xxxii., p. 355, of the great Bielid shower of 1872 November 27. For many years he compiled the annual reports of the luminous meteor committee of the British Association, and contributed, until 1880, the yearly notes on meteoric astronomy published in the anniversary number (February) of the Monthly Notices.

Prof. Herschel was a voluminous writer, and all those who enjoyed the pleasure of corresponding with him will agree that his letters were just as interesting as they were long. The writer of this notice will always have reason to be grateful to him for kind encouragement, advice, and instruction in the earlier years of his observing career. It is not too much to say that without the deep interest incited by Prof. Herschel's letters the meteoric observations obtained at Bristol during the last thirty-five years may never have been made.

As an observer of shooting stars Prof. Herschel was remarkably accurate, and he not only recorded their apparent paths with fidelity, but accompanied his results with descriptive details marvellous in their fulness. He computed the real paths of a great many fireballs and ordinary falling stars, and very ably discussed the often discordant observations which formed the basis of these inquiries.

The present writer has often been impressed at the acumen and sound judgment he displayed in dealing with difficult materials of this character. Meteoric astronomy has indeed lost one of its ablest votaries in Prof. Herschel, and it may truly be said that the present high position of this branch of science is due in no small measure to his prolonged and able researches.

W. F. Denning.

NOTES.

A correspondent recently directed our attention to a sensational report that certain signals are regularly received at one of the Marconi wireless telegraph stations, and are believed to be communications from Mars or another planet. As Mars will be in opposition on July 6, and is well situated for observation in southern observatories, the rumour will probably be extensively circulated during the next few months. A copy of the report was sent, therefore, to Mr. Marconi, who has favoured us with the following reply:—"There is no truth whatever in the statement which has been freely published for the last year or two that mysterious signals have been received at Cape Clear from probably some distant planet. There is, in the first place, no wireless telegraph station at Cape Clear. The stray or vagrant electrical effects which do manifest themselves from time to time at wireless telegraph stations are due to atmospheric discharges or other natural causes. To attribute this phenomenon to any such source as is contemplated in these newspaper reports is, so far, purely imaginative and idle speculation."

We regret to have to record the death of the well-known ironmaster, Mr. Thomas Andrews, F.R.S., at Wortley, near Sheffield, on June 19. Mr. Andrews was born at Sheffield in 1847, and succeeded his father as proprietor of the Wortley Iron Works many years ago. He was the author of numerous papers, chiefly on metallurgical subjects, but his researches were of a varied nature, and included such widely separated subjects as the composition of river waters and the strength of railway axles. Of late years his writings dealt chiefly with the micro-structure of metals, carrying on work which originated in Sheffield. He was awarded a Telford medal and premium by the Institution of Civil Engineers in 1884, and was elected a Fellow of the Royal Society in 1888. He was also a gold medallist and Bessemer prizeman of the Society of Engineers, London.

Mr. A. W. Hill, fellow and dean of King's College, Cambridge, and university lecturer in botany, has been appointed assistant director of the Royal Gardens, Kew.

Profs. Guido Castelnuovo, of Rome, George William Hill, of New York, Camille Jordan, of Paris, and Vito Volterra, of Rome, have been elected honorary members of the London Mathematical Society.

A charter of incorporation has been granted by the King to the Society of Chemical Industry, which was founded in 1881 to promote the application of chemical science to arts and manufactures.

A committee has been appointed by the President of the Board of Agriculture and Fisheries to inquire into the nature of distemper in dogs in Great Britain and the methods of its infection, and to report whether any, and, if so, what, preventive or remedial measures, exclusive of ordinary medical treatment, can with advantage be taken with respect to it.

A conference on the prevention of infant mortality and the welfare of nursing mothers and suckling infants will be held at the Town Hall, Pancras Road, N.W., on July 1, at 3.30 p.m., to inaugurate the opening of the School for Mothers at 6 and 7 Chalton Street, Euston Road, N.W., the centre of the St. Pancras Mothers' and Infants' Society. The Mayor of St. Pancras will welcome the conference, and Lord Robert Cecil will preside.

On Monday next, July 1, at 2.30 (weather permitting), there will be a display of scientific kites and other aëronautical experiments on Chobham Common, Sunningdale, where the Aëronautical Society will hold the concluding meeting of the present session. Kites will be displayed by Mr. W. H. Dines, F.R.S., Mr. C. J. P. Cave, Mr. S. H. R. Salmon, and Mr. R. M. Balston. Mr. Cave will send up pilot balloons to determine the rate and direction of the wind at different heights, and demonstrations of the method will be given by means of a theodolite specially made from designs by M. de Quervain. Mr. Cave will also send up a *ballon-sonde* carrying self-recording instruments complete, as used by him for the international aëronautical ascents, which take place on fixed days simultaneously throughout Europe. Mr. José Weiss will perform experiments with model gliders.

As the result of an extensive correspondence with entomologists of various countries of Europe and America, it has been decided to issue, in the course of this summer, invitations for an International Congress of Entomology, to meet in 1908, probably at Brussels. The purpose of the congress is the promotion of the interests of entomology, and therefore of biology in general, by furthering cordial cooperation between the entomologists of different countries, and by stimulating research and directing it into channels where it may be most fruitful or where special research is most needed. Questions of applied entomology will likewise be dealt with in lectures and discussions, the large experience of devotees to pure entomology being applicable, with profit, to economic and hygienic entomology. Entomologists are cordially invited to advise and assist in the organisation of the congress. All communications, until further notice, should be addressed to Dr. K. Jordan, Zoological Museum, Tring (Herts).

The fifth annual meeting of the South African Association for the Advancement of Science will be held in Natal on July 10–17 next under the presidency of Dr. James Hyslop, D.S.O. The first part of the meeting, from July 10 to July 13, will be held at Pietermaritzburg, and the second part at Durban. The council of the association has revised the arrangement of the sections. Section A, the president of which this year is Mr. E. Nevill, comprises mathematics, physics, astronomy, meteorology, geodesy, and geography. Sections B and C, including chemistry, metallurgy, mineralogy and geology, engineering, mining, and architecture, will be presided over by Mr. Cathcart W. Methven. The president of Section D, Mr. H. Watkins Pitchford, will take the chair at meetings concerned with botany, zoology, agriculture and forestry, bacteriology, physiology, and hygiene. Mr. R. D. Clark is the president of Sections E and F, before which papers will be read on education, philology, psychology, history, archaeology, economics and statistics, sociology, anthropology and ethnology. It will be remembered that, in connection with the South African medal and fund, the council of the British Association adopted a resolution "that, in accordance with the wishes of the subscribers, the South African Medal Fund be vested in the names of the trustees appointed by the South African Association for the Advancement of Science; and that the dies for the medal be transferred to the association, to which in its corporate capacity the administration of the fund and the award of the medal shall be and is hereby entrusted under the conditions specified in the report of the medal committee." The council of the South African Association accepted with high appreciation the offer made by the British Association, and undertook the award of the medal and fund in accordance with the terms of the conveyance. The fund, amounting to 1376*l.*, has been invested, and rules for the award of the medal and fund are being framed and will be dealt with at the forthcoming meeting. It is intended that the first award shall be made at the 1908 meeting of the association. The assistant general secretaries are Mr. E. Hope Jones for Cape Colony and Rhodesia, and Mr. Fred Rowland for the Transvaal, Orange River Colony and Natal. They may be addressed at P.O. Box 1497, Cape Town.

The first part of a new serial, *Records of the Canterbury Museum* (N.Z.), is devoted to a list of New Zealand fishes, by Mr. E. R. Waite, based on the one in the late Captain Hutton's "Index Faunæ Novæ Zealandiæ," but containing references to the original descriptions.

Articles on the fresh-water bryozoans of the country and the plankton of the coast—the former by Dr. A. Oka and the latter by Mr. K. Okamura—are included in the latest issue (vol. vi., part ii.) of *Annotationes Zoologicae Japonenses*.

No. 10 of the Indian Forest Bulletin is devoted to an account, by Mr. E. P. Stebbing, of the ravages inflicted by a longicorn beetle (*Butocera rubus*) on fig-trees in Baluchistan. The beetles made their appearance two years ago in a garden in the Duki district noted for the size of its fig-trees, on which they have inflicted very serious injuries. It is hoped, however, that by the use of suitable remedies the plague will shortly be stayed.

According to the annual report for the year 1906, the Zoological Society of Philadelphia is in a rather unsatisfactory financial condition, owing to the increased cost of almost everything connected with the upkeep of the menagerie. The result is an account overdrawn by nearly 3000 dollars. Neither have animals been acquired so rapidly as usual, very few new to the collection having been added during the year.

Despite the plethora of popular ornithological literature, there seems certainly room for a journal devoted to the purpose of recording recent additions to our knowledge of the birds on the British list. This gap is to be supplied by *British Birds; an Illustrated Magazine devoted to the Birds on the British List*, of which the first (June) number is now before us. Edited by Mr. H. F. Witherby, with the assistance of Mr. W. P. Pycraft, the magazine is to be published monthly by Witherby and Co. at the price of one shilling. The frontispiece to the first part is an exquisite photograph of an osprey descending on its nest, the most important article in this issue being one in which Mr. Howard Saunders enumerates the species added to the British list since 1899.

In the May number of the *Quarterly Journal of Microscopical Science* Miss Georgina Sweet, of Melbourne, continues her elaborate account of the anatomy of the marsupial mole (*Notoryctes typhlops*), dealing in this instance with the structure of the skin, hair, and reproductive organs. In examining the structure of the skin of the head, certain curious modified groups of cells with a more or less definite arrangement were detected, and similar cells were also found to exist in a modified patch of skin on the rump as well as in the region of the pouch. Although direct proof of the existence of nervous function is lacking, it seems probable that these modified cells represent some form of tactile sense-organ, which would obviously be of very considerable use to a blind burrowing creature like Notoryctes. It is unfortunate that at present nothing is known with regard to the embryology and development of this remarkable animal.

To the first part of vol. xvi. of *Anales Mus. Nat. Buenos Aires* Dr. F. Ameghino contributes four interesting plates in which skeletons of the extinct Hippidium and Machaerodus (Smilodon) of Argentina are respectively contrasted with those of the modern horse and tiger. In its huge skull and short limbs the extinct horse presents a remarkable contrast to its existing representative. It may be added that, through the kind offices of Dr. Ameghino, plaster reproductions of the skeletons of the two extinct species are now exhibited in the British Museum (Natural History). In a second paper in the same issue the author records the existence of what he regards as rudimentary horns in certain members of the toxodont group. In one instance (Trigodon) the rudiment takes the form of a low median frontal boss, compared by its describer to that of the Old World Elasmotherium, but in a skull figured under the name of Ceratoxodon there appear to be at least four pairs of smaller prominences.

THE fifth annual report of the Rhodesia Museum (Bulawayo, 1907) shows that the accessions to the museum in 1906 exceeded in importance those of any previous year, and that the number of visitors was 2292. A considerable number of interesting minerals and rocks were examined during the year, the number of identifications made for prospectors having been exceptionally large. Gem-stones were especially in evidence. For the guidance of prospectors, an able essay on the mineral wealth of Rhodesia has been written by the curator, Mr. F. P. Mennell, and is appended to the report. With the appointment of Mr. E. C. Chubb, of the British Museum (Natural History), as an additional member of the staff to take charge of the zoological department, the activity of the museum cannot fail to be increased in various directions.

OF the various branches of work undertaken by the Liverpool Institute of Tropical Research, the most productive and useful have been the missions abroad, especially the two expeditions to West Africa, where the representatives of the institute had the opportunity of noting conditions and resources, and brought away valuable collections. The results are summarised by the director, Viscount Mountmorres, in the fourth number of the Quarterly Journal issued by the institute. In the same number Dr. D. Spence communicates an account of two substances prepared from the resin of *Ficus Vogelii*, leading to the conclusion that the resinous products are closely related to caoutchouc, and Mr. R. Newstead discusses three types of weevils that are found in West African grain, and the suggested methods of destruction.

A PAMPHLET has been received in which the author, Mr. P. Frazer, describes experiments undertaken with the view of tracing the sources of injury to vegetation in the neighbourhood of manufacturing works. The results are in accord with former investigations, that the poisonous effects are produced chiefly by oxides of sulphur coming into direct contact with the leaves of plants, while the acids percolating into the soil do not injure the roots. A full bibliography is appended to the paper, which was read in April at the New York meeting of the American Institute of Mining Engineers.

IT has been observed that when potato plants are grown in a very moist atmosphere, swellings or intumescences often develop on the leaves. An account of experiments undertaken by Miss E. Douglas to examine their origin and discover the causes regulating their production was published in the *Botanical Gazette* (April). The intumescences are due to the growth of the cells, generally the palisade cells of the mesophyll, that elongate and divide until they break through the epidermal layer. The experiments indicate that the growth is the result of an abnormal state of turgescence when more water is absorbed than can be transpired or used in normal growth, and this is probably caused by the accumulation of osmotically active glucose.

THE twentieth volume of the Journal of the College of Science, Tokio University, is devoted to an enumeration of flowering plants and ferns from Formosa, compiled by Prof. J. Matsumara and Mr. B. Hayata. The compilation is based on specimens collected by several Japanese botanists who have toured through the island, their routes being shown upon an accompanying map. The number of new species is not very great, and the majority are figured in the excellent plates appended. Under *Spiraea prunifolia*, a plant that with double flowers is common in Japan, the authors describe a single-flowered plant, and mention that it is the first they have seen. A new order, Alniphyllaceæ, is proposed for a plant receiving the name of *Alniphyllum pterospermum*, that bears strong affinities both to the Styraceæ and Ericaceæ.

SOME admirably planned and instructive investigations carried out by Mr. W. J. Cudworth and Mr. Wilson Worsdell on the North-Eastern Railway are described in *Engineering* of June 14. The object of the investigations, which have extended over fourteen years, was to ascertain the cause of the inequalities which from time to time develop on the surface of rails. The results, though not conclusive, are stimulating. They show that the structure of the metal is an important factor in the wear and tear of rails, the difference in structure being probably due to the varying conditions of temperature and the different speeds at which the rails are rolled. The hard knobs which develop in the course of usage on all lines may be produced by mechanical action due to vibration when the wheels are passing over the rails.

THE first report of the Royal Commission on Mines has been issued (Cd. 3548, price 1*s*. 3*d*.). The Royal Commission, of which Lord Monkswell is chairman, was appointed on June 6, 1906, to consider questions concerning the health and safety of miners. The present report, which covers fifty-two pages, is devoted to the use of breathing appliances. The Commissioners do not suggest that the use of such appliances, the compulsory provision of which would not be justified at present, is likely to lead to any considerable decrease in the number of lives lost by explosions. Apart from actual rescue work, they may, however, be of great service in making it possible to deal with underground fires safely and effectively. The use of breathing appliances is not unattended by risks, but such risks can be reduced to a minimum by a proper system of training, which could be provided by the establishment of central rescue stations. Appended to the report are reports on breathing apparatus, by Dr. Boycott; on colliery fires, by a committee of the South Yorkshire Coalowners' Association; on rescue apparatus, by a committee of the Fife and Clackmannan Coalowners' Association; and on breathing apparatus, by a French commission. For educational purposes the value of the report is enhanced by the accompanying detailed drawings of the pneumatogen, the Draeger, the Shamrock, the improved Fleuss, the Weg, and the Aërolith apparatus.

PROF. HANN presented a treatise on the daily range of temperature in the tropical regions of Asia and Australia to the Vienna Academy on April 25, being the conclusion of a laborious discussion of the daily range of temperature in the tropics. The principal object of the treatise in question was to obtain corrections for reducing to the true daily mean the means obtained from combinations of observations at various hours. The author finds that the best mean is obtained from the readings at $(7+2+9+9):4$ both for coast and inland stations, and that the mean obtained from the readings of the maximum and minimum thermometers, which is most usually adopted, is, except for higher latitudes, the worst that can be employed; a mean obtained from even two fixed hours daily would be more satisfactory than the mean of the daily extremes.

The mean and extreme meteorological values for twenty-five stations in the British Empire during the year 1905 are given in *Symons's Meteorological Magazine* for May. So far as these stations are concerned, the following high shade temperatures were recorded:—Calcutta, 106°·1 (June); Madras, 107°·9 (May); Melbourne and Coolgardie (West Australia), 108°·5 (January); Adelaide, 109°·7 (January). The lowest readings were:—Fredericton (New Brunswick), −33°·5, Winnipeg, −39°·1, Dawson, −50°·5 (all in January); the latter station had the lowest mean temperature (25°·2). Coolgardie had the highest temperature in the sun's rays, 178°·8, the lowest mean humidity, 52 per cent., and least rainfall, 7·86 inches. The greatest rainfall, 77·89 inches, was at Grenada, and the dampest station was London, 83 per cent. Similar valuable tables have been published monthly for more than twenty-five years, but it must be clearly understood that these few widely scattered stations are quite insufficient to give a complete conspectus of the climate of the vast area included in the British Empire.

The new method of lighting which has recently been installed in the courtyard of the Savoy Hotel is creating much interest, and is, we believe, the first installation of this particular system in this country. The system is the result of years of experimenting, and the results are now given by Mr. D. McFarlane Moore in his paper recently read before the American Institution of Electrical Engineers. The chief feature of the system is the automatic valve, which admits the exact quantity of air or gas required to prevent the violent spasmodic flickering due to the higher degree of vacuum in the tube causing a higher resistance, and which up to the present has prevented a perfect vacuum-tube lighting being placed on the market. The important points about the valve are its simplicity and its automatic action. The valve admits the air required about once a minute, and by changing the nature of the gas admitted the colour of the light can be arranged as required. The main objection to the system appears to be that a high pressure is required; consequently each tube must at the ends be led into a transformer. We should also like to know more about the initial cost of the installation, the length of life of the tube, efficiency, &c., than we are told by Mr. Moore in his paper. If the matters mentioned above are satisfactory in comparison with the present costs and efficiency of modern forms of lighting, the new system should prove of value for large shops, studios, and art galleries, where it is essential to have the lighting as near as possible to daylight. Further developments will be watched with interest, but fuller figures relating to tests will be required before the system can be considered seriously.

From Messrs. Hilger, Ltd., we have received a copy of their newly published "List A," in which many well-designed spectroscopes and pieces of spectroscopic apparatus are described and illustrated. The Hilger wave-length spectrometer may now be had fitted with a camera of 21 inches focal length at an additional charge of 6*l*. 10*s*. Spectroscopists will be interested, too, in the new series of six spectrographs—three of which are fitted with ultra-violet glass and three with quartz prisms and lenses—especially designed to give, with a short exposure, the whole length of spectrum, in good definition throughout, on a flat plate, and to be in permanent adjustment. The excellent results obtainable with these spectroscopes are illustrated by an enlarged copy of the spectrum of copper extending from λ 5782 to λ 2160, which we have examined. This was taken with a quartz spectrograph having two 30° prisms and lenses of 8″ focus, the distance from λ 6000 to λ 2160 on the original negative being 60 mm. ($2\frac{3}{8}$″), price 21*l*. 10*s*. The Michelson interferometer, reading to one ten-thousandth of a millimetre, is a fine instrument at the moderate price of 35*l*., as is also the Jamin refractometer at 17*l*. 10*s*. Messrs. Hilger also make a speciality of the strips of plane parallel glass for the Lummer and Gehrcke parallel-plate spectroscope. The prices range from 10*l*. for a plate 100×30×10 mm. to 39*l*. for one measuring 300×40×10 mm.

"What is Genius?" ("Che cosa è il genio?") is the title of a small book by Adolfo Padovan (Milan: U. Hoepli, 1907, second edition). The author discusses examples of genius among artists, poets, philosophers, and others; he distinguishes between genius and talent, and strongly advocates the view that genius is to be regarded as a healthy or physiological rather than a morbid or pathological quality. In this way he is led to the definition on the cover of the book: "a physiological state of exquisite and exceptional nervous sensibility."

Dr. Paul and Tatina Ehrenfest revive interest in the statistical problems of the kinetic theory in their paper on two of the objections to Boltzmann's minimum theorem in the *Physikalische Zeitschrift* (May). They deal, first, with Loschmidt's objection, based on the consideration of reversal of the motion, according to which for every possible direct motion there exists a possible reversed motion, and, secondly, with Zermelo's objection, based on the quasi-periodicity of the motion of a system of gas-molecules. The authors claim to have overcome these objections by showing that a state in which Boltzmann's function increases is statistically enormously improbable. It would, however, seem to follow, according to this view, that the existence of irreversible molecular phenomena must be regarded as due to the assumed preexistence of enormously improbable initial conditions.

Part vi. of "G. A. Fothergill's Sketch Book," which is published by Mr. James Dodds, of Darlington, continues the "History of Cleasby in Yorkshire, with Biography and Portraits of John Robinson, D.D., *The Last* Statesman-Bishop (1650 to 1723); and numerous Sketches of Blackwell Grange and Thornton Hall, Darlington, &c." Some good sketches of sundials are included in the part before us.

A lecture appreciative of the work and influence of the late Mr. Herbert Spencer, delivered by Prof. August Stadler in the Zürich Town Hall on December 6, 1906, has been published in pamphlet form by Mr. A. Muller, Zürich.

Divisional-volume ii. of "Practical Coal Mining," the first divisional-volume of which was reviewed in Nature of May 23 (p. 77), has just been published by the Gresham Publishing Co. The volume contains a continuation of section iv., on shaft-sinking, by Prof. Henry Louis; section v., on breaking ground, by Mr. H. F. Bulman; and section vi., on methods of working and timbering, by Prof. E. H. Robertson. We propose to defer any further notice of the work until the whole of the volumes have been issued.

We have received from the proprietors of the periodical called the *Young Citizen* (12 Salisbury Square, E.C.) a case containing twenty-four paper butterflies, pinned and outspread to resemble real specimens. They are, we believe, copied from a well-known work on the subject, and at a considerable distance might pass muster, but we regret that we are unable to speak favourably of the scheme. The palpi are clumsily represented, but the specimens show no trace of legs, proboscis, or even antennæ, the last deficiency being the most serious and inexcusable of all, especially as they could easily have been imitated in fine wire. We cannot suppose that so incomplete a design can have been executed by, or even submitted to, anyone with the slightest knowledge of entomology. The colouring is fairly good, though in the case of some of the white butterflies it has too greenish a shade.

The annual report of the Board of Scientific Advice for India for the year 1905–6 has reached us. It will be remembered that the Board is a central authority for the coordination of official scientific inquiry, and the object it has in view is the distribution of the work of research to the best advantage, the prevention of dissipation of energy by the useless duplication of inquiries, and its misdirection by a lack of inter-departmental cooperation. The Board by its advice also aids the Government of India in prosecuting practical research into questions of economic or applied science. During 1906 the Board appears to have held two meetings only, one at Simla in May and the other in December at Calcutta. The greater part of the report, which runs to nearly 200 pages, is made up of contributions by distinguished specialists on scientific work in various directions accomplished in India during the year under review.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in July:—

July 3. 8h. Uranus in opposition to the Sun.
6. 3h. Mars in opposition to the Sun.
7. 7h. Vesta in conjunction with Moon (Vesta 0° 15′ S.).
8. 12h. 29m. Minimum of Algol (β Persei).
10. 3h. 7m. Sun eclipsed, invisible at Greenwich.
11. 9h. 18m. Minimum of Algol (β Persei).
13. Saturn's Ring. Major axis $=42''\cdot11$, Minor $=1''\cdot72$.
15. 19h. Jupiter in conjunction with the Sun.
20. 11h. 58m. to 12h. 57m. Moon occults θ Libræ (mag. 4·3).
24. Partial eclipse of the Moon.
 13h. 59m. First contact with the penumbra.
 16h. 22m. Middle of the eclipse.
 18h. 46m. Last contact with the penumbra.
 Magnitude of the eclipse = 0·620.
 At 16h. 10m. the Moon sets at Greenwich.
27–31. Meteors numerous from Aquarius and Perseus.
28. 11h. 10m. to 12h. 14m. Moon occults 30 Piscium (mag. 4.7).
,, 13h. 4m. to 14h. 6m. Moon occults 33 Piscium (mag. 4·6).
29. 11h. 23m. to 11h. 55m. Moon occults 20 Ceti (mag. 4·9).
31. 10h. 40m. to 11h. 18m. Moon occults ξ^2 Ceti (mag. 4·3).

Comet 1907*d* (Daniel).—The following set of elements and ephemeris for comet 1907*d* have been computed by Dr. E. Strömgren, and appear in Circular No. 98 of the Kiel Centralstelle:—

Elements.

T = 1907 Sept. 2 0105 (Berlin M.T.)

$$\left.\begin{aligned}\omega &= 241^\circ\ 59'\cdot04\\ \Omega &= 143\ \ 41\cdot99\\ i &= \ \ 6\ \ 14\cdot81\end{aligned}\right\}1907\cdot0$$

$$\log q = 0\cdot11436$$

Ephemeris 12h. M.T. Berlin.

1907		α		δ		Brightness
		° ′		° ′		
June 24	...	0 31·3	...	+2 25·9	...	1·37
,, 28	...	0 44·1	...	+3 27·2	...	1·54
July 2	...	0 57·4	...	+4 29·0	...	1·73

The brightness at the time of discovery, given as equal to mag. 11·0, is taken as unity. As will be seen from the above, the comet is brightening considerably, and is travelling through Pisces, towards Aries, just south of the ecliptic. At present it rises above the eastern horizon about midnight.

Observations by Prof. Hartwig on June 15 gave the magnitude as 9·5, the diameter as 2′, and the magnitude of the nucleus as 10·0.

A Large Sun-spot.—One of the most marked features of the present year has been the large number of sun-spot groups of sufficient magnitude to be seen with the naked eye; according to the Greenwich report, fourteen such groups had been seen on the solar disc up to May 10. The accompanying photograph, taken at 2h. 30m. on June 21, shows the group of spots which appeared on

the eastern limb on Thursday, June 13, and for several days was quite an easy naked-eye object. The latitude of the group was about 17° S., and, as may be seen from the reproduction, its extreme length was about one-tenth of the solar diameter, or about 85,000 miles. The shape of the principal umbra changed considerably during the spot's progress across the disc.

The Variability of Asteroids.—A striking photograph, illustrating apparently rapid changes of brightness in an asteroid, accompanies a paper on the subject published by Mr. Joel Metcalf, of Taunton (Mass.), in No. 4, vol. xxv. (p. 264, May), of the *Astrophysical Journal.* The original negative was produced by making two exposures of equal duration on the same plate, the camera being guided so that the asteroid images are round and the images of the surrounding stars are shown as trails. The similarity of the two star trails for each star is evidence that the rating of the clock and the atmospheric conditions were constant throughout, and yet there is a marked difference in the size and density of the images of the asteroid—in this case 1906 *WE.* This plate was taken on November 6, 1906, and the two exposures had thirty-five minutes each, with an interval of a minute between them; therefore the asteroid appears to have changed considerably in magnitude during an interval of one hour eleven minutes.

Comet 1907*c* (Giacobini).—A set of elements and a daily ephemeris extending to July 11 are given for comet 1907*c* by Dr. Strömgren in No. 4183 (p. 128, June 14) of the *Astronomische Nachrichten.* Prof. Millosevich, at Rome, found this a difficult object to observe with the 38 cm. (15 inches) telescope, and, according to the ephemeris, it is decreasing in brightness.

THE ENGINEERING CONFERENCE.

THE fourth engineering conference of the Institution of Civil Engineers commenced on the morning of Wednesday, June 19, when an opening address was delivered by Sir Alexander B. W. Kennedy, F.R.S., the president of the institution. In the course of his remarks, the president referred to the essential catholicity of the aims of the institution. All and every department of industrial activity which can possibly be covered by the name engineering fell within the ken and interest of the institution. In spite of the very extended ground covered by the subjects of the sections, members of the Institution of Civil Engineers alone had been invited to take part. It was not necessary to go beyond the borders of the institution to find men, not only interested, but distinguished, in every department of engineering. The president emphasised the unity rather than the diversity of their work, and expressed the hope that members would not confine their interest and presence to those sections only with the business of which their every-day work was concerned. In conclusion, the president explained that the papers to be read were notes, intended merely to open and stimulate discussion.

The members then separated into the various sections. The discussions occupied the morning of Wednesday, Thursday, and Friday. The limitations of space permit of brief notices only of the more important matters dealt with.

Section I., Railways. Chairman, Mr. W. R. Galbraith. A discussion on the chemical composition of steel rails was opened by Mr. C. P. Sandberg, who described the effects of phosphorus, sulphur, manganese, silicon, and carbon. Mr. W. Willox stated that certain rails on the Metropolitan Railway had worn out in five months only; the Sandberg rail, he thought, would reduce the trouble considerably. In this type of rail the silicon is added in the form of silico-spiegel or ferro-silicon, which gives better results than silicon left in the steel from pig-iron during the conversion.

The subject of reinforced concrete for railway structures was introduced by Dr. C. A. Harrison. Evidence was sought of the ability of this form of construction to resist the fatigue and stress of railway traffic, and also as to whether the metal reinforcement is not liable to corrosion. Mr. W. Bell gave information regarding a building in ferro-concrete erected under his supervision for the North-Eastern Railway. He considered this building to be satisfactory, and found that, in places where it had been necessary to cut the concrete, the metal bars were clean and bright.

The use of a bituminous preparation in preference to paint wherever possible was advocated by Mr. B. Blount as being the best means of preserving iron and steel work. Mr. H. R. A. Mallock, F.R.S., contributed a note on the action between the wheel and the rail, in which he calculated from theoretical grounds that the wear on rails having a two-minute service for twelve hours a day would amount to 2·6 inches per year, a result which might be altogether avoided by somewhat increasing the tread.

Mr. W. Dawson described a system of audible signalling which has been experimented on by the Great Western Railway. The danger signal is given to the driver by means of a small steam whistle fixed to the cab of the engine, actuated by a fixed bar bolted to the sleepers. The fixed bar is electrified when it is desired to give the "all right" signal, and then has the effect of ringing a bell on the engine. Colonel Yorke expressed the importance attached by the Board of Trade to such apparatus, but stated that his department would insist on absolute trustworthiness before sanctioning its use.

In speaking on light-railway policy, Sir A. B. W. Kennedy thought that, in view of the development of motor traction, light railways had nearly reached their termination in this country, excepting in special cases.

Section II., Harbours, Docks, and Canals. Chairman, Sir William Matthews, K.C.M.G.

Lord Pirrie contributed a paper on harbour and dock requirements as affected by the development of shipping. In his opinion, finality in the size of ships had not yet been reached. The desire for greater economy and also passengers' wishes for greater comfort and luxury would lead to further developments. Owing, however, to existing conditions as regards dock accommodation and depth of channels, shipbuilders had been forced into increasing the length rather than the breadth or draught.

Ferro-concrete and reinforced concrete structures were also discussed in this section. Mr. C. S. Meik gave evidence of the strength and durability of the ferro-concrete pier at Purfleet on the Thames. Questions of dock equipment, dredging, and electric and hydraulic power for working dock machinery were dealt with. Mr. W. W. Squire considered that the tendency towards the extended use of electric appliances was on the increase.

Section III., Machinery. Chairman, Prof. W. C. Unwin, F.R.S.

The business of this section opened with a valuable and interesting discussion on the relative merits of turbines as applied to marine propulsion and of reciprocating engines. The principal point raised was the relative coal and steam consumptions. The Hon. C. A. Parsons stated that in war vessels the consumption has now been brought to substantially the same figure as with reciprocating engines, and that in pleasure steamers the turbine now showed an efficiency 5 per cent. to 15 per cent. superior to similar vessels having triple-expansion reciprocating engines. Sir Wm. White and Sir John Durston contributed to the discussion. Mr. Gerald Stoney referred to the great efficiency of the low-pressure steam turbine, and quoted instances of the successful application on land of such turbines working with the exhaust steam discharged from reciprocating engines, which steam would otherwise be wasted owing to the inability of reciprocating engines to deal economically with steam at very low pressures. Mr. Parsons was of the opinion that future development for slow-speed vessels such as cargo steamers would be in the direction of a combination of reciprocating engines for the high-pressure part of the expansion and of turbines to deal with the low-pressure part. He estimated that such an arrangement would show an improvement in coal consumption of about 12 per cent. over quadruple-expansion reciprocating engines, and from 15 per cent. to 20 per cent. over the best triple-expansion engines.

Other subjects discussed in this section were precision grinding, machine-tool design as affected by the use of high-speed cutting tools, the use of pneumatic tools, reciprocating air-compressors, and turbo-compressors for high pressures. The last subject was introduced by Prof. A. Rateau, of Paris, who described his recent work in the development of turbo-compressors. He specially directed attention to one of his machines (which consists essentially of a reversed steam turbine) placed in the mines at Bethune, which compresses the air to 6 and even 7 atmospheres, and has the further interesting feature of being driven by a steam turbine utilising the exhaust steam from one of the winding engines. The efficiency of turbo-compressors is about of the same order as piston compressors. Turbo-compressors have the advantages of simplicity of parts and the capability of being directly connected to high-speed motors.

Section IV., Mining and Metallurgy. Chairman, Mr. John Strain.

This section opened with a discussion on problems of the Witwatersrand goldfields, introduced by Mr. G. A. Denny. Questions of labour difficulties and machinery were dealt with. Shaft-sinking and shafts for deep winding were also discussed. Recent applications of the Poetsch freezing method of shaft sinking in the Durham coalfield were described by Mr. H. Louis. Arrangements of colliery surface works were described by Mr. E. M. Hann. Mr. J. E. Stead, F.R.S., introduced the subject of segregation in steel, and illustrated his remarks by reference to etched specimens. The causes of segregation and its effect on the mechanical properties were fully dealt with. Mr. B. Blount contributed a paper on electro-metallurgy, dealing with the present state of the industry and the possibilities of its application to the manufacture of steel. The subject of the education of students of mining and metallurgy was introduced by Mr. W. Rowley, who described the methods adopted in the West Riding of Yorkshire. Mr. Rowley severely criticised the present Government examination for certificates of competency, an examination which, he said, could be passed by men who have not that acquaintance with scientific principles which is desirable. The papers have often been so stereotyped that correspondence and other methods of cramming only are needed to enable a man to pass. The composition of the board of examiners had often been characterised by conspicuous absence of men qualified by scientific training and knowledge to examine candidates, however eminent might be their position in particular branches of the mining profession. Mr. Rowley emphasised his opinion that a solid foundation of a broad and liberal education was essential to the student prior to his course in applied science.

Section V., Shipbuilding. Chairman, Dr. F. Elgar, F.R.S.

A joint discussion with Section II. on harbour and dock requirements opened the work of this section. A very important discussion on the uses of high-tensile steel was opened by three papers contributed by Mr. A. E. Seaton, Mr. A. F. Yarrow, and Mr. E. W. De Rusett. High-tensile steel for structural work may be described as steel having an ultimate tensile strength of about 40 tons per square inch. In the Forth Bridge such steel was used in compression only; Mr. Seaton was of the opinion that to-day there need be no hesitation in using it under tension. By use of this material it is possible to reduce largely the weight of a given structure. Recently the huge Cunard ships have been constructed so as to withstand the heavy expected stresses by the free use of the high-tensile steel of Spencer and Colville. Mr. Yarrow quoted the present Admiralty practice of steel of 37 tons to 43 tons per square inch with specified minimum elongations in 8 inches. In his own practice a considerable reduction of dead weight had been effected by the use of high-tensile steel. Mr. E. W. De Rusett gave information as to the use of high-tensile steel in the construction of the *Mauretania*. By instruction of the authorities of Lloyd's Registry, rivets of mild ingot steel were adopted. The rivet holes in plates less than ½ inch thick were punched ⅛ inch under size and rimered out. This method was found not to interfere with the strength of the joints. Rivet holes in plates more than ½ inch thick were drilled. Sir Wm. White recommended for the proper use of high-tensile steel (*a*) thorough testing in the makers' works; (*b*) proper treatment of the material (as regards heating, &c.) in the shipbuilders' yards; (*c*) structural arrangements suitable for the new material. He was of the opinion that both mild steel and high-tensile steel can be successfully used in the same structure. Rivets of quality agreeing with the material of the plates should be employed, and such was the practice of the Admiralty. Sir P. Watts said that high-tensile steel rivets were at present used successfully in the Service. Mr. Colville gave the results of the experience of the Steel Co. of Scotland on the manufacture of high-tensile steel. Mr. Ritchie, of Parkhead Forge, quoted the case of a steam boiler of high-tensile steel working at 500 lb. per square inch pressure. Mr. Thearle, of Lloyd's, spoke of the necessity for avoiding improper heat treatment of high-tensile steel rivets. Other subjects dealt with in this section were structural details of cargo steamers, arrangements for working cargo, high-speed vessels, modern applications of superheating, and the welding of structural materials in place. In the last, methods of electric welding, welding by the oxy-hydrogen and oxyacetylene flames, and welding by the use of thermit were discussed.

Section VI., Waterworks, Sewerage, and Gasworks. Chairman, Sir George Thomas Livesey.

The first paper read in this section was on the comparative cost of pumping by steam, internal combustion engines, and electricity, based on actual working. The authors, Messrs. Charles Hawksley and Henry Davey, made out a strong case in favour of direct pumping by steam engines. Speakers in the discussion disagreed with certain figures given in the paper. Thus the authors give 1 lb. of oil per B.H.P. generally for oil engines, but the Diesel oil engine has a guaranteed consumption of 0·4 lb. of oil per B.H.P.; 1·75 lb. of coal per B.H.P. for gas engines is stated in the paper to be the engine-maker's estimate, but 1·25 lb. would be nearer. Electric current could also be obtained at a cheaper rate than that given, viz. ½*d*. per unit.

Papers on water softening and water hardening were contributed by Messrs. W. Matthews and J. Watson respectively. Softening is of value in many cases where the water is too hard to be available for supply, and the process also gives a means of defence against bacteria. The working in practice of various systems of water softening was discussed. The practice of hardening water for domestic purposes is intended to counteract acidity and neutralise peaty water possessed of lead-dissolving properties.

Applications of towns' gas as a heating agent were described in a paper by Mr. W. H. Y. Webber. The author referred to the practice now generally adopted by gas engineers of speaking of their product in terms of its calorific value rather than of its illuminating power. The domestic uses of gas for heating purposes were dealt with, and the author expressed his opinion that producer gas did not make headway against town gas at 2*s*. per 1000 cubic feet.

The distribution of gas at increased pressure was introduced by Mr. C. C. Carpenter, who described the present practice of the South Metropolitan Gas Company in using non-positive blowers giving an initial pressure of about 20 inches of water. Gas engines are preferred for driving the blowers as being more convenient. This company has 1200 miles of pipes, and finds that the unaccounted gas amounts to 4½ per cent. only.

Mr. J. D. Watson contributed a paper on sewage disposal by biological processes, in which he gave the results of the methods adopted at Birmingham, where sewage purification is effected by mechanical precipitation and septic treatment.

The relative merits of chemically treated, settled, and septic sewage in preparing the liquid for oxidising beds formed the subject of a paper by Mr. G. A. Hart. The author has compiled facts obtained from observations made on the sewage of Leeds during the last nine years. The most effective chemical precipitant was found to be a combination of 6 to 8 grains of lime and 2 grains of aluminium sulphate per gallon of sewage. Settlement is employed sufficient to reduce the suspended solids in crude sewage to an average of about 8 grains per gallon. Dealing with septic fermentation, the author stated that at a twenty-four hours' rate of flow about 30 per cent. of the suspended solids were digested in the tanks, 31 per cent. passed out with the effluent, and the balance of 39 per cent. remained as deposit.

Section VII., Applications of Electricity. Chairman, Colonel R. E. B. Crompton, C.B.

The first paper taken was on electrical transmission gears on motor vehicles, by Mr. A. A. C. Swinton. The author directed attention to the crude methods of gear changing used in petrol-driven motor vehicles, and gave short descriptions of several arrangements of electrical transmission which have been adopted. Mr. Hart gave the results of his experiments using continuous current machinery, which he had discarded in favour of polyphase alternating current. He had now an omnibus running in which the consumption of petrol amounted to one gallon per 6½ miles, the electric machinery being used for starting only, giving a smooth and rapid acceleration. Mr. W. H. Stevens advocated the use of continuous current. Mr. Swinton referred to the question of the weight of the petrol-electric equipment, which is greater than that of purely petrol machinery.

The subject of electric working of railway points and signals was opened by Mr. Ferreira, who enumerated the principal conditions considered essential in modern signalling, and discussed the various electric methods adopted for complying with these conditions.

Papers on upkeep charges on large electric generating sets and on modern applications of electricity to mines were contributed by Messrs. Burstall, Highfield and Sparks. In the last paper the application of the high-lift centrifugal pump in combination with the electric motor was mentioned as showing a great advance on previous methods of pumping.

On the evening before the formal opening of the conference, the James Forrest lecture, on "Unsolved Problems in the Design and Propulsion of Ships," was delivered by Dr. Francis Elgar, F.R.S.

During the conference the members had the privilege of visiting many works and generating stations, and these opportunities were taken advantage of to a large extent. The institution conversazione was held on Thursday evening in the Albert Hall, when a large and representative gathering met for social intercourse.

THE ROYAL SOCIETY CONVERSAZIONE.

MOST of the exhibits of scientific interest at the Royal Society on June 19, on the occasion of the soiree to which ladies as well as gentlemen are invited, were shown at the conversazione on May 8, and have been described already in NATURE (May 16, p. 57). It will be sufficient, therefore, to refer briefly to exhibits not mentioned in the previous article.

Lantern and other demonstrations were given during the evening by Prof. H. A. Miers, Prof. Flinders Petrie, and Mr. Louis Brennan. Prof. Miers showed experiments illustrating the growth of crystals in drops of solution, and indicating that the latter are of two sorts. If a solution be sufficiently strong, crystallisation may be started spontaneously by mere shaking or friction. In such a solution the crystals are apt to grow rapidly in the form of delicate needles and fronds. If the solution be supersaturated, but not strong enough to give birth to crystals in this way, they can only grow if introduced from without (by "inoculation" of the drop), and are apt to grow in symmetrical forms. A solution, as it cools, passes quite suddenly from the one state to the other. Prof. Petrie lectured on houses in ancient Egypt, and Mr. Brennan again showed and described his working model of the Brennan mono-railway.

The subjoined descriptions of the exhibits have been abridged from the official catalogue:—

Mr. A. A. Campbell Swinton: Vacuum tube phenomena. (1) Exhibition of the mechanical effects of kanal rays in causing the rotation of mill-wheels in Crookes tubes. These rays, which are positive, travel in the opposite direction to the negative rays that proceed from the kathode. They can be detected both when they are approaching the kathode, and also, if the latter is perforated, after they have passed through the apertures. (2) Photomicrographs of the bubbles that are developed by sudden heating of portions of the glass walls of Crookes tubes, owing to the occlusion by the glass of the residual gas during prolonged use. (3) Exhibition in the microscope of a special case of the above, in which the sudden heating was occasioned by an electric spark, which has thus impressed its own image on to the glass. The image is entirely made up of minute bubbles, and from its form it is clear that the spark was a positive one.—*Mr. C. E. S. Phillips:* (1) A fibre electroscope. In this electroscope the gold leaf is replaced by a fibre of electrically conductive glass which is delicately hinged so as to move very readily under the influence of a difference of potential. (2) An electroscope charger. The ease with which celluloid may be electrified by friction, together with its poor insulating property, are made use of in this apparatus. A celluloid rod is rubbed at one end by a flannel-lined split brass tube. The charge so produced slowly spreads to the opposite extremity of the rod and is there utilised. Either a positive or negative charge may be obtained with the same instrument. (3) Electrically conductive glass. The composition of this glass is as follows:—sodium silicate, thirty-two parts; borax, eight parts; Powell's flint glass, 1·25 parts. The electrical conductivity is about 500 times as great as that of any other glass, and this material is suitable for the windows of electrostatic instruments as well as for supplying the fibres used in the fibre electroscope.—*Mr. J. Mackenzie Davidson:* Stereoscopic X-ray photographs in a revolving lenticular stereoscope. A single X-ray photograph is a central projection shadow of the object placed between the Crookes tube and the photographic plate, and cannot therefore correctly indicate the real relative position of the parts—but *stereoscopic* X-ray photographs at once give a combined image which shows correctly their relative size and position. This could be observed in the series of transparencies exhibited.—*Mr. A. Kershaw:* A new visual method of measuring the speeds of photographic shutters. This consists principally of a variable-speed revolving disc with radial slits, in conjunction with a stationary illuminated slit.—*Mr. Edward Whymper:* Photographs taken in the Rocky Mountains of Canada and in the Alps.

Mr. William Burton: Pilkington's Lancastrian lustre pottery. The examples illustrate the perfecting of the old lustre process of decoration. By this method metallic vapours of silver and of copper can be driven into pottery glazes at a very low red heat under the influence of reducing gases. The surface of the metallic film so obtained glows with brilliant iridescent colours. The process has been reduced to such precision that the kilns are hermetically sealed during the firing, and no "trials" of any description are drawn from start to finish of the process. The temperature is recorded by the use of two thermocouples, placed at the bottom and top of the kiln respectively. The reducing gases are of standard composition, so that the process is so far as possible automatic.—*Hon. C. A. Parsons, F.R.S.:* Photographs of diamonds obtained from pure iron heated in a carbon crucible in an electric furnace and rapidly cooled. Scale, 150 diameters.—*Dr. Herbert Smith:* Precious stones, cut and uncut. The exhibit includes most of the mineral species that are available for jewellery purposes. The following are the more noteworthy of the specimens:—a star-twin of diamond; crystals and faceted specimens of olivine (peridot) from the Red Sea; sapphires from Montana and Ceylon; natural and "reconstructed" rubies; various opals, including opalised shells; diamonds, chrysoberyls, and topazes from Rhodesia; garnets from German East Africa; and specimens of the rare species phenakite, axinite, and diopside.—*Dr. Tempest Anderson:* Photographs illustrative of the volcanoes of Central America, and of a revisit to the Soufrière of St. Vincent. The volcanoes of the Soufrière of St. Vincent and Montagne Pelée in Martinique, both to the east of the Caribbean Sea, erupted in 1902. The volcano of Santa Maria in Guatemala, to the west of the same sea, erupted in the same year, and when it was examined this spring the eruption proves to have been of the same character.

The Royal Society: The Linnæus bicentenary—original certificate of candidature of Linnæus, dated 1753, for election into the Royal Society.—*Dr. W. A. Cunnington and Mr. C. L. Boulenger:* Examples of the fauna of the Fayûm Lake, Birket-Qurun, investigated at the request of the Egyptian Survey Department. (1) Series of the fishes, including examples of the three different kinds of Bulti (Tilapia). The females take charge of the eggs and young, which they seclude in the mouth and gill-chambers. (2) Series of the invertebrates of the lake, including examples of a new lacustrine medusa (*Moerisia lyonsi*).—*Prof. Charles Stewart, F.R.S.:* (1) Specimens illustrating alternation of generation. (2) Various invertebrates and birds showing colours due to structure; mostly thin films, and not pigment; consequently the colour is lost on crushing.—*Prof. S. J. Hickson, F.R.S.:* A collection of species of the genus Corallium, and a specimen of *Corallium maderense*, polished and mounted in silver.—*Dr. Ernst Hartert:* Birds represented in the British Isles by peculiar forms, and their Continental allies. So late as 1892 Wallace accepted only three birds as peculiar to the British Isles ("Island Life," p. 340), and even more recent works have not mentioned more than three or four. Careful investigations, however, have shown that about twenty British birds show constant and often easily recognised differences from their Continental allies. Eighteen of these are exhibited, with their allies, in order to show their differences.

Prof. Flinders Petrie, F.R.S.: Pottery soul-houses, 3000 B.C. These models, made by the Egyptians, were found at the cemetery of Rifeh in Upper Egypt, where they had been placed upon the graves. They were developed from the trays of offerings for the dead, to which a shelter was added, and further enlarged with the addition of furniture so as completely to resemble an actual house, in which the soul was supposed to dwell. Their period is from the ninth to the twelfth dynasty. Found by the British School of Archæology in Egypt, 1907.

THE CRUISE OF THE "NEPTUNE."[1]

THE cruise of the *Neptune* is the official narrative of the voyage of the Dominion Government Expedition to northern parts of Hudson Bay and the north-eastern Arctic islands in 1903–4 in charge of Mr. A. P. Low.

The Dominion Government in the spring of 1903 decided to send a cruiser to patrol the waters of Hudson Bay and those adjacent to the eastern Arctic islands, and to aid in establishing on the adjoining shores permanent stations for the collection of customs, the administration of justice, and the enforcement of the law as in other parts of Canada.

Major J. D. Moodie, of the North-West Mounted Police, was appointed acting commissioner of the unorganised north-eastern territories. The expedition carried a scientific staff.

Dr. L. E. Borden, besides being the medical officer, collected data relating to ethnology, botany, and zoology; Mr. Andrew Halkett, naturalist of the Department of Marine and Fisheries; Mr. C. F. King, who was attached from the staff of the Geological Survey, took charge of the topographical and meteorological work, assisted by Mr. C. F. Caldwell (photographer) and Mr. Ross (purser).

Mr. Low undertook the geological work. The latter writes in the preface to the book:—"The greater part of the credit for the complete and successful accomplishment of all the instructions for the voyage is due to Captain S. W. Bartlett, the officers and the crew of the *Neptune*." The latter was the largest and most powerful ship of the Newfoundland sealing fleet, 465 tons net register and engines 110 nominal horse-power.

Besides the narrative of the voyage during the seasons 1903–4, there is a short historical account of earlier explorations and discoveries in north-eastern Arctic America, a geographical sketch, and chapters dealing with the Eskimo inhabitants and the geological formation of these north-eastern territories, and a description of the important whaling and sealing industries, and opinions as to the possible navigation of Hudson Strait and Hudson Bay.

In the form of appendices are the results of the meteorological observations taken on the voyage, notes on the thickness and growth of ice, and lists of the birds, plants, and fossils collected in these northern regions. The full results, especially with regard to the determination of marine invertebrates, are promised in a future publication.

The *Neptune* wintered in Fullerton Harbour, at the entrance to Roes Welcome (latitude 64° N.). During the winter various tribes of Eskimos congregated about the ship and kept it supplied in fresh caribou meat. The two long chapters on the Eskimos are fascinating reading, and contain a mass of information for the anthropologist. In the form of an appendix there are notes on the physical condition of the Eskimos by the surgeon to the *Neptune*, Dr. L. E. Borden.

The excessive cold of the early spring practically rendered impossible any surveying or other scientific work until the month of April. The minimum temperature observed was −53° F., early in March. The really cold months were January, February, and March, the mean temperatures being respectively −23°·0 F., −27°·0 F., −20°·6 F. The thickness of the ice around the ship continued to increase until April 25, when it attained a maximum of 74 inches.

The *Neptune* broke her way out of Fullerton Harbour on July 18, after having been fast frozen for nine months, and proceeded on her summer cruise to the Arctic islands. Chapter x. contains a great deal of valuable information concerning whales and whaling. Although the capture of a right whale repays the expenditure incurred in outfitting a steam whaling ship, and if more than one is killed on the voyage it means large dividends to the owners, the chase is becoming more and more unprofitable owing to the few whales remaining and to the frequent "empty" voyages made of late years. The future of the whaling industry certainly appears to be very gloomy.

The chapters on geology are perhaps the most valuable portion of the book. Although they contain little that is absolutely new, the results of former expeditions and work of former geologists have been brought together in a concise and interesting manner.

The work is admirably written, and contains more real information than such narratives usually do. The illustrations are fairly good, and the geological map compiled by the Geological Survey of Canada to illustrate the cruise of the *Neptune* (scale, 50 statute miles to 1 inch) is probably the best of its kind published.

L. C. B.

[1] Report on the Dominion Government Expedition to Hudson Bay and the Arctic Islands on Board the D.G.S. *Neptune*, 1903–1904. By A. P. Low (officer in charge). Pp. xvii+355 and map. (Ottawa: The Government Printing Bureau, 1906.)

NATURAL HISTORY IN NORTHUMBRIA.[1]

THE third and concluding part of the first volume of the new series of the Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne has just been issued, and it proves that the district is able to maintain its reputation as a home of eager and distinguished naturalists. In addition to the usual reports on the field meetings and the short notes on local natural history, which do not present any noteworthy features, there are six papers of more general interest which may be regarded as serious contributions to knowledge.

Among these we notice a paper by Miss M. Lebour on the larval trematodes of the Northumberland coast. Having chosen for her investigations a field of work that has unfortunately been very inadequately explored, this author is able to contribute more that is really original than her companions. A list of thirteen common littoral mollusca is given in which larval trematodes were found, and of these *Paludestrina stagnalis* was proved to be the host of no less than six different species of trematodes. Although no single complete life-history was worked out, reasons are given for supposing that the first host of *Distomum* (*Echinostomum*) *leptosomum* is *Paludestrina stagnalis*, and that encystment may take place in the same species of mollusc or in *Scrobicularia tenuis*, the final host being the dunlin. The bucephalus larva of Gasterostomum, the well-known fluke of the angler fish, was found in the cockle, this being only the second time in which the larva has been recorded in British waters. The paper is well illustrated by five plates.

In an interesting paper by Dr. Brady several species of Crustacea new to the district are recorded from a pond at Amble that has been formed by the filling up of an old quarry from the adjacent sea. The occurrence in the pond of a new ostracod for which a new genus (Proteocypris) is instituted is of special interest, as, according to the author, it is the only instance of a typically fresh-water cyprid occurring in a truly marine habit. It is to be regretted that Dr. Brady makes no statement of his opinion as to the relations of this genus or of the family to which it belongs.

The longest paper in the part is one by Mr. A. R. Jackson on the spiders of the Tyne valley. This paper will doubtless be of considerable value to arachnologists, but apart from the description of five species new to Britain, of which three species were at the time of their discovery new to science, it does not present any features of general interest.

In some interesting notes on rare local beetles, Mr. Bagnall describes his experiences in proving that the female *Epuraea angustula* enters the bores of different species of Trypodendron in order, as he believes, to deposit her eggs on those of the borer, and suggests that the staphylinid *Acrulia inflata* is similarly parasitic on Trypodendron.

Geology is represented in the part by two papers—one, on the result of the borings in the valley of the Tyne Derwent, by the Rev. A. Watts, and the other by Dr. Woolacott, on the recent landslip at Claxheugh. The photographs that illustrate this last-named paper are of permanent interest and value.

In bringing the first volume of the new series to a conclusion, the society may be congratulated on the evidence it affords of the interest taken in natural history by its members and of the valuable work they are doing.

[1] "Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne." Vol. i., parts i.–iii. (1907). Price 5s. 6d.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Among the additions made during the year 1906 to the collections under the charge of the museums and lecture-rooms syndicate, special mention has been made in the forty-first annual report of the syndicate of the gift to the school of botany, by Mr. Francis Darwin, of the scientific library of his father. Dr. E. C. Stirling has presented to the museum of zoology a cast of a skeleton of the gigantic extinct marsupial *Diprotodon australis*, and the Duke of Bedford two specimens of Przewalsky's horse from the collection at Woburn Abbey. The collection of antelopes has been largely increased, principally through the donations of Mr. C. B. C. Storey, Mr. A. L. Butler, Major W. B. Emery, and Captain E. Mackenzie Murray. The executors of the late Mr. J. S. Budgett have presented a number of specimens to the museum of zoology, and certain pieces of apparatus to the zoological laboratory. The Strickland curator directs attention to the completion of the late Prof. Newton's "Ootheca Wolleyana," and to the fact that the whole of Prof. Newton's magnificent collection of palæarctic eggs becomes thereby the property of the University. Numerous anthropological gifts to the museum of human anatomy are recorded in the reports of Dr. Barclay-Smith and Dr. Duckworth.

A SUMMER school for university extension students will be held at Oxford during August. The inaugural address will be delivered in the examination schools on Thursday, August 1, at 8.30 p.m., by the Earl of Halsbury, F.R.S. The meeting will be divided into two parts, the first of which will extend from August 1 to August 14, and the second from August 15 to August 26. The lectures in the science section will be arranged with the object of illustrating the part played by Oxford in the advancement of science, particularly in the seventeenth century. Among the lecturers will be Dr. T. B. Strong, Dr. W. Osler, F.R.S., Mr. J. Wells, Dr. Brereton Baker, F.R.S., Prof. F. Gotch, F.R.S., Prof. H. H. Turner, F.R.S., Prof. E. B. Poulton, F.R.S., and Mr. J. L. Myres. There will also be special classes in practical map-making, nature-study, and principles and practice of education.

PROF. A. S. HEMMY, Government College, Lahore, writes to correct a report as to the state of science in the Punjab which appeared in the *Civil and Military Gazette*, and was summarised in NATURE of May 16 (p. 70). The local paper pointed out that comparatively few students present themselves for examinations in the science faculty of the Punjab University, and therefore suggested that scientific studies are not making much headway in India. Prof. Hemmy remarks that though the study of science in the Punjab is in a somewhat backward condition, the various laboratories being badly endowed, the article in the local paper, upon which our note was based, is misleading. The regulations of the Punjab University permit science (of a very slightly lower standard) to be taken up for the arts degree as well as for the B.Sc., and the great majority of students who take up science do so as part of the more popular B.A. course. It appears that the numbers quoted in the note only represent, therefore, a fraction of the total number studying science. For 1907, in the arts faculty, out of 3666 candidates for matriculation, 1426 took up physics and chemistry; out of 689 candidates for the intermediate, 254 took the same subject; of the 340 for the B.A., 25 took physics and 32 chemistry; while of the 52 M.A. candidates, 3 took physics and 4 chemistry.

AN exhibition of selected specimens of work of pupils in the rural schools of East Suffolk was held at the County Hall, Ipswich, on June 15. The exhibition was arranged by Alderman the Rev. C. J. Steward, chairman of the Education Committee of the East Suffolk County Council, to whose energy and enthusiasm this movement owes so much. It is clear that valuable work is being done in East Suffolk schools to train observational powers and to stimulate interest in natural phenomena. Forty-three distinct exhibits were shown, including some excellent collections of the grasses and wild plants of each district, while mounted and labelled specimens illustrating the history of common plants and animals, meteorolog... records kept and displayed in the form of charts, pl... of the villages and of the school buildings, caref... selected specimens showing the structure and growth ... common timber trees, plans of school gardens, records ... the country month by month, and excellent studies of ... changes in ditches and ponds during the year, were a... shown. In addition, there were records of bee-keeping a... illustrations of budding and grafting. East Suffolk ... made a good start in the newer teaching, and the exhi... tion itself, as well as the numbers of those who attend... from all parts of the county, shows that a genuine inter... is being taken in the matter. A selection of the exhib... is to be sent to the Royal Agricultural Society's show ... Lincoln.

A CONFERENCE will be held in Naini Tal this year, ... learn from the *Pioneer* of Allahabad, for the purpose ... considering many difficult questions connected w... technical education, and if possible to devise some prop... coordinated scheme which shall lead the way for the wh... of India. In an enlightened editorial article the *Pio*... reviews the objects the advocates of technical instruc... have in view, and indicates many of the special requ... ments of the Indian population which must be borne ... mind in devising a scheme suited to Eastern needs. ... is pointed out that for the success of any system provis... must be made for the different classes of workers engag... in modern productive industries, workmen or artisa... foremen or overseers, managers or masters, and that it ... necessary to provide grades of technical education cor... sponding to primary, secondary, and university or high... education. The lowest grade is that which presents m... difficulty in India. At the present time, the article stat... it is impossible to give instruction in elementary scie... in Indian village schools, but something might be d... to teach drawing and to give handicraft training ... means of a form of apprenticeship to village craftsm... It is proposed that the most promising of those so trai... might then be assisted to undergo a course at an indust... school in the nearest large centre, and thus the instruct... in the primary schools of the country could be brought ... touch with modern needs, and a system commenced wh... would advance any scheme of technical education fina... adopted. It is suggested that workshop practice could b... be given in India in apprenticeship schools of the Con... nental type, and that evening classes would serve t... purpose of improving the workmen and selecting th... capable of profiting from a systematic course of hig... study. No difficulty is anticipated so far as educating ... foremen is concerned, and technical institutes of the ri... kind are recommended as the best way to provide hig... technical education. Undoubtedly, the article contin... much has already been done in India to provide a syst... of technical education, and progress has been made ... means of art schools, industrial schools, and engineer... colleges, but there is a tendency to lose sight of mod... developments, and the immediate need now is a system... arrangement of the work at present undertaken.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 9.—"The Ascent of Water in Tre..." (Second paper.) By Prof. A. J. **Ewart.** Communica... by Francis Darwin, For.Sec.R.S.

The experiments detailed or quoted tend to show t... the continuous ascent of water is only possible in liv... wood, and that the power of conduction is rapidly lost ... death, without any mechanical blocking of the ves... being necessarily responsible for the change. Hence ... are forced to conclude that the living cells in tall tr... continually restore the conditions for the ascent of wa... wherever these are affected by the excessive emptying ... the vessels, and decrease the resistance to flow, as far ... possible, by maintaining continuous water columns in pa... at least of the wood. So long as these are prese... *ab initio*, a pumping action only becomes necessary in tre... more than 20 to 50 metres in height, but suspend...

columns cannot be maintained for any length of time in the vessels of tall trees without the aid of the living cells of the wood.

The energy required to pump water upwards in the tallest trees represents only a small fraction of that produced by the daily photosynthetic assimilation, and it is the feeble character and diffuseness of the pumping action which render it so difficult to demonstrate practically.

Experiments on the suction and exudation of trees at different levels and upon the influence of the entry of air and water under pressure showed that no continuous suspended water columns, or high internal tensions, existed in the conducting elements of the trees experimented on (maple and poplar) during active transpiration, or, indeed, at any period of the year.

The same was shown by direct measurements of the pressure in intact vessels of Wistaria during active transpiration. This fact, coupled with the high total resistance to flow, shows that this resistance is overcome locally from point to point, and not by any enormous tension from above or pressure from below, neither of which exists, nor could be maintained to a sufficient extent to carry on the elevation of water in a tall tree. A high tension from above leads to rapid blocking with air; a high pressure from below leads to great loss by lateral exudation from the vessels.

The surface adsorption of dissolved solids in the vessels plays a very important part in their function as translocatory channels, causing a delay in the ascent of dissolved solids, such as sugar and salts, and an accumulation of them along the outer walls of the vessels. The latter facilitates their outward diffusion, but at the same time renders the transference of small quantities of material between widely removed organs difficult or impossible.

The tallest trees in Australia do not appreciably exceed 300 feet in height, so that the values previously given for the maximal total resistance to the upward flow of sap in actively transpiring trees must be reduced to between thirty and fifty atmospheres.

May 30.—"Report of Private Expedition to Philippeville, Algeria, to View the Total Eclipse of the Sun on August 30, 1905." By Dr. T. C. **Porter** and W. P. **Colfox.**

The two observers camped out on a hill near the village of St. Charles, in lat. 36° 45′ 38″·7 N. and long. 6° 51′ 59″·1, and 690 feet above sea-level. The line of central eclipse passed directly over their station. They had magnificent weather on the day of the eclipse, and were able to carry out almost all the observations contemplated, both visual and photographic. Two simultaneous photographs were taken of the corona through two large Nicol prisms, the axes of which made angles of 45° with the horizon, and were at right angles to each other. The negatives, and also the reproductions given in the paper, show very strikingly the radial polarisation of the outer corona; one of the streamers, for example, can be traced with certainty from within 2′ 7″ to 2·2 diameters away from the moon's limb on *one* of these photos., whilst no part of it can be so traced on the other. There is unmistakable evidence in both photos. that the coronal development as a whole was more considerable on the N.E. limb of the sun, *i.e.* on the side where the great prominence was visible. The telescopic examination of the details of the inner corona on the N.E. limb proved exceptionally interesting, a superb radial "pillared" structure being seen, cut by the streamers at various angles, and limited externally by a very thin shell concentric with the sun, suggesting partial condensation and a possible differentiation of the "reversing layer" into concentric shells of vapours of varying condensability. Jets were also observed on the S.E. limb of a different colour from that of the prominences visible, their narrow stems being white, but passing into "rounded, soft-looking summits of the bluish-pink of the cyanogen flame." A photograph of the "coronium ring," taken with a specially prepared screen, revealed obvious jets, forty being easily counted on the enlarged negative, and it is shown in the paper that these must be attributed either to "coronium" itself or to some unknown element the radiation from which was capable of penetrating the screen used.

The so-called "shadow bands" were very well seen, both before and after totality, and are fully discussed in the paper. They were waved, and the waves seemed to have a motion of their own along the lines of shadow, which makes it almost certain that the true direction of travel of each band considered as a whole was *not* at right angles to its length, though at first sight the bands seemed to be so travelling. It was proved that the directions of the lengths of the bands coincided within the errors of experiment with the trace on the horizontal sheet on which they were observed of the plane passing through the cusps of the solar crescent and the sheet; the frequently observed rotation of their direction during the progress of an eclipse is accounted for. A full meteorological record was kept for a few days, both before and after the eclipse day, and the information gained is all exhibited on one chart, from which the reduced barometric height, the humidity, solar radiation, temperature of the air, direction and force of the wind, and amount and distribution of cloud, as well as its kind, can be read off for any hour of the day, and during the eclipse for every ten minutes. The total length of the certainly disturbed-barometer district at any one moment was some 5000 odd miles, the part of it *preceding* the *umbra* being some 200 miles shorter than that following it, and the barometric maximum seems to have travelled about 500 miles behind the centre of the umbra, and to have covered a region about the same number of miles in length, measured along the line of central totality. The eclipse wind is discussed, and seems to have been due to the inrush of air from all sides towards the centre of the shadow, the effect of this influx being superposed, at the station, on the northerly sea breeze. The direction of motion of the shadow bands had certainly a large northerly component, and thus their motion was also towards the line of central eclipse, thus following the general direction of the wind. A careful estimate of the height of the reflecting layers of matter in the earth's atmosphere, made by measuring the altitude of the orange glow seen near the horizon during central totality, gave six miles, a result coming very near the inferior limit given by many hundreds of observations in different latitudes by one of the observers.

The stars seen during totality were Venus, Mercury, Regulus, Spica, Arcturus, and Procyon.

"An Experimental Inquiry into the Nature of the Substances in Serum which influence Phagocytosis." (Second communication.) By George **Dean.** Communicated by Dr. C. J. Martin, F.R.S.

(1) Dilution of fresh unheated serum is not accompanied, so far as the higher concentrations are concerned, by a fall in the sensitising power for certain organisms (staphylococcus, tubercle bacillus). The diminution in this was found, as a rule, to begin at the quarter concentration.

(2) So far as the present experiments go, the points corresponding to the 1/4th, 1/8th, 1/16th, and 1/32nd dilutions of normal human serum lie on a parabola the equation of which is $y^2=4X$, *i.e.* for these dilutions the phagocytosis is proportional to the square root of the serum concentration.

(3) The phagocytic index obtained by mixing appropriate dilutions of a heated immune serum with a normal fresh serum is greater than results from the two substances acting separately.

(4) In the case of certain normal sera (guinea-pig and rabbit) previously investigated for amboceptor and complement in relation to the extra-corpuscular bacteriolysis of the typhoid bacillus (Wechsberg), an exact parallelism can be demonstrated to exist between that function and opsonisation. The normal amboceptor can be complemented by fresh serum in regard to both functions.

(5) An "anti-complement" serum, when mixed with a fresh normal serum alone or in a mixture containing heated immune serum, throws out of action the thermolabile substance, whereas it does not appear to influence the thermostable substance.

"The Correlation of the Ovarian and Uterine Functions." By E. S. **Carmichael** and Dr. F. H. A. **Marshall.** Communicated by Prof. E. A. Schäfer, F.R.S.

(1) The removal of the ovaries in young animals (rodents) prevents the development of the uterus and Fallopian tubes.

These remain in an infantile condition. The subsequent growth and general nutrition of the animals seem to be unaffected.

(2) The removal of the ovaries in adult animals (rodents) leads to fibrous degeneration of the uterus and Fallopian tubes (most marked in the mucous membrane). The animals' subsequent health and nutrition remain good.

These observations, for the most part, support the evidence obtained clinically in the human subject after surgical operation.

(3) The removal of the uterus in a young animal has no influence in preventing the further development of the ovaries. These are capable of ovulating and forming corpora lutea after adult life has been reached.

(4) The removal of the uterus in an adult animal does not give rise to any degenerative change in the ovaries, if the vascular connections of the latter remain intact.

These latter observations do not support the contentions of those surgeons who advocate subtotal hysterectomy, believing that the functional activity of the ovary is in some way dependent on the presence of the uterus.

"On Mitosis in Proliferating Epithelium." By Dr. J. O. Wakelin **Barratt.** Communicated by Prof. C. S. Sherrington, F.R.S.

(1) In epithelial proliferation brought about by scharlach R, both normal somatic and reduced mitoses occur. This statement applies to epithelium proliferating *in situ*, and also to the same implanted under the skin.

(2) In the reduction mitoses the number of chromosomes which could be counted varied from fourteen to eighteen. In the somatic form the number counted varied from twenty-eight to thirty-six.

(3) Reduction mitoses could be recognised less frequently than somatic mitoses.

(4) Post-reduction mitoses were met with.

(5) The character of the mitoses occurring was not definitely altered by implantation under the skin.

"The Solubility of Air in Fats, and its Relation to Caisson Disease." By Dr. H. M. **Vernon.** Communicated by Dr. J. S. Haldane, F.R.S.

At body temperature, fats dissolve more than five times as much nitrogen as an equal volume of water or blood plasma.

The special tendency of the fat-containing tissues (such as subcutaneous tissues, spinal cord, and peripheral nerves) of caisson workers and divers to suffer injury from the liberation of gas bubbles after rapid decompression is dependent on this great solubility.

Geological Society, June 5.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—A marine fauna in the basement beds of the Bristol coalfield: Herbert **Bolton.** During exploration at the Ashton Vale Colliery, fossiliferous shales were traversed in the lowest Coal-measures resting upon the Millstone Grit. A section of the Coal-measures in this part of the coalfield is given, and the chief fossiliferous shale is localised at a depth of 84 feet below it. The feature of the fossils is their dwarfed condition. The thickness of the Millstone Grit appears to be about 980 feet. The palæontological description embodies a list of fossils from the marine horizon, which shows correspondence with the list from the marine beds associated with the gin coal of North Staffordshire, but it is not desirable to conclude that the horizons are identical until further evidence has been obtained from the Bristol area. The brachiopod fauna contains forms identical with or closely approximating to species occurring in the Cyathaxonia and Dibunophyllum zones. The description includes notes on Productus, Chonetes, Derbya, and Orthothetes, contributed by Dr. A. Vaughan, and new species of Chonetes, Raphistoma, and Loxonema.—Brachiopod morphology: Cincta, Eudesia, and the development of ribs: S. S. **Buckman.** The test ornament of brachiopods is found in three main phases, smooth, ribbed, and spinous, and of these a costate species is more advanced than a smooth one and less advanced than a spinose one. The first phase of development dealt with may be called the lenticular stage; the next phase would be the Cincta stage, in which the front margin is rounded in youth, truncate in adolescence, incipiently excavate and bilobate in the adult. The Cincta stage may develop in two directions—out of broad forms the quadrifid stage, out of narrow forms the cornute stage. The next development may be called the quadricarinate or trigonellid stage, and the fourth stage the multicarinate or *pectunculus* stage. In Eudesia there is a highly developed multicarinate stage. In degree of ribbing it is higher than Cincta, and even higher than the *pectunculus* stage, but both the ribbing and the loop forbid connection with Cincta.

Chemical Society, June 6.—Sir William Ramsay, K.C.B., F.R.S., president, in the chair.—The relation between absorption spectra and chemical constitution, part vii., pyridine and some of its derivatives: F. **Baker** and E. C. C. **Baly.** The absorption spectra of pyridine and the pyridones are consistent with the view that the nitrogen atom tends to restrain the motions of the ring, this restraint being very much lessened by the addition of acid to the solutions.—The interaction of methylene chloride and the sodium derivative of ethyl malonate: F. **Tutin.**—The constitution of the diazo-compounds: J. C. **Cain.** The author proposes for diazo-benzene chloride the quinonoid formula, which bears much analogy to the formula of quinonechloroimide, which, like diazo-salts, loses nitrogen on boiling with water.—Dibromoaminoazobenzene: J. T. **Hewitt** and N. **Walker.**—Phenol-*p*-sulphoxide: S. **Smiles** and A. W. **Bain.**—*p*-Cresol sulphoxide and sulphide: S. **Smiles** and T. P. **Hilditch.**—Molecular weight of β-naphthol in solution in solid naphthalene: E. P. **Perman** and J. H. **Davies.** It is concluded from vapour-pressure measurements that in dilute solutions β-naphthol has the same molecular weight as in the gaseous state, whilst it associates in more concentrated solutions.—Synthesis of hexatriene derivatives. (Preliminary note): Miss I. **Smedley.**—The reduction of aromatic nitro-compounds to azoxy-derivatives in acid solution: B. **Flurscheim** and T. **Simon.** The conditions which favour or prevent the formation of azoxy-products by reduction of nitro-bodies in acid solution have been determined.—Action of selenium and tellurium on arsine and stibine: F. **Jones.** It is found that the action of arsine and stibine on sulphur, selenium, and tellurium corresponds with the rise in the atomic weights of these elements, stibine being readily decomposed by sulphur, more slowly by selenium, and still more slowly by tellurium.—The double nitrites of mercury and the alkali metals: P. C. **Rây.**—Silver-mercuroso-mercuric hydroxynitrates and the isomorphous replacement of univalent mercury by silver: P. C. **Rây.**—The molecular weights of amides in various solvents: A. N. **Meldrum** and W. E. S. **Turner.**—Some experiments on the oxidising action of hydrogen peroxide: W. H. **Perkin,** jun. Brazilein, hæmatein, benzil, phenanthrenequinone, and aurin are oxidised by 30 per cent. hydrogen peroxide, yielding products which are still under investigation. Experiments are in progress with the view of determining the special conditions under which hydrogen peroxide may be employed with success in the investigation of such substances.—Action of hydroxylamine on *o*-benzoquinonediazides. 3:5-Dibromo-*o*-azoiminobenzoquinone: K. J. P. **Orton,** W. C. **Evans,** and E. **Morgan.**—Oxime formation and decomposition in presence of mineral acids: A. **Lapworth.** The conversion of stable hydroximido-compounds into the corresponding ketones or aldehydes is, as a rule, to be effected by the use of hydrochloric acid in presence of formaldehyde. The latter is converted into formic acid in the process, while the nitrogen of the oxime appears mainly as ammonium chloride. When benzaldehyde is substituted for formaldehyde, benzaldoxime and sometimes benzonitrile are formed.—Note on the constituents of the seeds of the Para rubber tree (*Hevea brasiliensis*): W. R. **Dunstan.** The kernels of the seeds of the Para rubber tree contain about 50 per cent. of a fixed oil resembling linseed oil. The seed kernels, when ground with water, evolve small quantities of hydrocyanic acid and acetone, whence it appears that a cyanogenetic glucoside is present, similar to, if not identical with, phaseolunatin. A mixture of enzymes was prepared from the seeds which probably includes, besides a lipase-like enzyme, one capable of decomposing the cyanogenetic glucoside. The nature of the fixed oil, the cyanogenetic glucoside, and the enzymes is being fully investigated in this and the related species, *Hevea pauciflora* and *Hevea confusa*.

Mineralogical Society, June 11.—Prof. H. A. Miers, F.R.S., president, in the chair.—Hamlinite from the Binnenthal: H. L. **Bowman.** A mineral occurring in small brown six-sided plates in the white dolomite, to which the name bowmanite was given by Mr. Solly in 1904, is shown by analysis to be identical with hamlinite. The crystals show a division into six biaxial sectors, and are consequently pseudohexagonal.—Faceted beads of zinc: T. V. **Barker.** The president described beads of zinc deposited on crucible lids by sublimation of zinc through oxide of tin. Some of these beads are covered with brilliant facets, and present the appearance of crystals rich in faces. Mr. Barker has found that they do not lie in zones or obey the laws of distribution of ordinary crystal faces, and cannot therefore be regarded as the faces of a single crystal. There is, however, no evidence, from etching by acid, that the bead is an aggregate of crystals. The nature of these remarkable faces is difficult to understand. A bead of platinum presenting the same peculiarities was measured by the late Prof. Miller.—Chlormanganokalite: Dr. H. J. **Johnston-Lavis** and L. J. **Spencer.** A preliminary account of this new Vesuvian mineral was given by Dr. Johnston-Lavis in NATURE on May 31, 1906. A new analysis of the mineral gives the formula $MnCl_2.4KCl$. The crystals are rhombohedral with a rhombohedral angle of 57° 36′; they are optically uniaxial with very weak positive birefringence; the refractive index is 1·59 and the specific gravity 2·31.—Mr. L. J. **Spencer** exhibited a suite of beautifully crystallised minerals, presented to the British Museum by Mr. Percy C. Tarbutt, from the Rhodesia Broken Hill mines in north-western Rhodesia. In driving a tunnel through one of the kopjes, which consist mainly of cerussite and hemimorphite, a cavern containing flint implements and bones of recent mammals was encountered, and a cavity in the bone-breccia on the floor of this cave was encrusted with magnificent groups of hopeite crystals (the rare hydrous zinc phosphate discovered by Sir David Brewster in 1823). In the vicinity of the cave, crystals of another hydrous zinc phosphate were found in association with descloizite (hydrous vanadate of lead and zinc). The crystals of this new species, for which the name *tarbuttite* is proposed, are anorthic; they possess a perfect cleavage in one direction, through which emerges obliquely the acute negative bisectrix of the optic axes. Cavities in the ordinary ore are lined with large twinned crystals of water-clear cerussite, which are encrusted with small crystals of hemimorphite.—A group of quartz crystals from British Guiana was exhibited by Mr. **Anderson,** and a fine crystal of apatite by Mr. **Gordon.**

Mathematical Society, June 13.—Prof. W. Burnside, president, in the chair.—The number of representations of a number as a sum of $2r$ squares, where $2r$ does not exceed 18: Dr. J. W. L. **Glaisher.**—An extension of Eisenstein's law of reciprocity: A. E. **Western.**—Note on a special set of classes of partial differential equations of the second order: Prof. A. R. **Forsyth.**—Various extensions of Abel's lemma: Prof. T. J. I'A. **Bromwich.** —The arithmetical nature of the coefficients of linear substitutions, third paper: Prof. W. **Burnside.**—The invariants of the quintic: Dr. H. F. **Baker.**—Informal communications were made as follows:—Certain singular points of surfaces: A. B. **Basset.**—The minimum necessary postulates as to a function to be defined as analytic over a region: Prof. E. B. **Elliott.**

Royal Astronomical Society, June 14.—Mr. H. F. Newall, president, in the chair.—The inclination of binary star orbits to the Galaxy: Prof. H. H. **Turner** and T. **Lewis.** —The illumination of the field of view, and its effect on observations with a transit instrument: Sir W. **Christie** and H. **Christie.**—The spectrum of Mira Ceti, as photographed at Stonyhurst College Observatory: Rev. W. **Sidgreaves.** The photographs were taken during the late maximum, from December 1, 1906, to January 3, 1907, with a Thorp objective prism and with a Hilger compound prism. The spectra were compared with that of the star during the previous maximum of 1897–8. The absorption spectrum was substantially the same, but the bands were much weaker in 1906, quite sufficiently so to account for the very bright maximum.—The origin of certain bands in the spectrum of sun-spots: A. **Fowler.** The bands are hazy lines, which had not hitherto been traced to their source, various experiments made in 1905–6 having given entirely negative results. The author, however, had lately found that many of the bands are part of a fluted spectrum, and can be accounted for by the presence in the umbræ of spots of a compound of magnesium and hydrogen (magnesium hydride). The identification appeared extremely probable from a comparison of visual observations, but is rendered quite certain by reference to the admirable photographs taken by Prof. Hale at the Mount Wilson Observatory. The identification supports the view that the vapours in spots are at a relatively low temperature.—Account of the instruments and work of the Mount Wilson Observatory, California: Prof. G. E. **Hale.** A large series of slides was shown on the screen, including spectroheliograph pictures of the solar surface taken in calcium and hydrogen light, comparison of which led to important conclusions as to the relative height of the flocculi. It was suggested that the areas of the flocculi should be systematically measured, and that they might furnish data for determination of the solar rotation. A series of photographic spectra of sun-spots was also shown. Prof. Hale stated that he had found that the heat of the sun caused an actual bending of the mirror employed, the front side becoming convex and the rear side concave. He proposed to obviate this disadvantage by employing mirrors of exceptional thickness, a 17-inch mirror being under construction which is as much as 13 inches thick. Other modifications in the instrumental equipment are also in progress.

PARIS.

Academy of Sciences, June 17.—M. Henri Becquerel in the chair.—The question of the origin of the lunar seas: MM. **Lœwy** and **Puiseux.** The hypothesis of the formation of the lunar seas by external collisions is discussed and shown to depend upon very uncertain hypotheses, and even then is, taken alone, insufficient to account for all the facts.—The usual mode of publication of equatorial observations and on a means of improving it: G. **Bigourdan.**—Further remarks on the obliteration of the pleural cavity of elephants: Alfred **Giard.** Referring to a recent note on this subject by G. Vasse, the author remarks that the mere fact of the lungs separating easily is no proof of the existence of a pleural cavity, and quotes recent observations by Schmaltz, Ruge, and Chapman to support his point.—The preparation of anhydrous lithium moxoxide: M. **de Forcrand.** None of the methods previously used for preparing this substance gives a pure product. Purified lithium hydroxide, placed in a platinum or silver boat, is heated to 780° C. in a current of dry hydrogen. The conversion into Li_2O is complete in one hour.—A new method of diagnosis of tuberculosis in man by the tuberculin ophthalo-reaction: A. **Calmette.** One drop of a sterilised 1 per cent. aqueous solution of tuberculin is placed in the eye. After five or six hours, conjunctivitis, accompanied by copious secretions, becomes apparent in the tuberculous subjects. In non-tuberculous subjects the tuberculin is without effect. The author suggests the use of this in clinical work as a means of diagnosis, as the reaction is prompt, and neither pain nor permanent ill effects result.—Observations of the Daniel comet (1907*d*) made with the *coudé* equatorial of the Observatory of Lyons: J. **Guillaume.**—Observations of the Giacobini comet (1907*c*) made with the *coudé* equatorial at the Observatory of Lyons: J. **Guillaume.** This comet is of thirteenth to fourteenth magnitude.—A new method for resolving several problems on the development of an arbitrary function in infinite series: W. **Stekloff.** —The surfaces engendered by a circular helix: M. **Barré.** —The mechanical integration of the hodograph: L. **Filloux.**—The displacement of the absorption bands of crystals under the action of variations of temperature: Jean **Becquerel.** The bands of tysonite, parisite, and monazite are all displaced in the direction of the smaller wave-lengths when the temperature is lowered; in xenotime, however, a large number of bands move in the opposite direction.—A new method for the production of flame spectra of metallic bodies: G. A. **Hemsalech** and C. **de Watteville.** The air supplied to the lower part of a Bunsen burner carries some of the metal in a fine state of division. To produce this the air passes through a glass bulb containing two electrodes of the metal under examination. About ten powerful sparks per second, furnished by a condenser of high capacity, are allowed to pass between the two electrodes. Sufficient of the metal is removed in this way to give a flame rich in lines. The actual quantity used, however, is extremely small, and is hardly weighable after some hours' sparking. The method is therefore peculiarly adapted for studying the spectra of rare and costly metals.—Photomicrography in colour with autochrome plates by A. and L. Lumière: Ch. A. François **Franck.**—Remark relating to the detection of calcium: H. **Baubigny.** A reclamation of priority as regards the use of an ammoniacal solution of potassium ferrocyanide as a characteristic test for calcium.—The absolute atomic weight of manganese: Gustavus D. **Hinrichs.** An application of the author's method of calculation to the experimental results of Baxter and Hines. The value 54·95 found by these workers is converted into 55 exactly by these calculations.—Arsenic acid and the methylarsenic acids: E. **Baud** and A. **Astruc.** A thermochemical paper.—The action of fluorine on selenium in the presence of glass: Paul **Lebeau.** Experimental reasons are given for assuming that the substance produced by the interaction of selenium and fluorine in the presence of glass is not pure selenium hexafluoride, but a mixture of at least two substances.—The solubility of alumina in aluminium sulphide and of magnesia in sulphide of magnesium: Marcel **Houdard.** The oxides of both magnesium and aluminium have been obtained in a crystalline form when fused with the corresponding sulphide in the electric furnace.—The alloys of nickel and tin: Em. **Vigouroux.** The alloys of nickel and tin containing up to 40 per cent. of the latter metal are feebly magnetic. Under the action of nitric acid and potash a non-magnetic alloy having the composition Ni_3Sn can be isolated.—The glycol of anethol; its transformation into anisylacetone: MM. **Tiffeneau** and **Daufresne.**—A new method of ring formation of the substituted pimelic and adipic acids: H. G. **Blanc.** The acid is converted into its anhydride by treatment with acetic anhydride, and this, followed by slow distillation, gives the corresponding cyclic ketone. The yields are very good; details are given of eleven ketones prepared according to this method.—The dimagnesium compound of 1:5-dibromopentane: V. **Grignard** and G. **Vignon.** Dibromopentane readily forms a dimagnesium compound, soluble in ether. A preliminary account is given of the reactions of this substance with carbon dioxide, ethyl acetate, and diacetyl.—The application of the method of limiting densities to the liquefiable gases: Ph. A. **Guye.** The difficulty with these is the accurate evaluation of the term A'_0, representing the deviation from Boyle's law. A linear extrapolation from densities measured at pressures between 0·5 and 1 atmosphere is not sufficiently accurate, and the three modes of parabolic extrapolation proposed by D. Berthelot do not lead to identical results. It is pointed out that, admitting the idea of a gas constant, the parabolic extrapolation will not hold good.—The kathodic phosphorescence of complex systems. The paralysing action exercised by certain exciters of the rare earth series upon others of the same series: G. **Urbain** and Clair **Scal.**—The colloidal properties of starch: E. **Fouard.**—The comparative action of extracts of barley and of malt upon the more resisting dextrins: J. **Wolff.**—The amount of oxygen in oxyhæmoglobin from the horse: MM. **Piettre** and **Vila.**—The polymorphic transformations of isomorphous mixtures of three bodies: Fred. **Wallerant.**—The inverse bundle of *Zilla macroptera*: C. **Gerber.**—The detection of invertine, sucrase, or saccharose in various organs of the vine and in some fruits: V. **Martinand.**—Protective and evasive autotomy: Henri **Piéron.**—The structure of the divided nerves in a strictly physiological evolution: N. A. **Barbieri.**—The geology of the central Sahara: R. **Chudeau.**—The presence of Carboniferous strata in the neighbourhood of Taoudeni, south-western Sahara: G. B. M. **Flamand.**—The post-helvetian eruptions anterior to the recent volcanoes in the north-west of Sardinia: M. **Deprat.**—The storm of May 22 1907, in the department of Loiret: M. **Maillard.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 27.

ROYAL SOCIETY, at 4.30.—On the Dynamical Theory of Gratings: Lord Rayleigh, O.M., P.R.S.—On the Surface Tension of Liquids investigated by the Method of Jet Vibration: S. D. Pedersen.—Cases of Colour Blindness, No. VI. to No. XVIII., together with Eleven Selected Examples of Normal Colour Sensation: Dr. G. J. Burch, F.R.S.—On the Occurrence of Post-tetanic Tremor in Several Types of Muscles: Dr. D. F. Harris.—On the Pressure of Bile Secretion and the Mechanism of Bile Absorption in Obstruction of the Bile Duct: P. T. Herring and S. Simpson.—Further Studies of Gastrotoxic Serum (Progress Report). Dr. C. Bolton.—Observations on the Life-history of Leucocytes, Part III.: C. E. Walker.—The Annealing of Copper with Special Reference to Dilatation: Prof. T. Turner and D. M. Levy.—On a Standard of Mutual Induction: A. Campbell.—A New Current Weigher and a Determination of the E.M.F. of the Normal Weston Cadmium Cell: Prof. W. E. Ayrton, F.R.S., T. Mather, F.R.S., and F. E. Smith.—On the Velocity of the Kathode Particles emitted by Various Metals under the Influence of Röntgen Rays and its Bearing on the Theory of Atomic Disintegration: P. D. Innes.—On the Force Required to Stop a Moving Electrified Sphere: G. F. C. Searle, F.R.S.—Some Notes on Carbon at High Temperatures and Pressures: Hon. C. A. Parsons, C.B., F.R.S.—The Hard and Soft States in Ductile Metals: G. T. Beilby, F.R.S.—Ranges and Behaviour of Rifle Projectiles in the Air: A. Mallock, F.R.S.—Experiments on a New Kathode Dark Space in Helium and Hydrogen: F. W. Aston.—Note on the Use of the Radiometer in Observing Small Gas Pressures: Sir James Dewar, F.R.S.—And other Papers.

FRIDAY, JUNE 28.

PHYSICAL SOCIETY, at 5.—Demonstration of the Uses of his Hot Wire Oscillographs and Hot Wire Wattmeters: J. T. Irwin.—Experiments on the Production of Sand Ripples on the Sea Shore: Mrs. Ayrton.—(1) A Cosine Flicker Photometer; (2) Some Phenomena in Colour Vision: J. S. Dow.—Description and Exhibition of Students' Apparatus for Measuring Permeability and Hysteresis: Prof. W. E. Ayrton and T. Mather.

WEDNESDAY, JULY 3.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, JULY 4.

CHEMICAL SOCIETY, at 8.30.—*iso*Nitroso and Nitrodimethyldihydroresorcin: P. Haas.—The Structure of Carbonium Salts: F. Baker.—Studies of Dynamic Isomerism, Part VI., The Influence of Impurities on the Mutarotation of Nitrocamphor: T. M. Lowry and E. H. Magson.—The Relation between Absorption Spectra and Chemical Constitution, Part VIII., The Phenyl Hydrazones and Osazones of α-Diketones: E. C. C. Baly, W. B. Tuck, E. G. Marsden, and M. Gazdar.—Permanganic Acid: M. M. P. Muir.

CONTENTS.

THURSDAY, JULY 4, 1907.

THE CONSTRUCTION OF DYNAMOS.

The Construction of Dynamos (Alternating and Direct Current). By Tyson Sewell. Pp. xi+316. (London: Crosby Lockwood and Son, 1907.) Price 7*s.* 6*d.* net.

SO many books have already been written on the subject of the dynamo that any new publication can only be justified on one of two grounds. Either it must contain new matter of practical importance not hitherto treated in such a way as to be useful to the designer, or it must be in comparison with existing books an improvement in the way of treating old and well-known matter, so that the student and the practical engineer may have less difficulty in grasping the subject than they often have with the existing books.

A perusal of Mr. Sewell's book will leave the reader with the impression that the designer of dynamos will learn nothing from it, and that the student may with equal advantage read any of the previous publications treating of the dynamo in a popular style. The book is in this respect no better and no worse than dozens of others. As regards its use for the design of dynamos, the author himself deprecates it, for he says in the preface:—

"The examples of design are introduced by way of illustration only. The actual designing of dynamos is the work of comparatively few men, most manufacturers having standardised particular lines which, with slight modifications, meet most requirements; and in view of the labours of the Engineering Standards Committee, further developments in the direction of uniform practice may be expected."

The idea underlying this sentence seems to be that as only few men have to design dynamos, and as the Engineering Standards Committee looks after these things, it is not necessary to treat of design in books. Yet in the first sentence of the preface the author says that his work is an attempt to treat of theory, design, and construction, and several chapters are devoted to working out the details of design.

The general arrangement of the book follows well-known lines. We get first the fundamental principles of direct currents, Ohm's law, its application to the "Silvertown Set" and Evershed's "Megger," though without description of the internal arrangement and only an outside view of the box. Then come a few pages on the magnetic field and on testing iron, but the treatment is incomplete, and in one case also misleading. This is the description of the magnetometric method, where the author fails to point out that it is only applicable to thin and long wires, and not to a turned iron rod, as he says; and that the effect of the solenoid must be eliminated by a special coil. In the next chapter we get all the well-known illustration (but on a prodigiously large scale) to show lines of force, and how by cutting them an E.M.F. is produced, and the formula for the E.M.F. of a two-pole dynamo. It would have been well if the author had also given the formula for a multipole machine in this place. The chapter following deals with the fundamental principles of the alternating current, and then we get to the alternating field. Here the author introduces the hysteresis loop, and mentions that its area is a measure of the work lost per cycle, but gives no proof. The figures he gives for the hysteresis coefficient of 0·002 to 0·008 are certainly much too large, and he is also in error when he says that in dynamo work the loss due to eddy currents is very small. It is well known that the losses in iron actually occurring in the dynamo are considerably in excess of the theoretically calculated losses, and that the increase is in a large measure due to eddy currents at the burred edges of the plates. When dealing with capacity the author gives a neat hydraulic analogy to show why the charging current is a quarter phase in advance of the E.M.F.

In the chapters on construction and theory of bipolar dynamos we find the usual illustrations, but all on a large scale, so that a good deal of space is uselessly occupied and the text correspondingly restricted. Although in the illustrations the author follows well-known lines, this cannot be said as regards his way of designing. Here we find some novelty, but hardly improvement on the usual practice. Thus, in giving the design of a 400 kw. 550 v. machine, he starts with the rule that 100 kw. is a fair average allowance per pair of poles, and finds thus that eight poles is the right type. Then he calculates the number of commutator bars on the basis of 5 v. per bar, and by assuming a certain thickness he arrives at the diameter, and again by assuming a certain circumferential speed he obtains the number of revolutions per minute. This freedom in the selection of speed may be convenient, but it is certainly not the condition which prevails in practice. As a rule the speed is given, and one has to design the dynamo to suit it. Having thus found the speed, the author proceeds to find length and diameter of armature by simply applying the so-called "output formula," but as he does it without critical investigation he gets rather unusual dimensions, namely, 93 inches diameter by $15\frac{1}{2}$ inches long, whereas a little common-sense reasoning untrammelled by adherence to formula would have shown him that 80 inches by 20 inches would make a far better and cheaper machine. The number of conductors is found from a formula of circumferential current density, and so the designing goes on simply by applying formulæ without criticism, not a method to be recommended either to students or to "engineers who have occasion to deal with technical matters," as the author says in the preface.

Another claim made in the preface is only partially justified. The author says that "the available space is almost exclusively devoted to machines representing present standard practice." There are a few illustrations of the fly-wheel type of alternator, and also a turbo-alternator, and in so far standard practice is considered, but the "mono-coil-claw" type, Fig. 200, the inductor machine, Fig. 201, and the ironless machines of Mordey, Ferranti, and Crompton, are certainly not present standard practice, whilst the details of armature housing shown in Figs. 192 to 197 may be modern, but are certainly not good practice. The author's explanation why field magnets are laminated is novel, and, moreover, so peculiar that it merits verbal quotation. He says:—

"The field cores are often laminated throughout to prevent eddy currents due to any swinging of the field caused by armature reaction, and this often leads to special methods of support."

Had he said that magnets must be laminated if the stator slots are wide and open, he would have been right, but the explanation he gives is quite beside the mark. Equally misleading is his indiscriminate recommendation of damping coils as a cure for hunting. As he mentions these coils just after saying that hunting is especially the fault of gas-engine driven machines, the reader is led to conclude that the damping coils would be especially useful in such cases, whereas every expert knows that damping coils are absolutely harmful if applied to an alternator driven by a gas engine. GISBERT KAPP.

STOKES'S SCIENTIFIC CAREER AND INFLUENCE.

Memoir and Scientific Correspondence of the late Sir George Gabriel Stokes, Bart., Past Pres.R.S. Selected and arranged by Prof. Joseph Larmor, Sec.R.S. Vol. i., pp. iv+475; vol. ii., pp. vi+507. (Cambridge: The University Press, 1907.) Price 24s. net, two volumes.

IT is well known that the record of Stokes's work, splendid as it is, which is contained in the five volumes of his collected papers is far from being a complete representation of the services which during a long life he rendered to science. From his first official connection with the Royal Society in 1854 the tide of production began somewhat to slacken, and after 1868, it may almost be said, no sustained piece of work of first-rate magnitude appeared under his name, although shorter papers, often of great value, and all showing the impress of the master-hand, were given out from time to time. His energies did not relax, and his powers never showed any sign of decay, but they were diverted into somewhat different channels. Partly owing to the rigorous sense in which he construed the duties of his various official positions, and partly in consequence of his own inexhaustible good nature, he was constantly occupied in examining, advising upon, and assisting in the work of others.

This gradual change in the manner of his work has been often wondered at, and sometimes deplored, but it came about quite consistently. There is a certain type of professional *savant* to whom systematic production, or at all events publication, with due form and circumstance, is as the breath of his nostrils; it must be maintained at all hazards. With this type Stokes had never any affinity. He took to mathematical physics, in the first instance, because his interests and his powers lay that way, and he published the results of his investigations, when they seemed valuable enough, as a matter of course; but when other duties came which had, as he thought, a more immediate claim, he turned to them without a moment's regret at the diminished opportunities of personal achievement which they involved.

For a complete memorial it was therefore essential that some presentation should be made of this important phase of his work. As Prof. Larmor explains, in the preface to the two volumes now before us, the material in the shape of letters is abundant; but it is naturally very varied in character, and often fragmentary, and much of it was from one cause or another difficult to turn to account. The labour of sifting and arranging the correspondence must have been enormous, and appears to have been aggravated by the circumstance of fresh letters continually coming to hand during the printing.

The material finally selected has been dealt with as follows. In "Section II." we have an outline of Stokes's general scientific career, illustrated by a chronological series of letters, which touch upon the various topics which at different stages attracted his attention. "Section III. A" contains "special scientific correspondence" with his father-in-law, Dr. R. Robinson, Prof. Cayley, and Sir J. Norman Lockyer. These letters contain matter which is, in different ways, of great interest; the letters to Dr. Robinson are specially valuable, as they preserve many interesting notes and explanations which would otherwise have been lost. The second volume continues "Section III.," and includes letters to and from Maxwell, Joule, Rayleigh, Reynolds, Froude, Airy, and others, nearly all bearing on scientific work of the first order actually in progress. It would be hopeless, and useless, to attempt an enumeration of the various points touched upon; but it is of interest to note with what zest Stokes turns, again and again, to the early objects of his scientific affections, such as the behaviour of sea-waves, the theory of the pendulum, and the varied problems of physical optics. The collection is most of all valuable in that we are allowed a glimpse into the workshop of the master. The most expert craftsman will find much to admire, whilst the novice may derive suggestion and encouragement, more perhaps than from the contemplation of the finished work, which is often apt to beget rather feelings of despair.

These volumes include also matter of a more formal biographical character. The introductory memoir by Mrs. Lawrence Humphry is a most attractive personal record, written with admirable tact and sincerity. To this are appended "appreciations" by intimate personal friends, Prof. Liveing, Sir Michael Foster, Sir William Huggins, and the Bishop of Bristol. Considerable space is devoted to the Jubilee celebration of 1899, and to the proceedings at the unveiling of the Westminster Abbey memorial. Both these occasions greatly impressed those who had the privilege of attending them, and the record will be highly valued.

All who are interested in Stokes and his work, in other words, the whole company of followers of physical science, will feel a deep debt of gratitude to Prof. Larmor for the devoted labour which he has expended on this memorial of his great predecessor. It appears, indeed, that our obligations to him are not yet exhausted. The reader of this notice will have remarked the absence of all reference to the relations between Stokes and Lord Kelvin. We are told that this long scientific friendship is to be commemorated by a special volume of correspondence. There can be no question as to the propriety of this arrangement, and the volume will be looked for with the liveliest interest.

HORACE LAMB.

FIVE SMALL GEOGRAPHIES.

Our Own Islands. By H. J. Mackinder. Pp. xv+298. (London: George Philip and Son, Ltd., n.d.) Price 2s. 6d.

The Oxford Geographies. Vol. I. The Preliminary Geography. By A. J. Herbertson. Pp. viii+149. (Oxford: Clarendon Press, 1906.) Price 1s. 6d.

The Oxford Geographies. Vol. III. The Senior Geography. By A. J. Herbertson and F. D. Herbertson. Pp. viii+363. (Oxford: Clarendon Press, 1907.) Price 2s. 6d.

The Dominion of Man. By Ernest Protheroe. Pp. xii+215. (London: Methuen and Co., n.d.) Price 2s.

Notes upon the Island of Dominica (British West Indies). By Symington Grieve. Pp. 126. (London: A. and C. Black, 1906.) Price 2s. 6d. net.

ALTHOUGH no close comparison can be made between the two elementary reading-books in geography which Mr. Mackinder and Dr. Herbertson have given us, since the former deals with the British Isles and the latter with the whole world, yet we may note certain similarities of method. Both build up their descriptions about an imaginary journey from place to place; both endeavour to present physical and industrial geography as cause and effect; both largely use diagram-maps, partly to supplement the atlas, partly to stimulate the use of it; and both adopt, to some extent, the method of "teaching by question." While this last innovation is a step in the right direction, it is but a hesitating step. The full advantage of this method cannot be obtained by occasional interpolations of questions or suggestions for map-study amid the descriptive matter. Such interruptions are apt to be shelved until a more convenient season that may never come.

Mr. Mackinder's book is arranged on a progressive plan. While map scales and directions are taken at the outset, contour-lines are not explained until half-way through the book. Description starts with the north of England, the uplands and lowlands of which present an easy contrast. Scotland follows, then Ireland, Wales, and finally the Midlands and south and east of England. Simply and lucidly written, with many views and maps, it is a most readable book. We must, however, object to county-towns being called "capitals" (p. 143), to the coupling of Shropshire (strictly Shrewsburyshire) with Berkshire as a county name not derived from a town (p. 263), and to the printing of Macaulay's magnificent Armada lines cut in halves (p. 275).

Dr. Herbertson is unconventional in the order in which he takes the continents, starting with the Americas, because their physical and climatic conditions lend themselves best to simple generalisations, and they thus serve as a type with which Asia, Australia, Africa, and Europe are in turn contrasted. The immensity of the subject-matter renders occasional "scrappiness" of treatment inevitable, though in general this has been very successfully avoided, and attention concentrated on broad general features and contrasts. Altogether, it is a refreshing change from the old-fashioned dry text-books, but it needs supplementing with views to enable the child to realise the scenes described.

Both books have suffered a little from the troubles incidental to process-illustrations. The hemispheres on p. 3 of the "Preliminary Geography" are not all printed the right way up (this should have been avoided by processing them in pairs, instead of singly); and a phantom coalfield appears in Cheshire in Fig. 37 of "Our Own Islands."

By dividing the world into natural regions and showing how political divisions are related to these, Dr. and Mrs. Herbertson have produced an altogether admirable book. Particularly to be noticed is the treatment of the Alps as a whole, and the historical development of the Central European States in relation to them. There are only two small matters on which it occurs to us that the student needs further enlightenment—viz., the use of *Mont* for the names of passes as well as of peaks in the Western Alps (it is a common mistake to cite Mt. Cenis as a peak), and the misleading name of the first Alpine railway tunnel, taken from the Mt. Cenis carriage-route which it superseded. The historical summaries given for each country are very well done. We have noticed very few mistakes. *West* Indies, on p. 105, should surely be *East*; William the Conqueror did not march down stream from Wallingford (p. 142); and the statement on p. 68 as to the origin of Boulder-clay is rather dogmatic for so disputed a subject. It is difficult to be consistent in the spelling of European place-names, but to us at least *Luzern* looks as out-of-place in an English sentence as would Torino or Firenze. These are trivial criticisms on a book the reading of which has given us a great amount of pleasure, and which should become the standard geography for schools.

Mr. Protheroe has produced a well-arranged treatise on the commercial products of all parts of the world, on communications, towns and markets. His enthusiasm for civilisation and progress gives his style a floweriness which is occasionally overdone, but his book is very readable. It is illustrated by a well-chosen series of photographs, and while not exactly a school-book, should be very useful to teachers of geography and to those numerous persons who wish to make good the deficiencies in their knowledge of commercial geography. We have noticed a few errors, the worst being the derivation of Portland cement from Portland stone (p. 94).

Mr. Symington Grieve recently paid a visit of investigation to Dominica, in the Lesser Antilles, and now gives an interesting account of the island, its natural productions and people, illustrated by photographs taken on his expedition. To anyone intending to visit the island, whether as tourist, naturalist, or trader, the book may be recommended as an excellent guide.

A. M. D.

SOME ASPECTS OF HUMANISM.

(1) *Studies in Humanism.* By Dr. F. C. S. Schiller. Pp. xvii+492. (London: Macmillan and Co., Ltd., 1907.) Price 10s. net.

(2) *Lectures on Humanism.* By Prof. J. S. Mackenzie. (The Ethical Library.) Pp. vii+243. (London: Swan Sonnenschein and Co., Ltd., 1907.) Price 4s. 6d.

(1) LIKE the youth in "Excelsior," Mr. Schiller has a strange device upon his banner, for his motto is "Back to Protagoras." But it is on no solitary or hopeless enterprise that he is engaged, for do not all the most fruitful developments of present-day philosophy point to Pragmatism, and have not all the sages of all times, when they were talking sense, been talking Pragmatism without knowing it? Kant, of course, was of us when he gave primacy to the practical reason and when he announced as his main principle that reality is largely of our making. Even Plato, who here suffers many hard knocks, is perhaps not so complete an intellectualist as he is generally thought, if Prof. Stewart's theory can be substantiated,

"that the so-called Socratic dialogues, so far from being scientifically negligible, are really essential to the complete statement of the Ideal Theory, and should be taken as exemplifying *the function of the Concept in use*, and as supplementing the account of the *abstract* concept given in the dogmatic dialogues, on which alone the traditional descriptions of Platonism have been based."

But after all it is to the strangely misunderstood Protagoras, and his principle that man is the measure of all things, that the world owes most. If only we had his complete works and not fragments—and not Plato's caricature of his philosophy! Then many things would have happened; among others we should not have had the amusing dialogues (containing a prophetic reference to the scholars from Rhodes) which Mr. Schiller has "translated from the Greek" to fill up the gaps in our knowledge.

So it is Intellectualism in all its forms, Platonism, Hegelianism, and that tyrant who has oppressed us so many years—Absolutism—that Mr. Schiller wishes to dethrone. His criticism is always well worth reading. On the other hand, his own system contains not a few features which will give many pause—a God who is essentially finite; a reality which is always incomplete and plastic, in which laws of nature are merely the habits in which things behave; an idea of truth which involves the almost hylozoistic position that inanimate bodies *know* us in some sense (on the level of their understanding) when we operate upon them. The dust of controversy which in this volume beclouds the battlefield will have to settle before it can be decided where most of the truth lies. One wonders—it is genuine Pragmatism to know results before one states principles—what the issue will be; whether the lively Troglodyte of three decades from this will be engaged in proving that new Humanism is but old Absolutism grown more dogmatic and arrogant, or the neo-Absolutist of the period in demonstrating that Absolutism and Humanism are both partial aspects reconciled in a higher unity.

About half the essays contained in this volume have already appeared in a shorter form in various periodicals. But most of the constructive part is new, and the work does not suffer from the manifoldness of the relations in which Humanism is regarded. Certainly, if to be incisive is to be convincing, Mr. Schiller has proved his case.

(2) This volume, containing the Dunkin lectures on sociology, delivered last year at Manchester College, Oxford, runs on very different lines from Mr. Schiller's. No doubt there is the same effort to show how much of Humanism lies implicit in a large range of philosophic works; but as it does not seek to prove a thesis, this book is not written with the same verve and passion. We have sober grey in grey, and never an attempt to bring out violent contrasts. Naturally, Mr. Schiller's Humanism is for Mr. Mackenzie only Pragmatism, but in the few paragraphs devoted to it it receives only reasonable criticism.

Prof. Mackenzie's own Humanism is described as "a point of view from which human life is regarded as an independent centre of interest"—as contrasted with a Naturalism and Supernaturalism which seek the explanation of human life either in the forces around man or in some powers distinct from man and those forces.

In the light of that description the influence of Humanism in philosophy, politics, economics, education, and religion is studied, and the two closing chapters examine the limitations and implications of Humanism. Prof. Mackenzie fears that the style of treatment may be regarded as sketchy; sketchy it is, and the title of the volume perhaps induces expectations that are not realised; but undeniably the work has substantial merits.

OUR BOOK SHELF.

Euclid's Parallel Postulate: its Nature, Validity, and Place in Geometrical Systems. By Dr. J. W. Withers. Pp. x+192. (Chicago: Open Court Publishing Co.; London: Kegan Paul and Co., Ltd., 1905.) Price 4s. 6d. net.

This is a philosophical thesis by a writer who is really familiar with the subject of non-Euclidean geometry, and as such it is well worth reading. The first three chapters are historical; the remaining three deal with the psychological and metaphysical aspects of the problem; finally, there is a bibliography of fifteen pages. Mr. Withers's critique, on the whole, is quite sound, although there are a few passages either vague or disputable. For instance (pp. 80–1): "Had man's spatial experience been confined to vision alone, the struggle between Euclid and Lobatchewsky could never have been, since for vision alone there are no such things as parallel lines." This is not convincing, and the sentence that follows does not add to the force of the argument. As a matter of fact, lines that we see apparently change their inclination as we change our point of view, and diverging lines looked at in a proper direction might very well arouse the concept of parallel lines. And however freely we admit the part taken by sensation in the development of geometrical ideas, we are compelled in the last resort to see that the science of geometry is the result of a free intellectual construction. Naturally we choose a scheme that with the simplest assumptions harmonises with the greatest number of facts; this is the reason why Euclidean geometry is that of common life. As Mr. Withers points out, there is very little chance of any change in this respect; for if a series of careful experiments upon the stars were to lead to triangles with the sum of their angles different from 180°, we should be more likely to give up the hypothesis of the strictly rectilinear propagation of light than to adopt a non-Euclidean geometry as that of "actual space." On the other hand, we may some time gain experience of a new kind, presenting itself as spatial, and requiring us to assume more than three dimensions in space.

Mr. Withers sensibly steers a middle course between the extremes of pure empiricism and the *a priori* hypothesis. That we cannot form any clear conception of four-dimensional space to which three-dimensional space is related in a manner strictly analogous to that in which a line is related to a plane in which it lies, shows clearly enough that we cannot do without experience; on the other hand, the definition of a surface as a boundary between two adjacent portions of space involves a concept which cannot possibly be deduced from sense-experience, and the recent theory of sets of points gives still more striking examples. Mr. Withers's main contention is that Euclid's parallel postulate is empirical, and this may be admitted in the sense that his argument requires; at any rate, he shows the absurdity of some statements of the *à priori* school.

Die Reizleitungsvorgänge bei den Pflanzen. By Dr. H. Fitting. Pp. xv+157. (Wiesbaden: J. F. Bergmann, 1907.) Price 3.60 marks.

ALTHOUGH the phenomena of irritability in plants are in a general way easily demonstrated, their elucidation is a matter of extreme difficulty, and in spite of the numerous original experiments that have been devised, absolute proof in support of the explanations offered is rarely possible. A notable instance is furnished by the debated question whether the perception of the stimulus of gravity is localised in the tip of the root. The experiments advanced by Charles Darwin in favour of this view were speedily disputed; Czapek's ingenious glass-shoe experiments, although widely accepted as proof, have been adversely criticised, and now more definite proof is hoped to be obtainable by growing seedlings on a rapidly revolving klinostat in such a position that the tip and growing region situated on different sides of the centre of rotation are subjected to centrifugal force acting in opposite directions. The debatable character of the arguments is one hindrance to a study of the subject, to which is added the difficulty of obtaining the literature, scattered as it is through numerous journals and pamphlets.

Dr. Fitting's monograph helps but little in the matter of literature, as in many cases space does not even permit of stating the arguments put forward by investigators, but as a critical guide to the estimation of the various theories his book will be found very useful.

The book consists of three portions, dealing with the occurrence of the phenomena, the path of transmission of the stimulus, and the manner in which it is transmitted. Owing to the absence of descriptions, the first part is only suitable to the reader who has a full acquaintance with the subject or is prepared to look up the literature. The discussions of the various paths by which the stimulus may travel and of the mechanism involved are the most instructive parts of the book, and particular interest attaches to the sections on protoplasmic communications, on the fibrillar structure in cells of the root-apex, and on the electrical phenomena connected with stimulation. Dr. Fitting has himself added materially to the facts of irritability phenomena and their interpretation, so that his opinions are extremely valuable, the more so because he is a searching but unbiased critic.

Birds and their Nests and Eggs found in and near Great Towns. By G. H. Vos. Pp. xii+148; illustrated. (London: G. Routledge and Sons, Ltd., n.d.) Price 1s.

To take birds' nests and their contents with the camera is in every way a more satisfactory proceeding than egg-collecting, and if the author of this little volume succeed in aiding the new movement he ought to obtain the gratitude of all bird-lovers—not to mention the birds themselves. Two things are essential in this pursuit: first, the capacity of "spotting" nests, which seems to be an inborn art, incapable of being acquired otherwise, and, secondly, skill in manipulating the camera. In the latter accomplishment the author excels, but for the former he has had to depend on a friend; and the combination of forces has produced most satisfactory results.

The numerous photographs of nests and eggs in their natural sites are all that can be desired, and as regards these no encomiums are too high. We wish we could say the same with regard to the photographs of the parent birds, which, we are told, are taken from "characteristically stuffed typical individuals placed in natural surroundings, illustrating as nearly as possible the conditions under which they were observed." In our opinion these "faked" photographs are thoroughly unsatisfactory, the birds being obviously stuffed (whether "characteristically," in the sense in which the author evidently uses the term, or otherwise), and appearing ill at ease in their pseudo-natural surroundings. The book would be far better without them. As the nests, which include those of a considerable number of species, were all observed within a radius of sixteen miles from the City, beginners whose homes are in large towns need not be deterred by lack of material from following in the footsteps of the author, to whom amateur photographers in general are indebted for showing how much can be done at a comparatively small expenditure of time and money.

R. L.

Kinship Organisations and Group Marriage in Australia. By Northcote W. Thomas. Pp. xvi+164. (Cambridge: University Press, 1906.) Price 6s. net.

MR. THOMAS has digested everything that has been written on the Australian natives. In this volume he gives us a very useful *résumé* of all the facts of their complex social organisation, separating the attested from the doubtful—a much-needed piece of work. The account is interwoven with Mr. Lang's theory of Australian kinship and marriage evolution, perhaps the most plausible hitherto advanced, though in the matter of totemic origins it may encounter opposition. Mr. Thomas suggests some real improvements in terminology—matrilocal instead of *beena*, matrilinear and patrilinear, matripotestal and patripotestal—these should be generally adopted, as no doubt they will. The author seems to be at his best in the discussion of such a vexed question as group marriage; the argument is closely reasoned, and brings out several new points. There is an excellent index. The book will be indispensable to anthropologists, and sociologists generally will find it an admirable and convenient text-book for the study of the beginnings of social organisation.

A. E. CRAWLEY.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Absorption of the Air for Light of Short Wave-lengths.

IN his well-known work on the absorption of the air for light of very short wave-lengths, Schumann has concluded that the opacity is due to oxygen, and that this gas, in thickness of a few millimetres, absorbs *completely* all wave-lengths shorter than about 1800 tenth-metres.

I have recently been investigating the question of gas absorption in this region by means of the vacuum spectroscope which I employed in measuring the lines in the spectrum of hydrogen.

In part my results agree with those of Schumann, for I find that hydrogen, nitrogen, helium, and argon are all quite transparent to very short wave-lengths. In one very important respect, however, I cannot agree with his conclusions, for I find that oxygen is not opaque for *all* wave-lengths below a certain value, but that its absorption is represented by a band with definite limits. With a gas path of nine millimetres and a pressure of one-half an atmosphere, this band extends from 1750 to 1275 tenth-metres.

Though the investigation of the behaviour of oxygen below wave-length 1230 is hindered at present by the opacity of the fluorite windows which enclose the absorption chamber, yet it appears possible that light of even the shortest known wave-lengths may be able to penetrate air paths of more than a centimetre. The application of this result to the behaviour of ether vibrations of extremely high frequency seems important. THEODORE LYMAN.

Jefferson Physical Laboratory, Harvard University, June 21.

The Structure of the Æther.

IN the issue of NATURE of June 13 (p. 150) Dr. C. V. Burton raises an objection, raised elsewhere by Prof. Hicks and Sir Oliver Lodge, to the correlation of the magnetic vector with the velocity of the æther, on the ground that the motion of an observer relative to the æther would alter the relative velocity of the æther, and thus produce a change in the magnetic vector in the direction of the change in the observer's motion.

If it were stated definitely that the magnetic force in the free æther was proportional to the velocity of the æther relative to the observer, the objection would be valid; but this is reading into the scheme of the æther more than can legitimately be done. In the discussion the fact has been apparently overlooked that the correlation of the two vectors extends only to their rates of change in space and time, so that if identified with one another at any one point at any one instant, they will be identical at all points at every instant; otherwise they may differ by any constant, corresponding to a uniform but undetermined constant drift of the æther as a whole, or, what is the same thing, to a uniform unknown velocity of the observer through the æther.

But it should be noticed that it is not permissible to speak of the velocity of an observer relative to the æther, as though the æther were a material medium *given in advance*. Even if it were possible to isolate a fixed frame of reference in such an æther—which appears questionable in an infinite continuum—there is no physical means of determining the velocity of a system relative to it. The æther, as we know it, is defined by its electromagnetic properties, and one property is that a uniform drift of the æther as a whole has no effect on electromagnetic phenomena. It is known that the correlation between a stationary and a moving system as regards the electrodynamic equations is exact, and not only correct to the second order. The objection to Prof. Larmor's scheme of the æther does not apply if that scheme is stated accurately as follows:—"The propagation of electromagnetic effects through space, relative to a given frame of reference, may be illustrated by the propagation of disturbances in a rotationally elastic medium, it being possible *for a given frame of reference* to construct such a medium, in which the rotational displacement at any point is proportional to the electric force at that point, and the velocity relative to the frame of a point of the medium is proportional to the magnetic force." Since the velocity of a point depends on the frame of reference, it follows that the media constructed for two frames of reference moving relatively to one another with constant velocity will not be identical. The æther is, in fact, not a medium with an objective reality, but a mental image which is only unique under certain limitations (*cf.* footnote, p. 334, "Æther and Matter"). Two frames of reference imply two æthers; so long as we restrict ourselves to a single frame, the objection to Larmor's scheme does not arise. E. CUNNINGHAM.

St. John's College, Cambridge, June 28.

Root Action and Bacteria.

I DO not think that there is necessarily any antagonism between the interesting results which Dr. E. J. Russell has for some time past been obtaining and our observations on the behaviour of trees in heated soil. His deal with the growth of plants, ours with the passage of the plant from the dormant to the active condition, a process analogous to that of germination. Nevertheless, it must be freely acknowledged that, until further work on the subject has been done, the view that bacteria are concerned in the matter is a mere suggestion, and Dr. Russell's opinion that the results may be the consequence of chemical changes produced by the heating is somewhat strengthened by the fact that the soil used was poor in lime, containing only about 1 per cent. CaO. There is, however, one strong objection to accepting an explanation based on chemical change, for two of the nine trees, as I mentioned, behaved exceptionally, and showed practically no retardation in starting. These were two which had been planted in earth heated to the highest temperature, 250°, and were two out of three planted in the same batch of heated earth. It seems impossible to explain these two exceptions if the general results are due to chemical change, but they are easily explained if these results are due to bacterial action, for re-inoculation of the soil might readily occur in one case and not in another.

It may be added that, so far, the trees are behaving normally as to their growth, now that they have once started. SPENCER PICKERING.

I HAVE always carefully looked for, but never found, any retardation of germination in our experiments. The young plants all come up at about the same time, and make equal progress for some weeks; then the plants on the heated soil take on a greener colour, become larger in the leaf and thicker in the stem, and ultimately make about 100 per cent. more dry matter than the control plants in unheated soil. There is no doubt, I think, that bacterial action is involved, because the yield is depressed when I inoculate the heated soils either by watering with unsterilised well water or by adding small quantities of unheated soil. A chemical change in the soil compounds must also be involved, because of the increased "availability" of the nitrogen and phosphorus compounds indicated by the analyses quoted in my earlier letter. All non-leguminous plants we have tried so far have shown similar behaviour.

It is, I think, quite possible to explain Mr. Pickering's results on a chemical hypothesis. In certain circumstances—deficiency of lime among others—organic substances which retard germination and growth may be formed in the soil; in other circumstances, *e.g.* admission of air, they are decomposed by soil organisms. If we assume that some of these substances were formed during the heating of Mr. Pickering's soil, and further assume, with him, that in two pots re-inoculation took place, the poisonous bodies would be destroyed and growth would no longer be inhibited. These assumptions are all based on well-known facts; on this view a soil rich in calcium carbonate should behave as our soils have done and cause no retardation.

However, as Mr. Pickering says, more work is wanted before we can get much further. In the meantime, he has established the very important point that growth may be retarded in a heated soil, and the further development of his experiments will be awaited with much interest.

EDWARD J. RUSSELL.

THE SHAPE OF THE EARTH.[1]

THE most promising suggestion towards a dynamical explanation of the distribution of land and water on the surface of the globe is to be found in the theory of gravitational instability propounded by Jeans in 1903. There is always a tendency in gravitating matter, if homogeneous, to condense towards a centre, or towards an axis, or in some more complex fashion. If the matter is heterogeneous, there is always a tendency for the density to increase where it is above the average and to diminish where it is below the average. Such changes of density imply compression of the material, and they are resisted by the elastic force with which the material resists compression. In the case of a planet we may ask two questions: How small must the resistance to compression be in order that sensible condensations may take place? In respect of what changes of density can instability manifest itself? The answers depend greatly upon the size and mass of the planet, and they depend also upon its constitution.

Whatever the internal constitution of a planet may be, it is certain that, owing to the mutual gravitation of its parts, great stresses will be developed within it. A direct method of attacking the problem of gravitational instability for a planet in such a state of stress was proposed by Lord Rayleigh in 1906. The development of this method leads to the result that a homogeneous spherical planet, of the same size and mass as the earth, could not exist unless the resistance to compression of the material of which it is composed were at least half as great as that of steel. If the resistance were less than a quarter of that of steel (so that the substance was less compressible than mercury but more compressible than glass) such a planetary body would be unstable, both as regards concentration of mass towards the centre and also as regards displacements by which the density is increased in one hemisphere and diminished in the opposite hemisphere. No matter how small the resistance to compression might be, the body would not be unstable as regards any other type of displacements. If the resistance to compression were small enough for a spherically symmetrical state of aggregation to be unstable, the density of the superficial portions would be less than the mean density, and the centre of gravity would not coincide with the centre of figure. If the planet were at rest under no external forces, a shallow ocean resting upon it would be drawn permanently towards the side nearer the centre of gravity, so that there would be a land hemisphere and a water hemisphere.

The average resistance to compression of the materials of which the earth is composed can be deduced from the observed velocity of propagation of earthquake shocks, and it is found to be decidedly greater than that of any known material at the surface—a result clearly associated with the increase of resistance under great pressure. There is, therefore, no tendency to gravitational instability at the present time; but the actual excess of the mean density over the density of surface rocks, and the fact that a very large proportion of the land lies within a great circle having its centre in south-eastern Europe, suggest that the resistance to compression was once much smaller than it is now. This suggestion offers a possible dynamical explanation of the fact that the centre of gravity does not coincide with the centre of figure, and the maintenance of the Pacific Ocean on one side of the globe is due to the eccentric position of the centre of gravity.

The actual shape of the lithosphere, or rocky nucleus of the earth, and its situation relative to the geoid, or the equipotential surface which coincides with the surface of the ocean, are due to many causes, of which the eccentric position of the centre of gravity is one. Other important causes are the rotation and the attraction of the moon. The moon was once very near the earth, and the day and the month were once nearly equal. The earth was then drawn out towards the moon nearly into the form of an ellipsoid with three unequal axes. The direct result of the rotation and the attraction of the moon would be to give to the lithosphere the shape of an ellipsoid differing slightly from the ellipsoidal figure of the geoid. If the centre of gravity coincided with the centre of figure, the lithosphere would protrude from the geoid near the North and South Poles and in two equatorial regions at the opposite ends of the longest equatorial diameter of the lithosphere. If the density were in excess on one side of a diametral plane and in defect on the opposite side, the effects of the rotation, and of those irregularities of attraction which are due to the ellipsoidal figure, would be greater where the density was greater, and the surface of the lithosphere would consequently be deformed in such a way that the deviation from the ellipsoidal figure could be expressed mathematically by means of a spherical surface harmonic of the third degree. The ellipsoidal deviations from sphericity are expressed by harmonics of the second degree, and the eccentric position of the centre of gravity is equivalent to a deviation from symmetry expressed by harmonics of the first degree. We can therefore account theoretically for the presence of harmonics of these three degrees in the formula for the shape of the lithosphere and its situation relative to the geoid.

Now it is known that the actual contour-line at mean-sphere-level (1400 fathoms below sea-level) divides the surface of the globe into two regions of equal area—the continental block and the oceanic region. The continental block is practically continuous, and there are two great ocean basins, one containing the deep parts of the Atlantic and Indian Oceans, and the other the deep part of the Pacific Ocean. A spherical harmonic analysis of the distribution of land and water, account being taken of the submerged portions of the continental block, yields the result that the actual outlines of the great ocean basins at mean-sphere-level coincide very approximately with one of the contour-lines of a certain spherical harmonic containing terms of the first, second, and third degrees, but no terms of any higher degree.

It appears, therefore, that the shapes and relative situations of the great ocean basins, and their positions relative to the polar axis, can be described, at least approximately, in the statement that the lithosphere is an ellipsoid with three unequal axes, having its surface deformed according to the formula for a certain spherical harmonic of the third degree, and displaced as a whole relatively to the geoid in the direction towards south-eastern Europe. The displacement of the surface as a whole is accounted for by the eccentric position of the centre of gravity, and this eccentric position can be regarded as a survival from a past state in which the resistance to compression was too small for a spherically symmetrical configuration to be stable. The ellipsoidal figure is accounted for partly by the rotation and partly as a survival from a past state brought about by the attraction of the moon at the time when the day and the month were nearly equal. The deformation of the ellipsoid according to the formula for a spherical harmonic of the third degree is accounted

[1] Based upon a paper on "The Gravitational Stability of the Earth," by rof. A. E. H. Love, F.R.S., read before the Royal Society on March 14.

for as being due to the interaction of the two causes which gave rise to the ellipsoidal figure and to the eccentric position of the centre of gravity. The main features of the existing division of the surface into continental and oceanic regions can thus be traced to the operation of simple dynamical laws.

PRESENTATION OF THE FREEDOM OF THE CITY OF LONDON TO LORD LISTER.

IN honouring Lord Lister on June 28, the City of London acknowledged the debt humanity owes to the conscientious man of science. Lord Lister was presented with the freedom of the City "in recognition of his eminence as a surgeon, and of the invaluable services rendered to humanity by his discovery of the antiseptic system of treatment in surgery, whereby so great a progress in surgical science has been achieved, so much suffering has been alleviated, and so many valuable lives have been prolonged."

The Lord Mayor attended in state, and among those invited to be present were the President of the Royal College of Physicians, the President of the Royal College of Surgeons, Sir Henry Roscoe and Dr. Charles J. Martin (representing the Lister Institute of Preventive Medicine), Sir F. H. Lovell and Sir P. Manson (representing the London School of Tropical Medicine), Sir Norman Lockyer (representing the British Science Guild), Sir Victor Horsley, Prof. Howard Marsh (University of Cambridge), Dr. L. W. Darra Mair (representing the Chief Medical Officer of the Local Government Board), Sir W. H. Broadbent, Sir William Collins, Sir Frederick Treves, and members of the medical staffs of several of the London hospitals.

Sir Joseph Dimsdale, the City Chamberlain, in admitting Lord Lister to the freedom, remarked :—

A century ago the Corporation of London paid her tribute of honour to the great professions of which Lord Lister is so bright an ornament. In 1803 the Freedom of the City was presented to Dr. Jenner, whose name will ever be associated with the discovery of vaccination, and whose researches superseded the system of inoculation—at that time so successfully and usefully employed to combat the dread disease of small-pox by such men as Dr. Fothergill and Dr. Dimsdale. To-day we meet to do honour to one whose life-long labours mark another epoch in the history of medicine and surgery. During the last half-century the strides made both in medicine and surgery have been little short of marvellous. What was impossible a few years back is now of daily and hourly occurrence. The treatment of disease—the safety in operations—and the careful and tender nursing of the patient are a few of the many developments of our time, and throughout this period Lord Lister has held a foremost place and has been recognised as one of the greatest and most prominent among surgeons. But it is not only as a great surgeon he is known. He is equally a great man of science, and it is by blending his antiseptic treatment with modern surgery that he has made possible so much that has—until lately—been impossible. He stands out as one who has been instrumental in assuaging suffering, lessening disease, and, under God's blessing, prolonging and saving numberless lives. Few are permitted to see the full fruition of their lofty aims and aspirations, but it is with sincere pleasure we greet Lord Lister in this ancient Guildhall, and rejoice to feel that he is able to enjoy the honours conferred upon him by his Sovereign—to be the recipient of universal expressions of esteem and admiration of his work from all seats of learning; while eulogiums from every quarter of the globe proclaim the appreciation the world in general feels for his life-long labours. It remains for posterity fully to gauge and comprehend the magnitude of the legacy he bequeaths to mankind. The City of London—and through her the country—places, I venture to think, the coping stone to-day to the monument of his fame. The citizens, in expressing their deep gratitude for his great services to the human race, ask his acceptance of the highest honour it is in their power to bestow. But while they fully recognise his great work, probably the trait that touches the hearts of his fellow countrymen most is his abnegation of self, and his humble-mindedness, which, amid all his triumphs, recognises that it is under Divine blessing he has achieved so much. Well might Lord Lister in the autumn of his life take to himself the words of Lord Byron :—

> No lengthen'd scroll, no praise-encumbered stone.
> My epitaph shall be my name alone;
> If that with honour fail to crown my clay,
> Oh! may no other fame my deeds repay;
> That, only that, shall single out the spot,
> By that remember'd, or with that forgot.

The name of Lister requires no embellishment, nor is the sculptor's art needed to perpetuate it in posterity. So long as humanity exists, so long as kind and sympathetic hearts beat in the breasts of mankind, so long as the human race is capable of estimating the worth and value of the truly great and good, so long will the name of Lister live, and the memory of him who bears it remain enshrined and held in affectionate reverence by succeeding generations.

Lord Lister in reply said :—

I thank you, Sir Joseph Dimsdale, from the bottom of my heart for your overpoweringly kind words. The work which it has been my great privilege to be engaged in has been its own all-sufficient reward. Perhaps I need not say that I value in the highest degree this, the greatest civic distinction in the world. If it were possible to enhance the honour you have conferred on me to-day this has been done by the extraordinary consideration shown by you, my Lord Mayor, and your Court for my personal convenience. Had it not been for this your extreme kindness it would have been impossible for me in my very infirm state of health to have received your gift here in this historic building.

The 18-carat gold casket in which the freedom was contained bears the following inscription :—

Presented by
The Corporation of the City of London,
with the Freedom of the City,
to the Right Honourable Lord Lister, O.M., M.D., F.R.S., D.C.L., etc.,
in recognition of his eminence as a Surgeon and of the invaluable services rendered to humanity by his discovery of the Antiseptic System of Treatment in Surgery.
Guildhall, E.C., June 28, 1907.

The end panels are decorated with emblems relating to Lord Lister's career, and on the curve of the base a series of figures symbolising scientific research are embossed.

We welcome this well-deserved honour to science, and congratulate Lord Lister upon the latest distinction conferred upon him. Men of science are gratified that the Court of Common Council has shown in such an appropriate way its appreciation of the value of scientific research to the community.

THE EXTENSION OF THE BRITISH MUSEUM.

ON June 27 the King laid the foundation-stone of the new buildings forming an extension of the British Museum. A distinguished company invited to attend the ceremony included Lord Rayleigh, President of the Royal Society, Lord Avebury, Lord Kelvin, Sir John Evans, Sir Henry Howorth, Prof. E. Ray Lankester, Sir Norman Lockyer, and Sir William Ramsay. The Archbishop of Canterbury, as one of the three principal trustees, in his address to the King, detailed the circumstances which had made the extension possible. The origin of the scheme for the extension was described in the address as follows :—

Your Majesty has graciously conferred on the trustees of the British Museum a great honour in being present here this morning to lay the foundation-stone of this, the first block of buildings of the British Museum extension. The scheme of the extension was initiated twelve years ago, when, in 1895, the opportunity presented itself for acquiring from the trustees of the Duke of Bedford's estate the property immediately surrounding the north, east, and west sides of the museum. At that time your Majesty was a trustee of the British Museum, and your Majesty was pleased to take a great personal interest in the negotiations which resulted in securing the property for the purpose of the future enlargement of this great national institution. This property consisted of the sixty-nine houses forming the western side of Montague Street, the southern side of Montague Place (the site on which this present building is being erected), and the eastern side of Bedford Square and Bloomsbury Street, and covering, with their gardens, an area of $5\frac{1}{2}$ acres. The acquisition of this property, added to the existing museum premises, put the trustees in possession of a four-square area of 13 acres, which, when the scheme of the extension shall be fully carried out, will be covered by the galleries of the completed British Museum of the future. In the negotiations for the acquisition of this property the trustees of the Duke of Bedford's estate met the proposals of the trustees of the British Museum in a most liberal spirit; and the purchase was effected without difficulty for the sum of 200,000*l.*, provided by her late Majesty's Government, the Chancellor of the Exchequer then being the late Sir William Vernon Harcourt, himself an elected trustee of the British Museum, who, both on this occasion and on others, manifested his interest in the welfare of the museum by advocating liberal treatment at the hands of the Lords of the Treasury. Five years afterwards, under the will of Mr. Vincent Stuckey Lean, who bequeathed to the trustees of the British Museum the sum of 50,000*l.*, "to appropriate at their discretion to the extension and improvement of the library and reading-room," the trustees received the sum of 45,000*l.*, being the amount bequeathed, less duty. With this sum in their hands, the trustees again approached the Lords of the Treasury and submitted a scheme for erecting the galleries, of which your Majesty is about to lay the foundation-stone, on the site of the houses forming the south side of Montague Place. There were two reasons suggesting the choice of this site. In the first place, the date of the expiration of the leases of the houses was approaching; and, next, the ground on the north side of the British Museum and contiguous to the library was that which could be most conveniently utilised for complying with the wish of Mr. Lean and devoting his bequest "to the extension and improvement of the library and reading-room." The Lords of the Treasury were pleased to give favourable consideration to the trustees' proposal, with the result that, for the purposes of the new building, the sum of 150,000*l.* was scheduled in the Public Buildings Expenses Act of 1903, in augmentation of the 45,000*l.* which passed to the trustees under the Lean bequest.

In the course of his reply to the address, the King said that during the many years that he was a trustee he took the greatest interest in the scheme for extending the Museum, and he was glad that it had been found possible to acquire sufficient adjoining property to allow of a further extension of the buildings in the future.

NOTES.

SIR JOSEPH D. HOOKER, G.C.S.I., F.R.S., celebrated his ninetieth birthday on Sunday, June 30, and received the sincere congratulations of many friends. We are delighted to see that the King marked the occasion by appointing Sir Joseph Hooker to the Order of Merit.

THE long list of honours announced on the occasion of the King's birthday includes the names of a few men of scientific eminence. Prof. E. Ray Lankester, F.R.S., has been appointed a Knight Commander of the Order of the Bath, and Dr. J. A. Ewing, F.R.S., has been appointed a Companion of the same Order. Among the four new peers is Sir James Blyth, Bart., who has rendered signal service to agricultural science, and has placed two farms at the disposal of the Government for the purposes of the investigations undertaken by the Royal Commission on Tuberculosis. With the thirty-one names of new knights are those of Prof. John Rhys, professor of Celtic at Oxford; Dr. J. Donaldson, principal of the University of St. Andrews; Mr. J. Gavey, C.B., engineer-in-chief to the Post Office; and Dr. H. R. Swanzy, president of the Royal College of Surgeons in Ireland, and formerly president of the Ophthalmological Society of the United Kingdom. Sir William MacGregor, K.C.M.G., has been promoted to the rank of G.C.M.G., and Colonel W. G. Morris, C.B., C.M.G., has been promoted to the rank of K.C.M.G. for services as superintendent of the trigonometrical survey of the Transvaal and Orange River Colonies.

MR. W. P. PYCRAFT has been appointed by the principal trustees an assistant on the permanent staff of the zoological department of the British Museum.

THE Anthropological Institute has received the King's permission to change its title to that of the Royal Anthropological Institute of Great Britain and Ireland, by which name it will henceforth be known.

SOON after 9 a.m. on June 26 Holyhead and other places in the western part of the Isle of Anglesea experienced an earthquake shock which greatly alarmed the inhabitants, and in some instances threw down pictures and crockery. The shock was accompanied by a noise like thunder, which lasted about twenty seconds. The vibration is stated to have come from the north-east.

THE council of the Royal Society of Edinburgh has awarded the Keith prize for the biennial period 1903–5 to Dr. Thomas H. Bryce for his two papers on "The Histology of the Blood of the Larva of *Lepidosiren paradoxa*," published in the Transactions of the society; and the Makdougall-Brisbane prize for the biennial period 1904–6 to Dr. Jacob E. Halm for his two papers on "Spectroscopic Observations of the Rotation of the Sun" and "Some further Results obtained with the Spectroheliometer," and for other astronomical and mathematical papers published in the Transactions and Proceedings of the society.

THE Lord Mayor presided over a meeting convened by the Bread and Food Reform League at the Mansion House on June 26. This league is organised to direct attention to the great importance of the food question, to promote the healthy nutrition of the people, and to diminish many of the diseases produced by ignorance of dietetic laws. Without advocating any special system of diet, it is desired to show the nutritive and economic importance of many neglected foods of staple value. It is believed that proper knowledge of the food value of various diets will promote health and temperance, and diminish the fearful infant mortality that exists at the present time. The meeting was addressed by the Lord Mayor, Miss May Yates (the hon. secretary of the league), Sir James Crichton-Browne, Dr. Heron, Dr. J. F. Sykes, Mr. Mayo Robson, and others.

IN reply to a question asked in the House of Commons on Monday, Mr. Haldane stated that the names of the members of Lord Rayleigh's committee now considering questions arising out of defective cordite are as follows:—

Lord Rayleigh, F.R.S., Sir J. Dewar, F.R.S., Sir A. Noble, Bart., F.R.S., Sir W. Crookes, F.R.S., Dr. J. A. Ewing, F.R.S., Dr. A. Dupré, F.R.S.—absent through illness; Major-General D. D. T. O'Callaghan, president, Ordnance Committee; Rear-Admiral R. F. O. Foote, vice-president, Ordnance Committee; Lieut.-Colonel Sir F. L. Nathan, superintendent, Royal Gunpowder Factory; Captain B. H. Chevallier, assistant to Director Naval Ordnance; Captain J. H. Thomson and Major A. McN. C. Cooper Key, H.M. Inspectors of Explosives, Home Office; and Mr. R. Robertson, superintendent in Chemist Research Department.

THE New Zealand Government is about to undertake extensive trawling of an experimental nature. Mr. L. F. Ayson, Chief Inspector of Fisheries, will be in charge, and Mr. Edgar R. Waite, curator of the Canterbury Museum, Christchurch, has been appointed zoologist to the expedition. Collections will be made of all marine products, which will be investigated, so far as possible, by New Zealand naturalists, and the material obtained will be the property of the Canterbury Museum. The committee for biological and hydrographical study of the New Zealand coast, appointed by the Australasian Association for Advancement of Science, will provide certain equipment for use in the deeper waters. The *Nora Nevin*, a new steam trawler just from the stocks at Grimsby, England, built to the order of the Napier (N.Z.) Fish Supply Co., has been chartered by the New Zealand Government, and it is anticipated that operations will extend over a period of three months.

THE annual general meeting of the Society of Arts, the 153rd since the foundation of the society, was held on June 26, Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., chairman of the council, being in the chair. The Prince of Wales was re-elected president of the society, an office which he has filled since 1901. It was announced that a committee has been appointed to make further investigation into the subject of the deterioration of paper, on which subject a committee reported in 1898. The council of the society is prepared to award, under the Fothergill trust, a gold medal, or a prize of 20*l*., for the best portable apparatus or appliance for enabling men to undertake rescue work in mines or other places where the air is noxious. Inventors intending to compete should send in a notice of their intention, together with a full description of their inventions, not later than March 31, 1908, to the secretary of the Society of Arts, John Street, Adelphi, London, W.C.

WE regret to see the announcement of the death, on June 28, at the age of eighty-two, of Sir William T. Gairdner, K.C.B., F.R.S., formerly professor of medicine in the University of Glasgow. Sir William Gairdner graduated as M.D. at the University of Edinburgh in 1845. He made numerous contributions to the science of medicine, more especially in the departments of pathology, public health and hygiene, and clinical medicine. He was recognised as one of the foremost physicians of his time, and his status in the medical profession is indicated by the fact that he was president of the British Medical Association in 1888. For several years he acted as the first medical officer of health for the City of Glasgow, and the measures he then initiated for securing the health of the community soon materially lowered the death-rate of the city, and have been adopted largely at home and abroad. Sir William Gairdner was appointed K.C.B. in 1889, and was elected a Fellow of the Royal Society in 1893. Among other distinctions, he received the degree of LL.D. Edin. in 1883, and that of M.D. Dublin (*honoris causa*), with the honorary Fellowship of the Royal College of Physicians of Ireland, in 1887. His principal works were "Clinical Medicine," 1862; "Public Health in Relation to Air and Water," 1862; "On some Modern Aspects of Insanity," "Lectures to Practitioners" (jointly with Dr. J. Coats), 1888; "The Physician as a Naturalist," 1888; and many papers in medical journals and in the transactions of pathological and medical societies.

THE death of Dr. Carl Braun, S.J., which we regret to have to announce, recalls the earnest efforts that Hungary has made of late years to assume a more prominent position in astronomical science. The late Archbishop of Kalocsa, who provided and equipped the observatory of that town, placed it under the charge of Dr. Braun, and here he worked indefatigably in those preliminary matters which are so necessary in a young institution. He mounted the instruments, determined the position of the observatory, and decided the course of future observation, which under Father Fenyi has been productive of such fruitful results. As a pupil of Secchi, he naturally turned to spectroscopic observation of the sun, and in this department the work of the observatory is well known. Such questions as the density of the earth also occupied him, and in the later years of his life he contributed papers on cosmogony. Indeed, his activity ranged over many subjects, and though he suffered much in the later years of his life, his colleagues speak of his untiring industry and continued perseverance. Dr. Braun was possessed of great mechanical ingenuity. This was manifested in the construction of, or rather suggestion for, a form of transit micrometer that reduced personal equation to a minimum, and of a plan for photographing the sun by monochromatic light, forestalling by many years the work of Hale and Deslandres.

THE annual meeting of the general committee of the Imperial Cancer Research Fund was held on Monday at Marlborough House, the Prince of Wales presiding. In moving the adoption of the report, Sir William Church said:—Our knowledge of the existence and frequency of cancer in various races of men is steadily increasing, and evidence is accumulating that its presence is not infrequently associated with native customs or religious rites which act as sources of chronic irritation of portions of the surface of the body and appear to determine the character and position of the cancerous growths most commonly met with. The information we have received lends no support to the view that cancer is associated with any particular kind of diet; populations living on a purely vegetable diet are apparently as subject to it as those whose food is of a mixed character. Resort to experiment must be had in order to trace more accurately the circumstances associated with the spontaneous occurrence of cancer both in individuals and in families. The removal by surgical means of cancerous tumours occurring spontaneously in mice prolongs their lives and has enabled us to breed from them; we have, therefore, now the means of observing descendants of mice of known cancerous parentage, and by successively crossing other spontaneously affected animals with the offspring of cancerous parents, we can concentrate the hereditary tendency, if it exists. This concentration in large numbers of animals of a known age and in a known amount should enable us, in the course of a few years, to determine whether there is a family or only an individual tendency to the disease. Other experimental investigations have been carried on; in former years we endeavoured by experiment to find out the essential features of cancer; during the past year we have been engaged in studying special problems, and more especially the relations of cancer-cells to those of the organism in which they occur. Considerable attention has been paid during the past year to the alleged cures for cancer which have come before us. I regret to say that it is impossible to ascribe a curative value to any of them. A further series of experiments with trypsin alone, or in conjunction with amylopsin or as pancreatic extract, have been made, and it appears in mice to exert no effect on the growth or development of the tumours.

We have received from Mr. Quaritch, of Grafton Street, a copy of the third part of a catalogue of rare and valuable works on natural history. The contents include works on various groups of invertebrates, on palæontology and geology, and on general biological subjects.

Supplemental notes on the mammals and a list of the myriopods of the Forth or Edinburgh area constitute the contents of No. 8 of vol. xvi. of the Proceedings of the Royal Physical Society of Edinburgh, both papers being by Mr. W. Evans. The additions to the mammal list include a bat and the Greenland, or harp, seal, a specimen of the latter having been taken in March, 1903, in the upper estuary of the Forth.

We have received copies of Nos. 1530–6 of the Proceedings of the U.S. National Museum. Among these, reference may be made to reviews of the loaches and sticklebacks of eastern Asia, by Mr. L. Berg (Nos. 1533, 1536), in which it is shown that *Misgurnus fossilis* (loach) and *Cobitis taenia* of the British Isles are represented by specifically identical forms in the Amur. The description of a new genus (Spherarmadillo) of terrestrial isopod crustaceans from Guatemala, by Miss H. Richardson (No. 1535), is also a matter of considerable interest.

In his report for 1906, the director of the Field Museum of Natural History, Chicago (the new title of the Field Columbian Museum), has to deplore the death of its founder, Mr. Marshall Field, which took place during the year under review. Mr. Field, although he held no official post in connection with it, was a constant visitor to the museum, where his commendation was always regarded by the officers as a high honour. In all departments the museum appears to be making steady progress, several new acquisitions and exhibits being illustrated in the report. Among the former, attention is directed to a series of meteorites from a recent fall in Kansas, and to a large number of vertebrate remains from the Loup Fork beds of Nebraska and Wyoming.

In connection with the preceding paragraph, reference may be made to the valuable series of catalogues of mammals compiled by Dr. D. G. Elliot, honorary curator of the zoological department of the Field Museum, Chicago, and published by the museum. While the previous volumes deal with the mammalian faunas of America, the one now before us is a catalogue of the specimens of mammals from all parts of the world in the collection of the Field Museum. Although simply a catalogue, with references to original descriptions, the volume contains a number of excellent illustrations of striking types of mammals, many of which students familiar with the subject will recognise as reproductions from well-known figures. The collection of mammals in the museum, now comprising about 15,000 specimens, has been mainly brought together by the energy of Dr. Elliot, and every specimen, with its full history, is catalogued in the present volume. Whether Dr. Elliot's views or nomenclature be generally accepted in their entirety or no, the work cannot fail to be of great value to naturalists, and the entire series of catalogues forms a monument to the untiring and ceaseless industry and perseverance of the author.

In the Scientific Memoirs of the Government of India, No. 27, Captain Patton, M.B., I.M.S., records the frequent occurrence of the Leishman-Donovan body in the peripheral circulation in cases of kala-azar in Madras, the parasite being seen in the leucocytes but not in the red blood cells nor free in the plasma. In certain cases of the disease, accompanied with extensive ulceration of the large intestine, the polymorphonuclear leucocytes are increased in number, and many of these cells contain the parasite. The parasite was recovered from certain lice allowed to bite patients, but not from several mosquitoes nor from a tick. In the Indian bed-bug (*Cimex macrocephalus*) the parasite was found in considerable numbers, and all stages of development, from the round body to fully developed flagellates, were observed. In Memoir No. 28, Captain Christophers, M.B., I.M.S., describes the sexual cycle of development of the hæmogregarine parasite of the dog, the *Leucocytozoon canis*, in the tick, *R. sanguineus*. Soon after the tick has ingested blood containing the parasites, free vermicules appear; some of these become embedded in the protoplasm of the gut cells and become stouter and more bulky. The bulky forms undergo fission into two, four, or even eight vermicules, some of which are large and sexually mature, conjugate, and form oocysts. The protoplasm of the oocyst then divides into sporozoits, but the means by which these reach and infect the dog have not been made out, as they have not been found in the ova of the tick.

A botanical exploration of the north-western portion of the county of Limerick, comprising the barony of Shanid, undertaken by Messrs. M. C. Knowles and C. G. O'Brien, has yielded several interesting plants and added many new species to the flora of the district. An account of their collections appears in the *Irish Naturalist* (June). Two notable discoveries were the grasses *Glyceria Foucaudi* and *Glyceria Festucaeformis*. A variety of *Rosa stylosa* was found in apparently native surroundings, and the same opinion is expressed with regard to the habitat of *Epilobium angustifolium*.

On the reproduction of trees from seedlings, a problem that offers peculiar difficulties to foresters in a hot, dry climate, several articles appear in the *Indian Forester* (April). The requirements of "sal" seedlings, *Shorea robusta*, with regard to soil, protection from frost and light are discussed by Mr. W. H. Lovegrove and Mr. E. M. Coventry, and Mr. L. S. Osmaston refers to experiments in connection with artificial methods for raising young trees. The discovery noted by Mr. E. P. Stebbing of the coccid *Lecanium capreae* on almond trees in Baluchistan provides the first record for India. A useful summary, by Dr. E. Nesbit, of Indian trees providing timber suitable for export is concluded in this number of the journal.

On the subject of the interrelation between the phases of the moon and the cutting of bamboos and other material, a correspondent writes to say that in Mexico and other American countries the belief is commonly and strongly held that material should be cut when the moon is waning if durability is desired. The statement is advanced on the evidence of an American ranchman, who offers the explanation that at the time of the full moon the bamboos are full of sap, and that the sap rises and falls with the waxing and waning of the moon. As mentioned in a paragraph in NATURE of February 14 (p. 377), Mr. E. P. Stebbing has met with the same belief in India, and refers to experiments made in southern India, but these were inconclusive. Seeing how widely the conviction is spread through the tropics, it would be interesting to obtain more evidence, but such evidence should be based on a systematic and carefully planned series of experiments.

FROM the *Agricultural News* we learn that the cultivation of new seedling sugar canes, as compared with the Bourbon and other varieties hitherto grown in British Guiana and elsewhere in the West Indies, shows considerable progress in recent years. From returns to hand, it appears that 28,801 acres were planted in British Guiana in seedling canes in 1906–7. The area in 1905–6 was 14,743 acres, and in 1904–5 9518 acres. Among the more important seedling varieties are the Demerara seedlings D. 109 and D. 625, while two Barbados seedlings, B. 208 and B. 147, are also largely cultivated. It is pointed out that an editorial note which appeared in the *International Sugar Journal* in May last (pp. 219–220) discussing the "Identity of Seedling Canes in Demerara," and stating that the seedling cane B. 208 cultivated on the well-known Diamond Plantation in Demerara "was not the original seedling of that variety," is without foundation. Samples of B. 208 from Diamond Plantation have since been submitted to a critical examination by the Imperial Department of Agriculture for the West Indies, and it is stated that they are identical with the original seedlings of that variety raised at Barbados.

THE Engineering Standards Committee has issued a new edition of the British Standard Specification for Portland Cement (report No. 12, price 2*s*. 6*d*.). Several alterations have been made with the view of extending the usefulness of the specification. The percentage of sulphuric anhydride has been slightly extended, the expansion under the Le Chatelier test has been reduced, and the maximum final settling time for the slow-setting cement has been increased. Other alterations have been made in the direction of rendering the meaning of the specification more clear.

ONE of the most interesting phases of the development of copper mines caused by the recent great demand for the metal and by the use of electric power has been the profitable mining of ores so poor that formerly they would have been regarded as valueless. A striking example of this is afforded by the mines of the Boundary District, British Columbia, which are described in detail by Mr. F. Keffler in a copiously illustrated article in the *Engineering Review* (vol. xxxiii., No. 3). In the same issue there are well-considered articles on efficiency in the burning of fuel under the steam boiler, by Mr. W. D. Ennis, and on the design of modern producers and gas engines, by Mr. R. E. Mathot.

WITH the *Engineer* of June 21 is issued a special supplement devoted to auxiliary machinery on merchant steamers. It contains seventy illustrations, and shows in a striking manner the remarkable changes that have been effected within recent years. The development of electricity on board ship for power purposes, as well as for lighting; the adoption of the turbine principle of propulsion for cross-Channel and ocean-going passenger steamers; the increase in the number and size of dead-meat carrying steamers; and the radical modifications in the general design and equipment of ships engaged in bulk-cargo carrying, with the view of extreme despatch in loading and discharging—all these are matters which have had distinct influence of late in modifying conventional and standard facilities and practice in respect of steamship auxiliary machinery.

THE *Mitteilungen* of the Berne Philosophical Society for 1906 contain observations of twilight phenomena and of the intensity of the magnificent Alpine glows at that place during the year, by P. Gruner. The glows were more frequent than usual, owing probably to the abnormally fine weather, but the cases of great intensity of colour were below the average. In "The Glaciers of the Alps" Tyndall pointed out that "the colouring must, in a great measure, be due to some variable constituent of the atmosphere"; we are glad, therefore, to learn that the author proposes to discuss the observations published since 1903, after at least a five years' series is available.

THE Egyptian Survey Department has decided to separate the meteorological work into two parts, the first dealing with the observations at Helwan Observatory and the second with the climatological stations, rainfall, and river data. These observations have now been published for 1904, and the reports for 1905–6 are promised shortly. Part ii. contains, in addition to the results of observations at the various stations in Egypt and the Soudan, a sketch of the climate of Egypt condensed from the discussion in "Physiography of the River Nile and its Basin," by Captain H. G. Lyons (see NATURE, vol. lxxv., p. 17). The chief climatological feature of the year 1904 is said to have been the failure of the north-east African monsoon, which was both late and weak. In Egypt itself the noteworthy features were the abnormally cool weather of spring and warm spell in October.

DR. G. PANCONCELLI CALZIA, of Marburg, is publishing in the *Medizinisch-pädagogische Monatsschrift* a summary of current literature on phonetics under the title "Bibliographia Phonetica." As the author points out, it has been necessary for specialists in this subject to consult literature extending over a wide range of other sciences in order to find the papers they want, the only guide in existence being the somewhat incomplete summary of the period 1876–1896 by Breymann. Dr. Calzia desires to receive copies of all papers or books bearing on phonetics for the purpose of abstracting, and rare and valuable books will be returned if desired.

A VERY suggestive article on the progress of our knowledge of the flora of North America is contributed to the *Popular Science Monthly* for June by Prof. L. M. Underwood. It is illustrated by figures reproduced from the early works of Porta (1591), Bock (1587), Cornut (1635), Plukenet, Micheli (1729), and Linnæus (1753). Perhaps the most noteworthy point emphasised in the article is the comparatively recent development of botany as a subject of university study. The late Prof. Asa Gray appears to have maintained a conservative spirit in regard to the study of systematic botany, and to have shown opposition to those who might have helped in the vast field of work required to be done. Thirty years ago America possessed only three professors of botany, and one Government botanist at Washington; now, both in the universities and in the Government stations, the botanists can be counted by hundreds.

UNDER the title "Tablettes des Cotes," M. Gaston Tarry publishes a triple entry table for the purpose of finding the prime factors of large numbers which are not divisible by 2, 3, 5, or 7. For this purpose the number in question is first expressed in the form $m. 20580 \pm (q\ 2 \cdot 10 + r)$. The tables headed with the numbers (Tablettes grillés) have slots cut in them which are placed over the columns headed with the columns r, and by following certain rules according to the sign in the above form, and noticing whether the figures ("cotes") in the subsequent lines of the columns are in dark or light type ("cotes grasses" or "cotes maigres"), it is possible to ascertain which of the prime numbers in the next adjoining column of the open tables are factors of the original number. We have verified the method, but the rules are a little difficult to apply at first. The tables are published by Gauthier-Villars, of Paris.

REFERRING to our note on the scientific uses of the kinematograph (NATURE, May 23, p. 87), Mr. W. F. Cooper, of Water Lane, Watford, writes pointing out the difficulties experienced by amateurs in obtaining sufficiently rapid films for the purposes of research. The fastest films he has been able to obtain have a speed of H. and D. 100, less than half that of ordinary snapshot plates. This speed is quite inadequate for the photography of operations, for in a case observed by Mr. Cooper an exposure of ten minutes would have been required. Mr. Cooper has been successful in recording the movements of blood corpuscle parasites, but the chief obstacle in the way of further progress is lack of general interest in the uses of the kinematograph on the part of scientific workers as opposed to professionals. He invites correspondence with others who have taken up this line of work with the view of producing a demand for films better suited to the purpose in the matter of speed and orthochromatic properties.

A SIMPLE lecture experiment to demonstrate the transformation of yellow phosphorus into the red variety is described by F. Zecchini in the *Gazzetta* (vol. xxxvii., i., p. 422). Ordinary dry phosphorus is melted in a glass tube 30 cm. long and 7–8 mm. in diameter by surrounding the tube with a bath of concentrated sulphuric acid the temperature of which is gradually raised to 180°. Sufficient phosphorus should be used to give about 10 c.c. of liquid. When the whole has melted, a minute crystal of iodine is added; as the crystal falls through the molten mass the immediate transformation of the latter into red phosphorus becomes clearly visible.

MESSRS. R. AND J. BECK, LTD., have published a pamphlet by Captain Owen Wheeler on "Telephotography Simplified for Naval, Military, and General Purposes." The price of the pamphlet is 1*s.* 3*d.*

OUR ASTRONOMICAL COLUMN.

COMET 1907*d* (DANIEL).—The daily ephemeris computed by Dr. E. Strömgren for comet 1907*d* is given up to July 10 in No. 4185 of the *Astronomische Nachrichten* (p. 155, June 21). The following is an extract therefrom:—

Ephemeris 12h. (M.T. Berlin).

1907	α (true) h. m.	δ (true) ° ′	Brightness
July 4	1 4·3	+5 0·0	
,, 6	1 11·2	+5 31·1	1·94
,, 8	1 18·3	+6 2·1	
,, 10	1 25·5	+6 32·9	2·17

An observation at Strassburg on June 17 gave corrections of +4s. and +0′·4, and the magnitude was estimated as 8·5 or 9·0. On that date the brightness, according to the ephemeris, was about 1·1. The apparent path as shown in the above ephemeris lies roughly between 80 and μ Piscium, and the comet now rises shortly after midnight.

PECULIAR SPECTRUM OF ϵ CAPRICORNI.—A note by Mr. V. M. Slipher, of the Lowell Observatory, on the spectrum of ϵ Capricorni (magnitude = 4·5) appears in No. 4, vol. xxv. (p. 285, May), of the *Astrophysical Journal*. Spectrograms taken last autumn showed bright lines, and more recent ones show that the hydrogen lines are paired—a dense dark line with a weak bright line above it. The dark hydrogen and the metallic lines indicate a radial velocity of about 45 kilometres for October 8, but on October 27 this had decreased to 35 kilometres, the lines being displaced towards the red. Broad and diffuse helium absorption lines are also shown, but do not participate in the displacement towards the red; in fact, measures of some of the sharper ones show a slight "shift" towards the violet, and it therefore seems possible that these, with the bright hydrogen lines, belong to one member of the system, whilst the dark hydrogen and the metallic lines belong to the second.

ATMOSPHERIC CURRENTS IN CELESTIAL BODIES.—A paper on the causes which produce different currents in the atmospheres of celestial bodies, such as Jupiter and Saturn, is published by Senor José Comas Solá in No. 4185 (p. 145, June 21) of the *Astronomische Nachrichten*. Senor Solá calls in the tide-raising effects of very small satellites revolving in close proximity to the primary to account for these atmospheric currents. Taking Jupiter as an example, these hypothetical satellites produce an accelerating effect in the superficial layers of the atmosphere near to the equator. The larger, more distant satellites produce a much deeper, retrograde current extending further from the equator, whilst in the circumpolar regions we see the normal rotation of the planet. Thus we get the shortest rotation period in the equatorial currents, and the slowest motion in the intermediate latitudes, where only the retrograding effect of the larger satellites is operating. This superposition of layers may account for the occasional passage of a mass of dark matter below the Red Spot, for, by the hypothesis, the latter, a superficial disturbance, is in the slower moving layer of the intermediate latitude, whilst the dark matter is a much deeper disturbance reaching down to the more quickly moving normal layer of the planet's atmosphere. Similarly, the proximity of rings of ponderable matter to Saturn and the sun may be held to account for the differential velocities observed in different zones of the atmospheres of those bodies.

OBSERVATIONS OF PLANETS.—In an account of the observations made on the summit of Mont Blanc during the period August 31 to September 5, 1906, MM. Hansky and Štefánik give details of their observations of Venus, Mercury, and Jupiter, made under nearly perfect atmospheric conditions. Difference in the markings seen near the poles of Venus and alterations in the contour of the terminator suggested a rotation of the planet, a suggestion which was apparently confirmed by the re-appearance of the same aspects after a lapse of nearly twenty-four hours. The two sets of observations made on September 3 and 4 gave the apparent rotation period as 23h. 20m. and 23h. 25m. respectively. Three dark spots, one at the middle of the terminator and two smaller ones near to the eastern limb of the planet, were seen on Mercury on September 5 at about 5h.

Numerous details of the observations of bands and spots on Jupiter are also given (*Comptes rendus*, No. 23, p. 1252, June 10).

THE MELBOURNE OBSERVATORY.—According to the report of the director, Mr. P. Baracchi, the astronomical work of the Melbourne Observatory for the period April 1, 1905, to November 30, 1906, was practically limited to meridian observations and the work for the Astrographic Catalogue. For the latter, the total number of satisfactory plates obtained was 191, of which ninety-three were triple-exposure chart plates and thirty-two were for the duplicate series of the catalogue; these bring the respective totals up to 588 and 487. The measuring bureau is the joint affair of the New South Wales and Victoria Governments, and the total numbers of plates measured to date are:—for Sydney, 551, containing 322,101 stars; for Melbourne, 836, containing 268,714 stars.

PAWNEE TRADITIONS.[1]

SOME time ago Mr. Dorsey, who is curator of anthropology at the Field Museum of Natural History, Chicago, undertook a series of investigations among the North American tribes of the Caddoan stock, to which the Pawnee among other Indians of the plains belong. The investigations were begun on behalf of the Field Museum, and have been continued for the last four years under the auspices of the Carnegie Institution. Of the results, one volume has been issued by the American Folklore Society, some detached articles have been published in the Journal of the same society and the *American Anthropologist*, and the present is the fourth volume issued by the Carnegie Institution. All materials in volume form are composed of traditional narratives, and it may at once be said that they form an important contribution to our knowledge of the aborigines.

A collection of native tales as extensive as that in the volume before us (it contains 546 quarto pages and 148 tales of varying length) must of necessity reveal incidentally much of native custom and belief. Especially is the religion abundantly illustrated, since many of the stories are connected either with the sacred objects or the sacred ceremonies. They profess to explain the origin of these, and are told, as a rule, only during the ceremonies. Moreover, they afford glimpses of the social organisation of the tribes and of their amusements, as well as of their more serious business of hunting and fighting. Pawnee is a word said to mean wolves, and the Pawnee were as noted for their bravery, their endurance, their skill, their untiring activity and relentless character as the animals the name of which they were proud to bear. Their religion was most actively concerned with the animals with which they came into contact. These animals were supposed to be organised in much the same way as themselves, and such of them as were articles of food were believed to give themselves willingly to mankind, always provided that they were treated with ceremonial respect and that dances and other rites were performed from time to time in their honour. From them and other animals human beings received magical gifts and more than natural powers if they obtained by prayer and fasting the favour of the chiefs of the animal lodges. Above the animals were a number of superior beings called "gods," most of them more or less vaguely conceived. At the head of the pantheon stood Tirawa, a quasi-creator, whose authority all the others acknowledged.

The word "mythology" on the title-page is a somewhat unfortunate choice. On the one hand, we do not get in this volume so complete a view of what may be called the sacred history of the Pawnee, apart from the origin of medicine ceremonies, as in Mr. Dorsey's previous work on the "Traditions of the Skidi Pawnee." On the other hand, many tales are included which can only be called mythology by an illegitimate extension of the meaning of that word. Such tales are not connected with the religion of the tribe, nor are they believed to be true. They are often concerned with the lower animals; and they correspond partly to our fairy-tales and partly to our apologues. Speaking of the stories in general, it may be said that the most superficial reader will at once recognise that in plot and incident they are to a large extent similar to those of the surrounding and allied peoples, are conditioned by their mode of life, and are peculiar to North America. At the same time many of the incidents, and sometimes whole chains of incident, are common to humanity. To mention only a few, we have the incident of the Magical Flight and Pursuit, the Task of Recognition to be performed by a husband who comes to find his bride, the story of Orpheus and Eurydice, the Swan-maiden Bride, the Transformation Fight. In the form in which they are presented they are so thoroughly native to the soil that it cannot be suggested that they are due to European intercourse. But in any case the old wild borrowing theory has long been given up as discredited. While it is admitted on all hands that transmission of stories does take place, students who are interested in the question seek proofs of transmission within saner limits.

[1] "The Pawnee Mythology" Part i., Collected under the Auspices of the Carnegie Institution of Washington. By George A. Dorsey. Pp. 546. (Washington, D.C.: Carnegie Institution, 1906.)

The second part of the work is not yet published. It is intended to include the music and text of the songs referred to, or given only in a free translation, in the present volume. It will also comprise a comparative study of the tales and incidents, in which they will be treated in their relation to "the tales of other tribes of the so-called Caddoan stock," and, indeed, to those of other American Indians. This is a very necessary complement to the author's other investigations. It is to be hoped he will also find opportunity then or very soon for a fuller description of the social organisation, the rites and beliefs of the stock than he has hitherto given. We want to know, for instance, what are the marriage-rules of the tribes, whether descent is traced in the male or the female line, what their clan-organisation is; we want full descriptions of their ceremonies, their taboos, and so forth. As already intimated, something may be gathered from the stories, but our inferences may be right or wrong; we need authoritative statements. Mr. Dorsey is so well qualified by life-long study, and by his eminence among American anthropologists, and he has given us in these collections of Caddoan traditions so much of interest and value, that he will pardon our demanding a key that shall unlock what at present remains closed. Our thanks to him are heartfelt, but they partake very largely of that gratitude which is a sense of (or at least an earnest hope for) favours to come.

E. SIDNEY HARTLAND.

PLANT DISEASES AND REMEDIES.

THE experiment station of the Hawaiian Sugar Planters' Association has issued as Bulletin No. 5[1] a remarkable publication which not only deals in a very comprehensive and thorough way with the fungus enemies of the sugar-cane, but also contains a series of valuable notes on associated insects and nematodes.

The volume has bound with it also Bulletin No. 4 of the same station, and by the same author. This bulletin is on some elements of plant pathology. In the course of the work mention is made of new blights found in the cane-fields of Hawaii, and of the new and threatening aspects of blights already known.

Part i. is introductory, and may be passed over. Part ii. deals with the root disease of sugar-cane. In this section, which covers eighty-five pages, we have a most accurate and interesting description of the strange Ithyphallus fungus, which is one of the causes of root disease. "Time alone can show," Mr. Cobb tells us, "what the relative importance of the Ithyphallus fungus will be among the root-diseases of cane." The serious losses caused by the fungus and its early history are first traced, and then the extraordinary fructifications are detailed and admirably illustrated. Then follows an account of the relations of insects to Ithyphallus. The author tells us that five species of flies, a beetle, and an ant frequent the fresh fructifications, and that some of the flies are so passionately fond of the sticky dark-green spore-mass that they can scarcely be driven away.

Dispersal of this fungus by their agency, especially in the excreta, is proved, and although the flies are not named generically, they were known to be Sarcophagidæ and Muscidæ. The work done in this subject is remarkable. It was shown that the spores are also carried in numbers on the feet. The spores from five of the fly tracks on glass were found to be 860,000 per track. Then follow notes on digestive power of flies, notes on defection (the number of spores found in a "fly-speck" was shown to be 22,400,000 in some instances); even the weight of a fly ration is gone into with wonderful exactness.

The use of lime as a fungicide is pointed out, and methods of cultivation given.

Parts iii. and iv. deal with the leaf-splitting blight and rind disease; the first-named is shown to be due to Mycosphærella. The pine-apple disease (*Thielaviopsis ethaceticus*) and the relation of certain insects and mites to it is detailed, and also the well-known yet little under-

[1] "Fungus Maladies of the Sugar Cane." By N. A. Cobb. (Honolulu: Hawaiian Gazette Co., Ltd., 1906.)

stood Eleau disease. Various experiments in the preparation and disinfection of cane cuttings and in testing cane varieties for their resistance to disease that have been carried out are recorded, and should prove most helpful to growers.

The ninth and concluding section deals with free-living nematodes inhabiting the soil about the roots of cane and their relation to root diseases. The root diseases are very serious, and in these soil-inhabiting nematodes we have organisms capable, through their punctures, of giving entrance to smaller parasitic organisms that would hasten the death of the plant roots.

The author describes no less than eighteen new species of these worms, and records five more found around the roots of diseased canes in Hawaii. They are included in the genera Dorylaimus, Tylenchus, Mononchus, Prismatolaimus, Cephalobus, &c., and one new genus, Anthonema, is described.

The whole work is excellent in every respect, not only from an economic point of view, but as an example of the thorough way in which such scientific investigations should be carried out.

The sixth report of the Woburn Experimental Fruit Farm deals with various washes used for the destruction of injurious insects.[1] Among the more important experimented with were the alkali washes, paraffins and emulsions, lime-sulphur and others in connection with the destruction of the mussel scale (*Mytilaspis pomorum*). The portion of the report dealing with the paraffin oils and emulsions will prove of great value, and also from a scientific point of view much else in the report. But some of the results do not at all agree with what growers have found, such, for instance, that lead arsenate wash badly scorches the leaves under certain conditions and at certain strengths. It has not, it seems, been found to do so in their hands.

Some interesting work on silver leaf is given in conclusion. As a scientific chemical work it is all that could be desired, but the reader must take certain results with care, for if "egg-counts" have been made taking into account the following sentence, "we certainly found a greater destruction of eggs by insecticides in the case of scales which had been thus bored (by Chalcididæ), than of those which were intact," then we must discount some of the results obtained. Some of the opening remarks might with advantage have been excluded by the authors.

But in spite of these few blemishes there is much useful reading, and horticulturists are indebted to the authors for their kindly interest, which we hope to see continued, for it is the first attempt at anything like sound treatment of the subject.

FRED. V. THEOBALD.

THE POSITION AND PROSPECTS OF CHEMICAL RESEARCH IN GREAT BRITAIN.[2]

The Status of Original Research.

TO all who are familiar with the influence of scientific progress on the evolution of civilisation, that is, to all students of the history of modern science, the general want of appreciation of research here cannot but be a matter of profound wonderment. It is not my intention to attempt an analysis of the causes of this public apathy on the present occasion. We must, I am afraid, deal with it as an accepted fact. Attention has from time to time been directed to this national weakness by the Press and by publicists whose influence should carry conviction to the lay mind. We can, no doubt, remember weighty utterances by statesmen such as the Duke of Devonshire, the late Lord Salisbury, Lord Rosebery, Mr. Chamberlain, Mr. Balfour, and, above all, in recent times, Mr. Haldane, who loses no opportunity of driving home the lesson of the importance of science and of scientific method to the national welfare. Nor have our scientific workers themselves failed to sound the note of alarm with all the authority of expert knowledge. But, in spite of these individual efforts, it cannot be said that we have made much headway; public interest in scientific research may still be considered to be on a low level—certainly lower here than in many other leading nations, and most decidedly lower than is desirable in the best interests of our country. A temporary flicker of excitement is caused when some sensational discovery is announced, or when some result of immediate practical (commercial) value is made known, but even in these cases the interest taken is only transitory and is narrowed down to the immediate issue; the broad cause which makes such results possible is lost sight of. The steady, plodding work which culminates in great discoveries is being carried on quite unheeded by the general public, and the workers themselves are practically unknown outside the ranks of science. Research as a "cult" is not understood; the national attitude towards the workers is one of "payment by results" in the very narrowest sense of the term.

How this state of affairs is to be remedied is a knotty question which I confess appears to me somewhat hopeless of solution at the present time. It may be that by persistent attack from within and the pressure of competition from without the country will, in fact must sooner or later, awaken to the situation. It may be that science will have to become more self-assertive and make its influence felt as a political power. There is need here, as has been often suggested, for a minister corresponding to the "Minister of Public Instruction," or the "Cultus-Minister" of other countries. The newly formed "British Science Guild" may fairly be expected in the course of time to help us in raising the level of public opinion towards the importance of research, this being, in fact, one of the primary objects for which this organisation has been founded.

The Jubilee of the Foundation of the Coal-tar Colour Industry and its Lessons.

The exaltation of scientific research into an abstract principle or "cult," which is the keynote of the remarks which I have put together for your consideration on this last opportunity when I shall have the honour of addressing you from the presidential chair, is, of course, a familiar subject to all who keep in view the objects of a society such as this. If I venture to formulate the principle somewhat more emphatically on this occasion, it is that the international gathering, which took place here last summer in honour of our distinguished past-president, Sir William Perkin, and in celebration of the jubilee of the foundation of the coal-tar colour industry, has given rise to many considerations which are intimately associated with the subject of this address. Although at that memorable assembly the voice of the nations was raised in gratitude for and in recognition of the numerous benefits arising from the establishment of a great industry, we must not forget that below the chorus of praise and congratulation, so justly sounded in honour of the founder, there was flowing an undercurrent of thought which, in some of the addresses and speeches, found verbal expression—the thought that this industry owed its existence to scientific research, and that it had been developed into its present magnitude by the never-ceasing applications of research. Speaking generally, it may be said that all the great steps, the new departures in the industry of coal-tar products, have been the outcome of pioneering work carried on in the first place without immediate reference to practical results. All honour to those who have developed these results into manufacturing operations, but honour in the first place to the scientific pioneers! This is the real lesson taught by the celebrations of last July. It may be of interest to consider in the next place how far this lesson has been learnt here on the one hand by the scientific public and on the other by the general public.

That the lesson has not been learnt by those who are most immediately concerned, the manufacturers themselves, is sufficiently apparent when we compare the enormous development of the industry in Germany with its comparatively small development here and its decadence in France, once an active centre and a successful competitor with us in the manufacture of coal-tar colouring

[1] "Sixth Report of the Woburn Experimental Fruit Farm." By the Duke of Bedford, K.G., and Spencer U. Pickering, F.R.S. Pp. v+235. (London: Eyre and Spottiswoode, 1906.) Price 4s.

[2] Abridged from the Presidential Address delivered at the annual general meeting of the Chemical Society on March 22 by Prof. Raphael Meldola, F.R.S.

matters. With respect to the public attitude, it may be said that such appreciation of Perkin's work as was expressed through our Press was just what might have been anticipated in a country where the true position of scientific research is imperfectly understood. The rejoicing was over the purely practical achievement—the discovery of the convertibility by chemical processes of so many otherwise useless tar products into saleable articles of commerce. The public cannot, as matters now exist in this country, go behind such proximate results. Moreover, the limitation of the appreciation in this way brings out very clearly the difficulties which must be encountered in any attempt to raise the status of scientific research in general, and of chemical research in particular, in the national estimation. Consider, by way of contrast, the works of the *littérateur* or artist; these appeal directly to the public or to some section of the public, and can be appreciated according to their merits. Not so the labours of the scientific investigator; his achievements are measured solely by the utilitarian standard; he is, as I said before, paid strictly by results. In other words, while literature and art have taken their position as "cults" in all civilised nations—a position to which they are fully entitled—science is judged by a lower and narrower standard, and certainly cannot be said to occupy in this country the same position as its sister branches of culture.

My contention is that scientific research, like every other branch of human culture, is worthy of national homage, whether it leads to immediately "practical" results or not—that its position in the scale of civilising agencies is not dependent upon such occasional stimulants as the jubilee of the foundation of a new industry or the announcement of a sensational discovery which furnishes materials for newspaper paragraphs. It would, I think, be generally admitted that any country which limited its appreciation of research to such branches of science as were likely to lead to industrial developments was on a low level in the scale of civilisation.

In maintaining the principle that scientific research has been, is being, and can always be carried on independently of its practical applications, I have no desire to give countenance to the view, somewhat prevalent, I fear, in this country, that there is some kind of antagonism between pure and applied science; that the scientifically trained chemist, for example, and the "practical" man, instead of being allies, as they should be, are in opposition. The days when such notions were held are, happily, passing away; if but slowly in this country much more rapidly abroad. My plea simply amounts to a claim for the re-adjustment of the positions of pure and applied science in the public estimation. The course of industrial development in the future is bound to become more and more interwoven with the development of pure science, and the perpetuation of erroneous ideas on this point cannot but act injuriously on both causes. In our own domain it is absurd to suppose that there is any antagonism between the two aspects of chemistry. Far from this being the case, it may safely be asserted from the experience furnished by the coal-tar industry that the rate of progress is actually measurable by the degree of substitution of pure science for empiricism. Those manufacturers who fail to recognise this principle do so at their own peril; those who have realised its truth cannot but admit that the more enlightened views respecting the function of science in the factory have been largely due to the influence of Perkin's work and example half a century ago.

Chemical Research in Educational and Manufacturing Centres.

I do not propose dealing in detail on this occasion with the very large question of the position of research in our universities, but putting the case broadly, we should, I think, all agree that after making allowance for the few noteworthy exceptions, the actual contributions to our science from these centres are far below the standard, both of quality and quantity, which might be expected and which we should all like to see attained. If any doubt on this point should exist, it is only necessary to call to mind the productive activity in the Continental universities as compared with our own. Judged by this standard, there can be only one conclusion—that many of our universities are distinct failures as centres of chemical research, and that the total output of work from university laboratories is by no means worthy of the great traditions of this country as a pioneering nation in scientific discovery. If these seats of the highest learning, called into existence for the dissemination and promotion of knowledge, can give such a comparatively poor account of their achievements in chemistry, it is evident that there must be deterrent causes at work. It would be going beyond my province to attempt a detailed analysis of these causes here; they are numerous and not easy to deal with in a limited time, but some of them are of the same nature as those affecting the position of chemical research in other educational centres. They may be summed up under such headings as ancient traditions, defective educational methods, want of sufficient means leading to the frittering away of the research faculty by the drudgery of "coaching," the poor outlook for chemical research as a career, and the pedantic notion that a subject requiring for its advancement something akin to manual labour is derogatory to high scholarship. Behind these causes is the general public ignorance of and apathy towards research, to which I referred at the outset, and if I may paraphrase the utterances of recent authorities in the educational world, over them all is the trail of the examining board.

If we ask whether the modern educational development brought about by the technical education movement has fulfilled our expectations with respect to the advancement of chemical science, I for one must confess to a feeling of profound disappointment. There may be better times ahead when that era of public enlightenment dawns, but at present, with a few notable exceptions, these twenty-three London polytechnics are, on the whole, so little productive that we may discount them as active centres of research. It must be remembered, moreover, that this class of institution has spread all over the country, and that the total expenditure in the way of money and teaching energy is so great in comparison with the output of original work that chemists have every right to ask why this state of affairs should exist.

Turning now to the consideration of the causes of this failure on the part of the new educational establishments, I must, in the first place, guard myself against the imputation that I am disparaging their work. The most acute form of disappointment is that which is experienced when we find weakness where we had looked for strength, and in emphasising their weakness from our standpoint I am not shutting my eyes to their usefulness in other directions. It is not a depreciation of the work which they are doing if we deplore their failure in another branch of work which they might be doing. From what I know of these institutions, and from information furnished by very good authorities, I am satisfied that in some directions, and more especially in connection with engineering and trade subjects and handicrafts—in all of which the artisan is an important element—they are doing a certain amount of good to the various industries concerned. But the danger for us is the general tendency in this country to ram the whole scheme of education into one mould, utterly regardless of the fact that the requirements of, let us say, an engineer are quite different from those of a chemist. It is for this, among other reasons, that our subject has suffered both in its scientific and industrial aspects, because the time and energy of the teachers of chemistry in these institutions are so largely frittered away in what might be called inconsequential labour on behalf of a class of student quite unprepared by previous training for assimilating the principles of our science and for the most part unable to give sufficient time to the subject to acquire any real working knowledge of it.

There is another factor to be added to those which are acting detrimentally towards the cause of research in these institutions, and that is the want of sufficient endowment. I am afraid that it is characteristic of our countrymen to neglect the most important interests until they are forcibly awakened to their danger, and then to try and make up for past neglect by rushing precipitately into the first plausible scheme that is presented. There is no doubt that the new educational development suffered much at the outset from this characteristic mode of procedure. The wrong kind of person was often allowed to frame the educational policy; the financial strength was exhausted in buildings and equipment, and the efficiency of the staff given only secondary consideration. We, of course, know that success in such educational work depends entirely upon the individual teacher—that the best mode of creating a school of chemistry, or any other subject, is to follow the advice of the late Sir William Flower with regard to the establishment of a museum: "First find a curator and let him build his museum around him." Had this principle been more generally adopted, the new institutions might by this time have been playing a really important part in the development of chemical science and chemical industry. As matters are, inadequate provision for maintenance having been made, the general standard of educational work is lowered in order that the grant-earning requirements of some examining board may be met, and as a result the establishments have to be run as purely business concerns.

There are other minor evils acting as retarding influences with respect to our subject and arising from the same cause, namely, the necessity of conducting these newer institutions, more or less, as commercial establishments. The prevalence of the "business" spirit among the committees and governing bodies gives an exaggerated importance to what may be called the office staff—the registrars and clerks. The work of the office staff is capable of being appreciated by the average committeeman, while the work of the scientific staff is generally beyond his comprehension, except so far as it can be measured by financial gain to the institution. It is not sufficiently realised that men of business and administrative ability are by no means rarities, while really good teachers of science are much scarcer, and men who combine both the qualifications of a good teacher with the inspiring zeal of an original investigator are rarest of all. Now if, as was professedly the case, the modern departure in technical education had for its object the improvement of the industries, then it is sufficiently well known to us here that the future of our subject is with the men of the latter class, and the joint exertions of all the registrars and clerks, backed by the efforts of the most skilful chemical pedagogues who get through their syllabus within the session and earn the largest grants or score the highest percentage of successful "passes," will never raise the level of this country either in chemical science or chemical industry.

It is sometimes stated that it was never contemplated that research should be carried on in these institutions—that this was the duty of the higher educational establishments. So it is the duty of the higher educational establishments, but the very fact that these are enabled to discharge their duty in a most imperfect way should have stimulated the newer institutions to make every effort to redeem our credit by making adequate provision for research. I will not venture to intrude my opinions concerning the vitalising influence of research upon other scientific subjects, but with regard to our own I have not the least hesitation in declaring the belief that a school of chemistry which is not also a centre of research is bound to degenerate and to become a mere cramming establishment not worth the cost of the maintenance. It is easy enough to follow the actual course of the degeneration process in such an institution. The teacher, who may be a man of real ability and who has entered with the hope of finding time and opportunities for research, finds himself, sooner or later, in the position of a chemical schoolmaster. The predominance of the business influence in the institution not only leads, as I have already indicated, to the lowering of the level of the instruction and to his own consequent degeneration, but he is, as a further consequence, so overweighted with business and administrative work that these, superadded to his teaching duties, leave him neither time nor energy for original work. The spirit of research within him is strangled by officialism, and his teaching faculties deadened by the monotonous toil of the annually recurring drudgery of routine teaching.

The scale of remuneration also does not enable these institutions to command the services of the best teachers, although I do not think that this is the chief deterrent cause, as there are numbers of young chemists of first-rate training and ability who would be quite willing to devote their time at the outset of their career to acquiring teaching experience in these establishments, even at some personal sacrifice, if facilities for research were given. In the present state of affairs one can only marvel at the fact that so many men of ability can be found willing to take service in these newer institutions, the more especially as, apart from the absurdly inadequate remuneration often given to the chiefs of the chemical departments, the payment of the subordinate members of the staff is generally on a scale which is nothing short of a scandal to the wealthiest of European nations. Considering the long course of training necessary to produce a competent teacher or demonstrator, and in view of the actual amount of work expected from these men who, by virtue of their attainments and position, are compelled to live up to a standard of high respectability, it seems almost incredible that the average scale of remuneration should not exceed the wages earned by an artisan, and is often below that standard.

According to the "Official List of Appointments" published by the Institute of Chemistry last year, there are on the staffs of the London and suburban polytechnics about fifty-four trained chemists. To these may be added 237 engaged in teaching in similar institutions in provincial centres throughout the United Kingdom. In one respect the hopes of those who expected great opportunities for chemists from the new departure in technical education have been realised. At the present time there are in this country in round numbers some 290 posts available for teachers of chemistry, which posts have actually been created by the latest movement in technical education. If now we ask whether the output of original work from these 130 centres is representative of the productive power of the 290 teachers, there can, I think, be only one answer, and that an emphatic negative. An examination of the lists of teachers in these centres shows that only about twelve out of the total number are carrying on research, and most of these in a desultory way. It is evident that there is justification for my complaint that there is this submergence of creative faculty going on all over the country; the nets have been spread and the capacity has been caught, but so far with comparatively little effect upon the development of new schools of chemical research.

The consideration of the question of the position of factories as centres of research is intimately bound up with the educational side of the subject, because we have to deal now with the educational establishments which are supplying the chemists for our factories. The feeders of the chemical factories are the universities and technical schools, British and foreign, and the question before us as the custodians of research is whether the absorption of the chemical talent from these sources by the factories is justified from the industrial point of view—whether these products of modern training, having entered into such careers, are being used to the best advantage. In other words, is that wastage of original faculty which, as I have endeavoured to show, is going on in the educational institutions, going on also in the factories? Whether the total number of chemists employed in our factories is what it should be is a point for the manufacturers themselves to consider. Even the extreme estimate of 1500 does not seem a very large chemical staff for the whole of the factories of Great Britain. In the German colour industry alone, according to information supplied to us seven years ago as jurors for the Paris International Exhibition, five of the great factories were employing 557 chemists—real scientific chemists, and not mere testing machines such as are dignified with the name of chemist in many of our factories.

From my own experience as head of the chemical department of a technical college, and with some knowledge of the requirements of chemical industry, I can state that the newer technical education, when conducted in the form of organised courses of day instruction extending over several years, has enabled us to capture a large amount of chemical capacity. Of the total output of trained chemists from the various institutions, a fair proportion—a number quite equal to the average in other countries—are possessed of the research faculty. We have seen what becomes of this when such men throw in their lot with the educational establishments. Are not we, the teachers, justified in asking whether the prospects of developing this faculty in our factories are such as might be reasonably expected from the known requirements of chemical industry?

In answer to this question I am afraid we must come to the conclusion that here also there is an enormous submergence of research talent going on. It is true that the position is improving—that some of our more enlightened manufacturers have realised the value of such men, and by taking advantage of their faculties have improved their various industries. But these cases are as yet exceptional, and the ideal will never be reached until the research laboratory becomes a recognised and well-staffed department in every chemical factory. Do our factories possess departments which can honestly be described as centres of research in the sense, say, of the research laboratories of the German colour factories? I am afraid not; indeed, I know of scores of young men of great promise and ability who have been swallowed up by the factories and gradually degraded, in the chemical sense, into mere machines carrying out routine work which really required no elaborate chemical education for its effective performance. There is, of course, no satisfactory means of measuring the influence of the newer education upon the chemical industries of this country, and we can only speak from individual experience concerning the careers of our own students. It is upon this experience that I base the conclusion that our country is wasting its resources in a most reckless way so far as concerns the chemical industries. There is an enormous amount of talent available if our manufacturers would only utilise it in the right way. It has frequently been pointed out how, on the Continent and in America, the educational establishments and the industries are brought into relationship by the cooperation between the manufacturers and the teachers. Here, so far as chemical industry is concerned, such cooperation is practically unknown, and, as a consequence, there exists more or less distrust where there should be confidence, and both the educational and the industrial sides of our subject are crippled. This is perhaps the most powerful influence at work in this country in checking that development which follows normally from cooperation between the representatives of science and of industry.

Checks to the Wastage of the Research Faculty; Research Funds and Scholarships.

Turning now from the consideration of the various deterrent influences, we may in the next place deal with such counteracting agencies as are available in this country. It is clear, from our point of view, that any means by which the research faculty, having once been captured, can be given free scope for development, must be a distinct gain to our cause. All who have had to do with the training of chemical students must in the course of their experience have come across young men of exceptional talent as original workers. We are concerned more particularly with the utilisation of this faculty for the promotion of our science and with the maintenance of the principle that the submergence of this faculty means so much dead loss to the national resources. Now it unfortunately happens that many of the men thus gifted come from stations in life which render it imperative that they should proceed at once from the college to some bread-winning occupation. A few may perhaps be lucky enough to find appointments in which there is scope for the development of their faculties, but I am afraid the majority do not; they undergo that process of extinction as original workers which I have already dealt with. One of the most valuable counteracting agencies, and one the importance of which, from our standpoint, cannot be overestimated, is that system of awarding research scholarships to men of proved ability so as to enable them to carry on original work after finishing their college training. The value of this most rational method of endowing research is due mainly to the fact that the right men are captured in the right way; they are not, as it were, squirted promiscuously out of an examination mould, but they are selected by the teachers who have had them under observation during the whole course of their training and who know their real as distinguished from their examinational capabilities.

The other agency working against the stream of adverse influences is to be found in the various funds from which grants are made to individual workers for the prosecution of particular researches. There are three such funds available for the promotion of chemical research, the Government Grant Fund of the Royal Society, the grants distributed annually by the British Association, and the income derived from our own research fund. Of these, the two former have to be distributed over every branch of science, and chemistry takes its chance with other subjects. The total amount available for chemical research is not very large, and all who have served on the committees of any of these funds know very well that the amount applied for is generally much in excess of the sum available for distribution. The main difficulty of administration is, in fact, the equitable pruning of the various applications.

With regard to the results obtained through the research fund of this society, the present occasion is in every way opportune for directing attention to our achievements and to our needs. The income derived from this fund has hitherto enabled us to distribute annually a sum of about 220*l.*—a very modest amount considering the number of claims and the activity of our workers. Of the value of the assistance thus given we are, of course, all thoroughly aware here, but it may not be generally realised by the outer public what an enormous amount of good work is being promoted by the judicious administration of this very modest income. In order to get at the actual facts, our assistant secretary, Mr. Carr, has been so good as to prepare a table covering the eight years from 1898 to 1905 inclusive, and setting forth for each year the sum granted, the number of grantees, the total number of papers published by the grantees in our Journal or elsewhere, and other particulars which will be found in the table itself. From this it appears that 151 grantees during that period published 203 papers, thirteen failed to publish, ten have not yet published, and eighteen grants are still in the hands of the grantees. The total amount granted was 1770*l.*, so that for this expenditure we have actually given to our science 203 papers, and more may be expected from those who still have grants in hand or who have not yet published their results. The figures as they stand, and even if nothing further is achieved, show that the grants average from 8*l.* to 9*l.* per paper, and, as we all know, each paper represents the results of at least one and frequently of several years' work. It is not going too far to say that there are no funds giving such substantial returns for so small an expenditure as these research funds, and their importance as aids to the advancement of knowledge cannot be overestimated.

With the additional capital by which our fund has been increased, the total income available for grants will be about 330*l.* per annum. In view of the demands upon that income it is obvious that even now we are possessed of but very limited means, and that the research fund committee will still be compelled, as has hitherto been the practice, to allot the grants for the purchase of materials or special apparatus. But, in addition to the promotion of research by the means indicated, there is another, and, according to my view, an equally valuable method, for assisting our workers in the prosecution of their researches, and that is the allotment of personal grants to enable the grantees to secure skilled assistance —to purchase, in fact, the services of human material as well as chemicals and apparatus. It is only want of sufficient income that has hitherto debarred the use of our fund in this way. I am so confident that an extension of our means towards this end would be productive of a most notable increase, both in the quantity and quality of the chemical research done in this country, that I have no hesitation in placing upon record the opinion that the next step taken in the forward policy of the Chemical Society ought to be in this direction. To do much good in the way of making personal grants we should, of course, require to capitalise a very large sum; we want an income of thousands instead of hundreds, and I confess that I see no immediate prospect of realising this dream. But there can be no doubt that for those who have the interests of our science at heart there could be no better method of subsidising research.

The general conclusion which appears to be justified by this inquiry into the position and prospects of chemical research is, that the position here is by no means as satisfactory as we could wish—that much more might be done if the conditions were made more favourable for our active workers. In view of the actual achievements, accomplished in spite of the existing disabilities, it appears that the prospects for this country as a home of chemical research have been improving during the last decade with greater rapidity than at any previous period in the history of our society. But it is also obvious that there is much work yet ahead of us before the environment in which our workers find themselves is properly cleared from obstructions.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A large and brilliant company assembled in the Sheldonian Theatre on Wednesday, June 26, to celebrate the Encænia. The recently elected Chancellor, Lord Curzon, presided. Reverting to a practice which has been discontinued for some years, the authorities reserved a portion of the upper gallery for undergraduates. Honorary degrees were conferred upon a number of men of distinguished eminence. The following is the text of the speeches delivered by Prof. Love in presenting the recipients of the degree of D.Sc. *honoris causa*. Dr. Ludwig Mond, F.R.S., upon whom the honorary degree of D.Sc. was to have been conferred, was unable to be present.

SIR RICHARD DOUGLAS POWELL, BART., K.C.V.O.

Humani generis defensor contra phthisim, pestem omnium tæterrimam, inventus est Ricardus Douglas Powell. Qui vir cum medicinæ se dedisset, ac præsertim huius morbi causas cognosceret, remedia excogitaret, curandi modos quos optimos esse iudicarat re probaret, summam gloriam et scientia et scriptis assecutus est. Difficile est pro meritis eum laudare qui nihil in vita egerit nisi ut laborantibus salutem afferat: illud brevissime dixerim hunc esse quo ne reges quidem nostri carere possint, seu adversa valetudine utantur, sive prospera. Fuit enim Reginæ Victoriæ nobis nuper ereptæ medicus ordinarius, et nunc Edwardo, regi nostro dilectissimo, medicus extra ordinem est. Viri merita declarat collegarum iudicium, a quibus Regalis Collegii Medicorum Præses factus est; declarant honores inusitati a rectoribus nostris collati, qui eum Baronettum et amplissimi ordinis Victoriani militem commendatorem creaverunt; declarant tacitæ tenuiorum gratiæ, quorum necessitatibus in maximis Londinii valetudinariis hic medicorum princeps ministrat.

SIR NORMAN LOCKYER, K.C.B., F.R.S.

Inter eos qui solis stellarumque natura quæ sit optime docuerunt primarium fere locum occupat Josephus Norman Lockyer. Dies me deficiat si miracula ab eo prolata de mundorum origine, de ratione quæ inter solis maculas et orbis terræ tempestates intercedat, si legationes solis defectus observandi causa in loca remotissima missas enumerare coner. Ex tot rebus gestis sumam duas tantum. Quadraginta abhinc annos duo viri, uterque suo Marte fretus, Jannssen in Gallia, in Britannia hic noster, instrumenta effinxerunt quibus usi flammas illas ingentes, quas e sole excurrere videmus quando eius orbi luna officit, sole non obscurato cernerent. Cum ex harum flammarum observatione multum de materia e qua sol constat colligi possit, res tanti habita est ab Academia Gallica ut numismate impresso insigniretur. Altera huius viri laus est singularis quod Acta Hebdomadalia, in quibus quicquid novi in omni Scientiæ Naturalis genere a viris doctis ubique repertum est enarratur, conscribenda curabit: qua in re cum summam diligentiam et peritiam præstaret, de omnibus qui scientiæ promovendæ student optime meritus est.

SIR WILLIAM RAMSAY, K.C.B., F.R.S.

In tenebris fere incognitis quæ inter Chemiæ et Physicæ fines intercedunt nemo certius insistit quam Willelmus Ramsay. Testis est illa Baronis Rayleigh vox in hac urbe tredecim abhinc annos audita, qui, cum vaporem incognitum quendam in aere esse confirmaret, hunc virum inventi socium esse dixit. Rariora posthac metallorum genera hic noster perscrutatus est, si qua huius vaporis vestigia deprehenderet; invenit autem non ipsum quidem vaporem sed metallum quoddam quod Helium vocant: hoc in sole exstare iam notum erat, nemo ulla eius apud nos indicia umquam odoratus est: mox cum de aeris natura subtilius quaereret, tres vapores novos detexit. His annis mirae eius metalli quod Radium appellatur virtutes et mutationes multorum animos commoverunt: hic vir exstitit qui stabile illud, quod ex his mutationibus gignitur, Helium esse ostenderet: quo facto causas quibus solis calor atque lumen per sæcula innumerabilia alitur illustrare potuit.

SIR WILLIAM HENRY PERKIN, F.R.S.

E conchis, radicibus, plantis, insectis antiqui pigmenta extrahebant, Willelmus Henricus Perkin inventus est qui ex carbonibus decoctis idem faceret, tanto successu ut hodie vel plantis vel animalibus supersederi fere possit. Quid? Nitidissimi calores quibus fulgent tot formosæ, quæ circumsedunt, dominæ, Doctorumque nostrorum vestes, quæ avium silvas Indicas incolentium plumas æmulantur, unde, quæso, hic splendor omnis profectus est nisi ex invento quod hic noster fecit, cum puer esset annos septendecim natus? Multi sunt, ut hunc omittam, qui ex hoc reperto divitias comparaverint, in Germania præsertim, ubi mercatores ita doctrina instituti sint ut inventa in usum convertere possint, et ea sit vectigalium ratio ut artificia nova pecuniis publicis adiuventur. Inventor ipse satis iam locupletatus se scientiæ totum dedit: lucis quidem repercussæ et ex alia re in aliam conversæ rationem et vim occultam nemo magis intellegit.

PROF. WATSON CHEYNE, C.B., F.R.S.

Rationum Listerianarum, ut cum chirurgis loquar, quasi personam gerit Willelmus Watson Cheyne, qui et in his constituendis inventoris socius fuerit et in exercendis multo longius progressus sit. Rebus in Africa Australi turbatis hic ad bellum profectus est civilis chirurgus cuius ope et cura milites uterentur. Dolendum est eius peritiæ tantum tum patuisse campum, medendi rationibus tantum fuisse opus: illud profecto gaudendum, hunc virum præsto fuisse qui sauciorum cruciatus leniret, quique chirurgiæ ratione usuque omni instructus multorum vitam conservare posset: nullo quidem in bello antea gesto tot e vulneratis redire potuisse notum est. Hodie pace confirmata chirurgiæ rationes optimas exponit, dumque multitudinibus in magnas urbes congregatis succurrit, diligentiam peritiamque suam difficillimo belli tempore probatam vir strenuus præstat.

MANCHESTER.—At the annual degree ceremony on June 29 the honorary degrees were conferred upon Baron D. Kikuchi and Prof. G. E. Hale, the presentation addresses being delivered by Prof. A. Schuster, F.R.S. Baron Kikuchi worthily upholds the spirit of open-minded fraternity which unites the universities of the world. A graduate of Cambridge, he has occupied the chair of mathematics in the Imperial University of Tokyo, and through his studies of the older mathematicians of Japan he has taught us interesting facts as to their methods of investigation. He has held the position of president of the Imperial University, and of Minister of Education; he has represented his country at important international conferences, and taken an active part in introducing a scientific system of weights and measures into Japan. Prof. G. E. Hale was formerly director of the famous observatory of the University of Chicago, built and equipped by the late Mr. Yerkes, and is the organiser and director of the Mount Wilson Solar Observatory, on the crest of the Sierra Nevada.

It is of interest to note that the M.Sc. degree was conferred upon the exceptionally large number of sixty-three candidates. Under the new regulations, the master's degree in science is only obtainable upon satisfactory completion of post-graduate study or research, and there is thus every indication of the success of the scheme in increasing the spirit of research in the University.

MR. J. STRUTHERS, lecturer in agriculture and chemistry in the West of Scotland Agricultural College, Glasgow, has been appointed secretary and agricultural chemist in Japan to the Asociación Salitrera, and leaves in August to take up his new duties in Tokyo.

THE offer of nomination for appointment by the Crown on the governing body of the Imperial College of Science and Technology has been accepted by the Earl of Crewe, Lord President of the Council; Mr. Gerald W. Balfour; Sir Francis Mowatt, G.C.B.; Sir Julius C. Wernher, Bart.; Sir William H. White, K.C.B., F.R.S.; and Dr. MacAlister, principal of the University of Glasgow. The other persons nominated as first members of the governing body are:—by the President of the Board of Education, Mr. A. H. D. Acland; Mr. F. G. Ogilvie, C.B., a principal assistant secretary of the Board of Education; Mr. J. C. G. Sykes, an assistant secretary of the Board; and Dr. R. T. Glazebrook, F.R.S., director of the National Physical Laboratory; by the University of London, Sir E. H. Busk, past Vice-Chancellor of the University; Prof. Capper; Prof. Farmer, F.R.S.; Sir Henry E. Roscoe, F.R.S.; and Sir A. W. Rücker, principal of the University; by the London County Council, Mr. A. A. Allen, M.P.; Mr. H. Percy Harris, chairman of the Council; Sir C. Kinloch-Cooke; Mr. R. A. Robinson; and Mr. J. T. Taylor; by the City and Guilds of London Institute, the Earl of Halsbury, F.R.S., chairman of the council of the institute; Sir J. Wolfe Barry, K.C.B., F.R.S.; Sir Owen Roberts, clerk to the Clothworkers' Company; Sir Walter S. Prideaux, clerk to the Goldsmiths' Company; and Sir John Watney, hon. sec. of the institute; by the Royal Commissioners for the Exhibition of 1851, Viscount Esher, G.C.V.O., K.C.B., and Lieut.-Colonel Sir Arthur Bigge, G.C.V.O., K.C.B.; by the Royal Society, Sir Archibald Geikie, F.R.S.; by the professorial staff, Prof. Tilden, F.R.S., Prof. Gowland, and Prof. Dalby; by the Institution of Civil Engineers, Sir Alex. B. W. Kennedy, F.R.S., president of the institution; by the Institution of Mechanical Engineers, Mr. T. Hurry Riches, president of the institution; by the Institution of Electrical Engineers, Mr. R. Kaye Gray, past-president of the institution; by the Iron and Steel Institute, Sir Hugh Bell, Bart., president of the institute; by the Institution of Naval Architects, Dr. F. Elgar, F.R.S.; by the Society of Chemical Industry, Dr. E. Divers, F.R.S., past-president of the society; by the Institution of Mining Engineers, Mr. A. Sopwith, past-president of the Institution; and by the Institution of Mining and Metallurgy, Mr. W. McDermott, past-president of the institution. The draft charter for the establishment of the college will be submitted to His Majesty for approval at the council fixed for July 6.

THE Board of Education has published (Cd. 3538) a summary of figures relating to State-aided secondary schools in England. The number of schools dealt with in the summary is 600, but in addition to these there are ninety-three secondary schools provisionally recognised by the Board or seeking recognition, though these are not included. The total number of scholars, excluding pupil teachers, in the 600 schools is 104,938. About 80 per cent. of the total number of scholars are fifteen years of age or under, and the remaining 20 per cent. represent the number of pupils in State-aided secondary schools more than fifteen years of age. About a quarter of the total number of pupils in these secondary schools previously attended public elementary schools and are paying no fees in the secondary schools, while 54 per cent. of the total number previously attended public elementary schools. It is important to remember that the curriculum of secondary schools receiving grants from the Board of Education is dominated by a four years' course of work designed for children who will remain at school until they have completed their sixteenth year at least, and that no grants are paid for pupils under twelve years of age—nearly a quarter of the above total—nor for those who have completed the approved course. There seems, in fact, to be little relation between the character of the prescribed course and the special needs of the majority of the children. If 80 per cent. of the pupils finish their school life at fifteen or under, the curriculum might with advantage be modified in such a way that thoroughness and completeness in a few fundamental subjects may be secured by the majority of the pupils rather than to allow them to fritter away their few valuable years in beginning a course of work which is doomed to be left unfinished and from which little advantage can be gained.

NUMEROUS handsome bequests have been reported in *Science* during the last three months, and in addition to specially large gifts there has been a continuous record of munificence as represented by sums which are small only when judged by American standards. Among other large amounts, the following deserve special mention:—Creighton University has received 500,000*l*. under the will of the late Mr. J. A. Creighton; Teachers College, Columbia University, has been presented with 80,000*l*. by an anonymous donor, and 60,000*l*. under the will of the late Mr. F. P. Furnald. The State Legislature has provided the University of Alabama with 80,000*l*. for buildings and 5000*l*. a year for maintenance. Dartmouth College benefits to the extent of 50,000*l*. under the will of the late Captain Thomas P. Salter. The University of Chicago has received land from Mr. J. B. Rockefeller worth more than 500,000*l*. The Princeton University has received anonymously a gift of 240,000*l*.

DR. J. C. MCLENNAN, for some years director of the physical laboratory in the University of Toronto, has been elected to the professorship of physics in succession to Dr. James Loudon.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 23.—"The Relation of Thallium to the Alkali Metals: a Study of Thallium Sulphate and Selenate." By Dr. A. E. H. **Tutton**, F.R.S.

The author finds that the crystals of thallium sulphate and selenate resemble those of the analogous salts of potassium, rubidium, cæsium, and ammonium adequately closely morphologically to enable them to be classed in the same orthorhombic isomorphous series, the average difference of corresponding interfacial angles on analogous potassium and thallium salts being less than half a degree, and the maximum difference only just exceeding a degree. These differences, however, though small, are greater than those between any other of the salts, the average difference, irrespective of direction, being proportional to the higher atomic weight of thallium.

The law revealed by the author's former work, that the changes in the interfacial angles are progressive functions of the atomic weights of the interchanged metals, only applies, however, to potassium, rubidium, and cæsium, which belong strictly to the same family group of the periodic classification of the elements; for the differences in the case of thallium occur in either direction indifferently.

The molecular volumes and topic axial ratios (separation along axial directions of centres of contiguous molecules) are almost identical with those of analogous rubidium and ammonium salts, so that structurally thallium comes alongside rubidium and ammonium, intermediate between potassium and cæsium.

Optically, however, the thallium salts are quite different, the refractive indices, molecular refractions, and dispersion being far higher, indicating the essential chemical difference of thallium from the true alkali metals and ammonium.

Entomological Society, June 5.—Mr. C. O. Waterhouse, president, in the chair.—*Leioptilus carphodactylus* in Britain: Dr. T. A. **Chapman**. A living example; one of the first bred British specimens.—*Microdon mutabilis* and *Kleditoma myrmecophila*: H. St. J. **Donisthorpe**. A specimen of *Microdon mutabilis*, with the empty pupa-case, bred from a larva taken in the nest of *Formica fusca* at Porlock, April, 1907; also ♂♂ and ♀♀ of *Kleditoma myrmecophila*, n.sp., bred last month from a nest of *Lasius fuliginosus* found at Wellington College in March.—New Phytophaga from Australia: M. **Jacoby**. Examples of small beetles, new to science, of the new genus Clythridæ (Phytophaga), including *Leasia australis*, Jac.—Types of Proctotrupidæ: A. J. **Chitty**. The three types of the three species of Proctotrupidæ described by Westwood, but entirely overlooked by subsequent authors.—A parasitic South African fly: E. E. **Austen**. Examples of *Cordyloba anthropophaga*, Grunb., an African fly, parasitic in the larval stage on human beings and animals—a true Muscid—hitherto confused with another fly. The author exhibited *Bengalia depressa*, Walk., a totally different insect.—The significance of some secondary sexual characters in butterflies: Prof. E. B. **Poulton.**—Report of entomological observations made in South Africa during the visit of the British Association in 1905: Dr. F. A. **Dixey** and Dr. G. B. **Longstaff.**

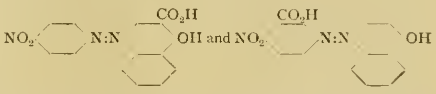
Linnean Society, June 6.—Prof. W. A. Herdman, F.R.S., president, in the chair.—Contributions to our knowledge of New Zealand Holothurians: Prof. **Dendy** and E. **Hindle.**—Report on the marine fishes collected by Mr. Stanley Gardiner in the Indian Ocean: C. Tate **Regan.** The collection contained examples of nearly 200 species, more than fifty of which were new to science, among them some remarkable new generic types. A large proportion of the new species were dredged at considerable depths, and the others chiefly belonged to genera the species of which have been supposed to be more variable and more widely distributed than proves to be the case.—The Ixodidæ collected in the above expedition: Prof. **Neumann.**

Physical Society, June 14.—Mr. H. M. Elder, vice-president, in the chair.—The electric arc: Mr. **Upson.** Arcs were described in which the electrodes consisted of carbon, copper, iron, and aluminium in different combinations, maintained in air, hydrogen, and coal-gas. With 110 volts supply, metal arcs in hydrogen took the form of a spark discharge. At that voltage the maximum length of arc it was possible to obtain, with current up to 15 amperes, was $0''.05$, except where both electrodes were of the same metal. When carbon is one of the electrodes a true arc is formed. If carbon is negative the maximum length of arc with the above voltage is $0''.07$. Volt-ampere characteristic curves were shown for arcs in air and hydrogen of length $0''.05$. The general position of the curve is determined by the material of the negative electrode. With carbon negative, in hydrogen, the curves for various positive electrodes very nearly coincide. With carbon positive, they keep the same curvature, but vary in distance apart, according to the material of the negative. In general, the position of the curve is governed by the negative, but its particular shape seems to come from the influence of the surrounding gas.—The Poulsen arc as a means of obtaining continuous electrical oscillations: Dr. J. A. **Fleming.** Dr. Fleming showed and described an apparatus for forming an electric arc in an atmosphere of coal-gas between a carbon rod kept in slow rotation and a cooled copper anode, the arc being formed in a magnetic field of 600 to 1000 C.G.S. units. The arc was supplied with continuous current at a pressure of 400–500 volts. A condenser of 0·003 mfd. capacity in series with an inductance of 200,000 cm. was shunted across the arc, and experiments shown to prove the existence of high-frequency oscillations in the condenser circuit. A long resonance helix of insulated wire was then joined to the condenser circuit, and when tuned to it created a powerful high-frequency field round it in which vacuum tubes glowed brilliantly. By vibrating or rotating a neon vacuum-tube of spectrum type near the helix, and showing that the band or disc of light was cut up by dark spaces, Dr. Fleming supported the contention that the oscillations so produced are not absolutely uninterrupted, but cut up into groups.—A direct-reading conductivity bridge for testing rods of steel or other material, where there is considerable range of conductivity between successive specimens, and where it is necessary to eliminate the resistance of end contacts: R. **Appleyard.**

Chemical Society, June 20.—Sir William Ramsay, K.C.B., F.R.S., president, in the chair.—Some properties of radium emanation: A. T. **Cameron** and Sir W. **Ramsay,** K.C.B. It has been discovered that the emanation from radium undergoes a rapid change of volume shortly after its change from the solid to the gaseous state; this is followed by a slow change corresponding with its loss of electrical activity. It has been shown by thirty sets of measurements that the emanation behaves in accordance with Boyle's law, both before and after this preliminary change. Measurements have been made of the initial volume of the emanation obtained from a solution of 87·7 milligrams of radium (metal) as bromide and sulphate. From these it would appear that, instead of the previously accepted value for the average life period of radium, 1100 years, a much shorter life must be deduced, namely, 236 years.—The affinity constants of aminosulphonic acids as determined by the aid of methyl-orange: V. H. **Veley.** The affinity constants of the aminonaphtholsulphonic acids when determined by the tintometer method show, as regards the effect of the introduction of the hydroxyl grouping in the naphthylaminesulphonic acids, relationships similar to those observed by Ostwald by the electric conductivity method for the hydroxybenzoic acids as compared with benzoic acid. One possible case of steric hindrance induced by the introduction of the hydroxyl grouping in the 8-position was noted.—Azo-derivatives of 1:3-diphenylbarbituric acid. Dynamic isomerism among the coloured hydrazones of 1:3-diphenylalloxan: Miss M. A. **Whiteley.** In order to throw some light on the structure of the compounds obtained by the action of aromatic diazonium chlorides on the 5-alkyl-substituted derivatives of 1:3-diphenylbarbituric acid, the investigation has been extended, and the action of the β-substituted derivatives of phenylhydrazine on 5:5-dibromo-1:3-diphenylbarbituric acid has been examined. The results show that the yellow compounds obtained in the first reaction are azo-derivatives, whilst the red ones obtained in the second are hydrazones.—A series of coloured diazo-salts derived from benzoyl-1:4-naphthylenediamine: G. T. **Morgan** and W. O. **Wootton.** The examination of the diazo-salts of benzoyl-*p*-phenylenediamine and benzoyl-1:4-naphthylenediamine has been continued, and it has been found that the diazo-derivatives of the latter base are extremely stable substances which are invariably coloured. These coloured salts might be regarded either as *syn*-diazo-derivatives or as equilibrium mixtures of diazonium and *syn*-diazo-derivatives, although their great stability somewhat militates against the assumption that they consist wholly or in part of *syn*-diazo-compounds.—Colour and constitution of azo-compounds, part i.: J. T. **Hewitt** and H. V. **Mitchell.** The authors recently directed attention to the very marked change in colour when *p*-nitro-derivatives of arylazo-*p*-phenols were dissolved in alkalis. The explanation was offered that, whilst benzeneazophenol forms alkaline salts of corresponding constitution, the *p*-nitro-derivatives furnish salts with the metal attached to the nitro group, and therefore diquinonoid in structure. The relationships are rendered apparent by the formulæ

$$C_6H_5.N:N.C_6H_4.OK \text{ and } KO_2N:C_6H_4:N.N:C_6H_4:O.$$

Comparison of the two carboxylic acids



indicates that the frequency of the absorbed light is lowered by increase in the length of the chain of alternate single and double linkings. The introduction of substituents may modify the length of the chain owing to the possibility of more stable salt formation in other directions.—The oxidation of hydrazines by free oxygen: F. D. **Chattaway.**—Calmatambin: a new glucoside: F. L. **Pyman.** This glucoside from the bark of a West African tree, probably *Canthium glabrifolium*, has the formula $C_{19}H_{28}O_{13},2H_2O$, contains one methoxyl group, and is readily hydrolysed by dilute acids and by emulsin forming calmatambetin, $C_{13}H_{18}O_8,\frac{1}{2}H_2O$, together with dextrose. The former is readily decomposed by the action of dilute acids, and yields a small amount of a scarlet, crystalline substance, $C_{11}H_{12}O_3$.—The decomposition of hyponitrous acid in presence of mineral acids: P. C. **Rây** and A. C. **Ganguli.** Hyponitrous acid when liberated from silver or mercurous hyponitrite by the action of dilute nitric, hydrochloric, or sulphuric acid at 25° decomposes at once according to the equations (1) $2HNO=H_2O+N_2O$, (2) $5HNO=2H_2O+HNO_3+4N$.—The chemical composition of petroleum from Borneo: H. O. **Jones** and H. A. **Wootton.** The petroleum from Borneo consists of approximately equal quantities of homologous hydrocarbons of the paraffin, *cyclo*-hexane, and aromatic series, and contains the members of the naphthalene series to the extent of about 6 per cent. to 7 per cent.—The synthesis of phenonaphthacridines: trimethylphenonaphthacridines: A. **Senier** and P. C. **Austin**.—The condensation of aldehydes with mixtures of α-naphthol and α-naphthylamine: synthesis of 7-aryl-$\begin{array}{c}\alpha\text{—N——}\alpha\\ |\\ \beta\text{—CH—}\beta\end{array}$-dinaphthacridines: A. **Senier** and P. C. **Austin**.—An improved form of apparatus for the rapid estimation of sulphates and salts of barium: W. R. **Lang** and T. B. **Allen**. The authors have simplified the apparatus of Tarugi and Bianchi for the estimation of sulphates and salts of barium by a volumetric method based on the rapid clearing of turbid solutions in tubes of narrow calibre.—The determination of sugar by Fehling's solution: W. R. **Lang** and T. B. **Allen**. The apparatus described by the authors (preceding paper) was also employed for the determination of dextrose by means of Fehling's solution.—Studies in asymmetric synthesis, vi., the asymmetric synthesis of the optically active tartaric acids: A. **McKenzie** and H. **Wren**. The asymmetric synthesis of *l*-tartaric acid was accomplished in three ways:—(1) by the oxidation of *l*-bornyl fumarate in glacial acetic acid solution by potassium permanganate; (2) by the oxidation of the potassium salt of *l*-bornyl hydrogen fumarate in aqueous solution by potassium permanganate; (3) by the oxidation of *l*-menthyl fumarate in an analogous manner. The asymmetric synthesis of *d*-tartaric acid was accomplished by the oxidation of the potassium salt of *d*-bornyl hydrogen fumarate.—Some derivatives of 2-phenyl-1:3-naphthylenediamine, part i.: N. **Lees** and J. F. **Thorpe**. Typical derivatives of the base have been prepared and investigated, and the conditions have also been determined under which it is converted into the corresponding dinaphthol and the two amino-naphthols.

EDINBURGH.

Royal Society, May 6.—Dr. Robert Munro in the chair.—Inbreeding in the Barbary sheep and in the common goat: Prof. J. C. **Ewart**, F.R.S. The herd of Barbary sheep, which had been living for about a century at Abercairney, in Perthshire, seemed to be as vigorous and prolific now as when they were first introduced, and yet there had been no fresh blood added for at least fifty years. The problem was, why should this vigour continue in spite of inbreeding? To answer this question a series of experiments had been begun in 1899 with a pair of common goats. The great-great-grandson in 1905 was as vigorous as the original male, whom he closely resembled, and his offspring with the grand-daughter of the original pair were decidedly more vigorous than the first pair of goats born in 1900. It was found that, as a rule, the offspring of immature males was weak, and that it was more important for the male to have reached his full strength than for the female to have reached maturity. One reason why inbreeding in herds did not lead to deterioration seemed to be that the weaklings were eliminated, and every now and again there was a restoration of a vigorous ancestor.—Report on fossil fishes collected by the Geological Survey in the Lower Carboniferous rocks near Gullane, East Lothian: Dr. R. H. **Traquair**, F.R.S. The list contained thirteen species, of which two were new. A comparison with the fossils of other similar shales showed that the Gullane rocks corresponded most closely with the Wardie shales, there being eight of the thirteen species in common.—Heusler's magnetic alloy: Alexander D. **Ross**. The particular alloy experimented with had a composition of manganese 25 per cent., aluminium 12·5 per cent., a trace of lead, and the remainder copper. The aim of the research was to find how the magnetic susceptibility varied under various thermal treatment, such as heating up to different high temperatures, cooling down to the temperature of liquid air, and bringing back the alloy to its original state either suddenly or gradually. When quenched at 610° C., the material showed distinct diminution in permeability, which was not so marked when the quenching was from either higher or lower temperatures. This was perhaps the most interesting among a number of other results obtained.—The physical properties of mixed solutions of independent optically active substances: Clerk **Ranken** and Dr. W. W. **Taylor**. The properties chosen for measurement were the viscosity, the density, and the electric conductivity. The optically active substances were the normal potassium tartrates and the tartar emetics, and, for the sake of comparison, potassium racemate and racemic emetic. The independent optically active substance was cane sugar, and in one set of experiments maltose. Equivalent solutions of the three *d*, *l*, and *r* substances were made, and the physical properties determined at 15° C. and 25° C. A definite weight of sugar was then added, and the measurements again made. The general conclusion was that the addition of an independent optically active substance to solutions containing optically active stereoisomers does not cause any recognisable differences.

May 20.—Dr. Traquair, vice-president, in the chair.—A new method of ascertaining twist in single threads: Thomas **Oliver**. The usual microscopic method in the case of combed yarns is fairly accurate, but is very unsatisfactory in the case of carded woollen threads. The new method depended on the relation formerly obtained by the author between the "take-up" and the turns per inch in the twisted thread, and consisted in determining the number of turns required to give the maximum length as the thread was untwisted.—The influence of twist on the strength of a thread: Thomas **Oliver**. Under tensile stress the elongation of a thread is not quite proportional to the stress. With increasing stress the increment of elongation increases. At length a certain point is reached when the increment of length for a given increment of stress becomes distinctly greater, and goes on increasing to the breaking point. This yield point was chosen as an indication of the strength, and thus it was possible to compare the strengths of the thread in different conditions of twist without breaking it. The relation between the strength *y* and the number of turns of twist per inch *x* could be represented by the equation $y = bx^2/(x^2 + b^2/k)$, where *b* and *k* are constants for each thread. The paper contained a critical examination of a formula given in 1879 by Prof. Hartig, and of some conclusions advanced by Profs. Hübner and Pope in a paper on the influence of certain reagents on the tensile strength of cotton yarn.—Notes on some oligochætes found on the Scottish Loch Survey, and also on some Turbellaria from Scottish lochs: C. H. **Martin**. The notes were chiefly concerned with the genital organs, and one new species of oligochæte worms was described. An interesting point was noted in connection with the Turbellaria. This worm feeds on the Hydra. The nematocysts are not digested, but, retaining their vitality, work out to the external skin, finally assuming the position normally occupied in the Hydra.—The composition of red clay: Dr. F. W. **Clarke**. Fifty-one specimens of red clay from various localities had been supplied by Sir John Murray. These were combined in equal weights, and the composite sample so obtained carefully analysed. In most respects the analysis agreed fairly well with the average of the original *Challenger* analyses, but showed distinctly less iron and a small quantity of a number of minor elements not hitherto reported, such as titanium, barium, strontium, vanadium, &c.—The glaciation of east Lothian, south of the Garlton Hills: Prof. **Kendall** and E. R. **Baily**. This paper gave a detailed account of the glaciation of the district described, the positions and manner of formation of the various glacial lakes and their outflows being indicated as the ice advanced and retreated. Some interesting illustrations were given of the way in which a tributary falling into a flat valley formed an accumulation of detritus which finally turned back the course of the upper tributaries into another channel and quite altered the watershed. The view which explains certain so-called raised beaches as the result of glaciation was also emphasised. The evidence of the old lake basins and of the Boulder-clay deposits led to the same conclusions.

June 3.—Prof. Crum Brown, F.R.S., in the chair.—Temperature changes occurring in fresh-water lochs: E. M. **Wedderburn**. There were three types of temperature distribution occurring in the Scottish lochs. From December to March the temperature was practically uniform throughout; from April to July the heating of the surface waters led to a distribution in which the gradient of temperature with depth was at no place very rapid, but from August to November a "discontinuity temperature layer" came into existence, the so-called *Sprungschicht* of the Austrian and German naturalists. Down to the depth of this discontinuity layer the temperature varied very slowly, and below it, down to the bottom of the loch, there was an almost constant temperature, but within the layer the temperature varied very rapidly. This the author believed to be due to the action of the winds blowing over the surface and separating out the two great masses of water of different temperature and density. The explanation was illustrated experimentally by means of a trough containing a layer of salt water with a layer of fresh water above it. A blast of varying strength could be blown along the surface, causing the fresh water to heap up towards the leeward end, and producing a back current along the bottom of the fresh-water layer. This back current drew the upper layer of the salt water after it, and set up a feeble return current in the salt-water layer in the same direction as the original current on the surface due to the wind. When the blast ceased a seich-like movement was produced in the salt-water layer, exactly similar to the temperature seiche which had been observed in the Scottish lochs.—A specimen of *Helix pomatia* with paired male organs: Dr. J. H. **Ashworth.** In addition to the normal set of reproductive organs present on the right side, this specimen possessed on the left side a set of accessory male organs. The normal and supplementary male organs were equally developed and were symmetrically placed, and the supernumerary genital aperture occupied a position on the left side exactly corresponding to that of the normal aperture on the right side. The form of the supplementary organ supports the view that the present position of the genital ducts in Helix and other Stylommatophora has been derived from a condition existing in the ancestral form in which the vas deferens and penis were connected with the primitive genital aperture by means of a lateral groove, such as still exists in Pythia.—Encystment of Tardigrada: James **Murray.** This remarkable transformation began with the forming of a cyst under the original skin of the mature animal, the skin gradually shrivelling, the feet disappearing, and the creature reverting to an embryonic state with loss of all its principal organs. After a period of rest the organs develop again, and the animal finally emerges from its case exactly as it was before the encystment began.

PARIS.

Academy of Sciences, June 24.—M. Henri Becquerel in the chair.—A new mineral species from the high temperature fumerolles of the recent eruption of Vesuvius: A. **Lacroix.** The mineral has the composition

$$PbSO_4.(K \text{ or } Na)_2SO_4,$$

and the name palmierite is proposed for it.—A new method of preparing anhydrous oxide of lithium: M. **de Forcrand.** Pure lithium carbonate is heated to a temperature of 780° C. to 800° C. in a platinum boat in a current of dry hydrogen. In about three hours the whole of the carbon dioxide is eliminated, and pure Li_2O remains. The heat of solution of pure lithium monoxide, prepared in three different ways, was found to be 31·2 calories, or more than five calories higher than the previously accepted number of M. Beketoff.—The addition of water to ethylenic oxides by means of sulphuric acid: Louis **Henry.** Now that an application of Grignard's reaction gives a means of preparing ethylene oxides in a general manner, the author has studied the mode of hydrolysis by dilute acids, and gives a series of glycols, with their boiling points, which have been prepared.—The secretary announced the death of Charles Trepied, correspondant for the section of astronomy, and A. Crova, correspondant in the section of physics.—Observations of the comets *c* and *d*, 1907, made at the Observatory of Algiers: MM. **Rambaud** and **Sy.** Observations were made on eight nights between June 5 and 19. The positions of the comparison stars and the apparent positions of the comet are given.—A species of analytical geometry of systems of additive functions: Frédéric **Riesz.**—The functional equation of M. Fredholm: A. **Korn.**—Ensembles of functions and linear operations: Maurice **Fréchet.**—The secondary kathodic emission of metals under the influence of the α-rays: Marcel **Moulin.** The existence of a secondary radiation of the α-rays, at first generally admitted, has been called in doubt by several recent workers. Preliminary experiments in favour of the hypothesis of the existence of such secondary radiations are given.—Drops formed in a magnetic field: H. **Ollivier** and Pierre **Sève.**—Thermochemical data relating to the ammonio-mercuric base and its hydrates: H. **Gaudechon.** The immediate solution effected by a solution of potassium cyanide is utilised as a means of carrying out the thermochemical measurements. The data used as a basis for the calculations are indicated in full.—The nature of sulphammonium: P. **Lebeau** and P. **Damoiseau.** A repetition of the work of Henri Moissan and of Otto Ruff and Geisel. The latter indicate a reversible reaction between sulphur and ammonia, giving rise to nitrogen sulphide and ammonium sulphide. In the present paper it is shown that if minute precautions are taken to ensure the complete absence of moisture, neither nitrogen sulphide nor ammonium sulphide is formed. The weight of sulphur recovered after evaporation of the liquid ammonia is exactly the original weight, and no trace of sulphuretted hydrogen is given off during the evaporation.—The combinations between silicon and molybdenum. Molybdenum bisilicide: Ed. **Defacqz.**—The various molecular states of anhydrous ferric sulphate and hydrated ferric sulphate: A. **Recoura.**—Cuprous iodide: Marcel **Guichard.** All attempts to prepare cupric iodide by working at low temperatures failed. Hydriodic acid, liquefied at a low temperature on cupric chloride, gives rise at once to a mixture of cuprous iodide and free iodine. The iodine appears at the commencement of the reaction, and is easily separated either by solution or sublimation. A new method of analysis of iodides is given.—A study of the alloys of cobalt and tin: F. **Ducelliez.** The method of isolation and the properties of the alloy CoSn are described.—A molybdo-uranic combination: André **Lancien.** The precipitate formed by the interaction of ammonium molybdate and uranyl nitrate has the composition of uranyl molybdate, UO_2MoO_4.—Lupeol: E. **Jungfleisch** and H. **Leroux.** A comparison of the properties of the alcohol lupeol, isolated from different samples of gutta-percha.—The action of some esters of the α-iodo-fatty acids on the iodide of magnesium phenylamine and magnesium orthotoluidine iodide: F. **Bodroux** and F. **Taboury.**—The origin of the deposits of colouring matter in red wines: A. **Trillat.** The deposit is caused by the formation of an insoluble compound of the red colouring matter with acetaldehyde. In the absence of the aldehyde the red substance is not affected by the oxygen of the air.—The synthesis of an aldehyde possessing the odour of violets, cyclo-lemonylidene-propenol: Ph. **Barbier.** Lemonal and propionic aldehyde are condensed by dilute soda in weak alcoholic solution. The resulting aldehyde is treated with 60 per cent. sulphuric acid. Two aldehydes result, both possessing an intense odour of fresh violets, and superior to that of ionone. These have the drawback of oxidising very rapidly by exposure to air, and losing their smell in consequence.—The phenomena of coloration of brown bread: Gabriel **Bertrand** and W. **Mutermilch.**—Observations on the primordial leaves of various species of the genus Achillea: Léon **Dufour.**—The fungus-cultivating ants of Madagascar: H. **Jumelle** and H. Perrier **de la Bathe.**—Some variations observed in the rose: Lucien **Daniel.**—The morphological value of the spines of coral: Louis **Roule.**—The persistence of the trocophore in a Hesionian: C. **Viguier.**—Some new ideas on the white bearded gibbon. *Hylobates leucogenys*: Louis **Boutan.**—A general table of the encephalic weights as a function of the body weight: Louis **Lapicque.**—The association of unicellular algæ with *Sarcophytum mycetoides*: Ch. **Gravier.**—The measurement of the pulmonary field and its activity: Gabriel **Arthaud.**—The physiological action of some colouring matters and their urinary excretion: Jean **Gautrelet** and Henri **Gravellat.**—The relation between oceanic whirlpools and volcanoes: E. A. **Martel.**

NEW SOUTH WALES.

Linnean Society, March 27.—Annual general meeting.—Mr. Thomas Steel, president, in the chair.—Presidential address: Some questions in terrestrial physics: T. **Steel.** The first section was devoted to a discussion of radium and the earth's internal heat, the nature of radium and the phenomena accompanying its disintegration being described. The consequences of the acceptance of the theory that the present internal heat of the earth is due to radium contained in the crust were detailed, and the immense importance of the theory in connection with the problems of geological time fully considered. The concluding portion consisted of a consideration of the question of the influence on climate of possible variations in the composition of the atmosphere, more especially with regard to its carbon dioxide content. The manner in which climate is influenced by the amount of this substance in the air was clearly described, and the causes leading up to its removal or replacement were discussed. Consideration was also given to the possibility of climate being influenced by the earth's internal heat. The address concluded with a brief account of some of the proofs of the former glaciation of the earth's surface to regions well within the tropics, and with the possible explanation of this phenomenon by mutations in climate caused by variations in the carbon dioxide in the atmosphere.—Ordinary monthly meeting, Mr. A. H. S. Lucas, president, in the chair.—Decapod Crustacea from Norfolk Island: the late F. E. **Grant** and Allan R. **McCulloch.**—Descriptions of Australian Microlepidoptera, part xix., Plutellidæ: E. **Meyrick.** In the "Handbook of British Lepidoptera," the family Plutellidæ was regarded as comprising the three groups Yponomeuta, Glyphipteryx, and Plutella. In the present paper, not without due consideration, the family receives a more extended application so as to include, in addition, Gracilaria and Zelleria, formerly included in the Tineidæ.

April 24.—Mr. A. H. S. Lucas, president, in the chair.—Descriptions of new or little-known Desmids found in New South Wales: G. I. **Playfair.** Dr. Otto Nordstedt has recorded nine species from the Blue Mountains, and Dr. M. Raciborski seventy-seven species from Centennial Park, Sydney, the papers of these two writers representing the only published contributions to a knowledge of New South Wales Desmids available at present. The material studied by the author represents about 350 species, of which 230 have been identified as forms not restricted to New South Wales, fifty require further investigation, and seventy are treated and figured in the present paper, of which fifty are regarded as previously undescribed.—Revision of the Thynnidæ (Hymenoptera), part i.: Rowland E. **Turner.** The present paper, part i., treats of the subfamilies Diamminæ and Thynninæ, the former comprising only one genus, Diamma, represented by a single species, and the latter seven genera and two subgenera, represented by 102 species, of which forty-six are described as new.—Contributions to a knowledge of Australian Foraminifera, part ii.: E. J. **Goddard** and H. I. **Jensen.** The material described in this and previous papers has been obtained from localities sufficiently far removed from one another to enable the authors to make deductions regarding the distribution of Foraminifera in Australian waters, and also to discuss the probable conditions of climate and deposition at the time the Table Cape beds were laid down.

CALCUTTA.

Asiatic Society of Bengal, May 1.—An abnormal branch of the mango (*Mangifera indica*, Linn.): I. H. **Burkill** and G. Chunder **Bose.** A young grafted mango bore two abnormal branches, which were leafy along one side, but flowering along the other. The internal anatomy of the larger branch was studied, and it was ascertained that the xylem was much more developed on the leafy than on the flowering side.—Note on the Shahin falcons (*Falco peregrinator* and *F. barbarus*): Lieut.-Colonel D. C. **Phillott.** Their habits, breeding, employment in falconry, and Eastern names.—Note on the red-headed merlin (*Æ salon chiquera*): Lieut.-Colonel D. C. **Phillott.** Its breeding, habits, and use in falconry.—Magnetic induction in spheroids: D. N. **Mallick.** This paper deals with the problem of magnetic induction in a magnetic substance in the form of a prolate spheroid, due to a current circulating in a wire wrapped round it along a part of its length.—The fats of Garcinia species: D. **Hooper.** The author enumerates four species of Garcinia the seeds of which are known to yield fixed oils, employed for lighting, edible, and medicinal purposes. Two of these have been examined by the author, who confirms the analysis of Heise in showing that the fat of *G. indica* consists chiefly of oleodistearin, and from an examination of gamboge butter, the semi-solid fat of *G. Morella*, its constitution is shown to be that of stearo-diolein.

DIARY OF SOCIETIES.

THURSDAY, JULY 4.

CHEMICAL SOCIETY, at 8.30.—*iso*Nitroso and Nitrodimethyldihydroresorcin: P. Haas.—The Structure of Carbonium Salts: F. Baker.—Studies of Dynamic Isomerism, Part VI., The Influence of Impurities on the Mutarotation of Nitrocamphor: T. M. Lowry and E. H. Magson.—The Relation between Absorption Spectra and Chemical Constitution, Part VIII., The Phenyl Hydrazones and Osazones of α-Diketones: E. C. C. Baly, W. B. Tuck, E. G. Marsden, and M. Gazdar.—Permanganic Acid: M. M. P. Muir.

ASSOCIATION OF ECONOMIC BIOLOGISTS (IMPERIAL INSTITUTE), at 11.30 a.m.—Some Notes on Ticks: C. Warburton.—A Remedy for the Spruce-gall and Larch-blight Diseases: E. R. Burdon.—Demonstration in the Public Galleries of the Imperial Institute by Mr. W. G. Freeman, the Superintendent of the Colonial Collections.—At 2 p.m.—A Note on the Cecidomyidæ or Gall-midges: W. E. Collinge.—The American Gooseberry-mildew, and the Proposed Legislative Measures: E. S. Salmon.—The Bionomics of the Calypterate Muscidæ, and their Economic Significance: C. Gordon Hewitt.

FRIDAY, JULY 5.

GEOLOGISTS' ASSOCIATION, at 8.—The Geology of the Appleby District, Westmorland: Dr. J. E. Marr, F.R.S.

CONTENTS.

THURSDAY, JULY 11, 1907.

THE WOLLEY COLLECTION OF BIRDS' EGGS.

Ootheca Wolleyana, an illustrated Catalogue of the Collection of Birds' Eggs formed by the late John Wolley, jun. Edited from the original notes by Alfred Newton. Part iv., Alcæ—Anseres; with supplement and appendix, map, and three plates. (London: R. H. Porter, 1907.) Price 25*s*. net.

THE recent death of Prof. Alfred Newton attaches a melancholy interest to this work, which, though not of a strictly scientific nature, may, in some respects, be regarded as the *magnum opus* of the editor and joint author; whilst his friends should at least take comfort in the reflection that he was spared long enough to complete it. The publication was commenced in 1864, when part i. was issued; then suspended for a period of thirty-eight years, and recommenced in 1902, when part ii. completed the first volume. Part iii. appeared in 1905, and, together with the present issue, constitutes the second volume.

Part iv. includes the divers, grebes, shearwaters, &c., and also the herons, but the most important entries relate to the swans, geese, and ducks, in which John Wolley took an especial interest on account of the difficulty of obtaining properly identified eggs of these birds. There is also a supplement and appendix, the latter containing the publications of Wolley on natural history other than those included in the text of the "Ootheca," such as papers on mammals, reptiles, batrachians, and especially on insects. The supplement is occupied with corrections, omissions, and additions, the names of species not before included being in thick type. These latter are fairly numerous, and serve to bring the work up to date, especially in those cases where the earlier collectors had been unable to discover authentic eggs. There are also some corrections in nomenclature, especially in the case of the owls, some half-dozen of which receive different names, whether of genus or of species. This reminds us of the protest of the late Dr. Bree against the generic divisions of the owls. He was writing of the Ural owl, which, by the way, is one of the new species recorded, the editor having received an egg from the Lower Danube, taken in 1866; subsequently he obtained two from Finland, as recently as 1905. Again referring to the subject of nomenclature, the editor deplores the necessity for changing the name of *Falco sacer* into that of *F. cherrug*. But Rip van Winkle rubs his eyes when he finds his old friend *Aquila imperialis* become successively *A. mogilnik* and *A. heliaca*, and is very much disposed to ask, "What next?"

Since the "Ootheca Wolleyana" is now completed, we may take a retrospective view of the entire work. The editor disclaims for it any special scientific value, and remarks that

"there is no need to observe too strictly the technicalities of science. The arrangement (I will not call it classification) of the species named is one of them. The ideal taxonomy of birds is beyond the range of my vision."

Thus he only deals with genera and species, and does not further classify under families and orders. It is obvious that in all works on natural history, authors are bound to adopt some kind of sequence. Even the alphabetical plan used in the index is not absolutely free from difficulties, since such are the changes in genera that unless one knows the name likely to have been adopted, the search is apt to be troublesome. But this is a minor matter, for the whole subject of the classification of birds is very much in the condition of the British army at the present time, viz., as we are told, "in the melting-pot." Are the Accipitres or the Passeres ultimately to have precedence?

The scope and object of the work are, however, of much more importance than any questions of classification, and, since it relates to discoveries made chiefly about the middle of the nineteenth century, the present generation of ornithologists might naturally ask for information on these points. The answer would be that it is an illustrated catalogue containing details of the most authentic and probably one of the largest collections of European and Palæarctic birds' eggs that ever was made. Practically there are two authors, since the contributions of the editor equal, if they do not exceed, the extracts from the writings of Wolley himself. John Wolley died in 1859, at the early age of thirty-six, and shortly before his death he requested that his collection of birds' eggs should be handed over to his friend and companion, Alfred Newton, who likewise became his literary executor. The "Ootheca Wolleyana" is therefore justly dedicated to the Rev. John Wolley, of Beeston, Notts (long since deceased), "as an acknowledgment of his generosity in fulfilling the last wishes of his son." The sources for the compilation of the catalogue are letters to friends, fragmentary diaries, and, above all, his "egg-book." In bringing their joint contributions into notice, the editor's method has been to print the observations of Wolley in full-sized type, whilst the editorial explanations, including references to specimens obtained since 1859, are in small type.

It should be understood that there are practically two collections, since the collection originally formed by Alfred and Edward Newton in partnership has been incorporated with the Wolley collection, and increased by subsequent additions. For a few years after his friend's decease, the editor maintained a connection with some of his principal collectors in Lapland, and thus continued the work which commenced in 1853. Moreover, the original collection was confined to European species, but the editor has chosen to extend its limits to those of the western half of the Palæarctic region. Some idea of the magnitude of the catalogue may be gathered from the fact that there are, inclusive of those in the supplement, 6076 entries or sections, consisting of one or more eggs, to which a special history is attached. The number of eggs in each entry ranges from *one* to some *twenty* or *thirty* in the case of birds breeding in colonies. The average may be a little over four, which would give a total of about 25,000 eggs. This is only a rough calculation, and may be wide of the mark. The number of species listed is approximately 650. Two samples of entries, slightly modified, are given :—

(1) *Falco Gyrfalco*, Linnæus. Sect. 192. *Four*. West Finmark, May 7, 1854. "J. W. *ipse*."

(2) *Tringa subarquata*, (Guldenstädt). Sect. 6065. *One*. Kotelny Island, New Siberian Group, June 11, 1902.

It might perhaps be objected that the collection contains too many duplicates, and this redundance receives illustration, for instance, in the case of Buffon's skua. The first egg of this species was obtained by Wolley himself near the sources of the Tana on June 20, 1857, both birds being shot, and very few additional specimens were obtained during his lifetime. But from 1860 to 1862, the latter being the great lemming-year, the number of entries, mostly of pairs, occupies about nine pages of the catalogue. The fact is that Wolley had originated a movement which could not be stopped, and his collectors, having been once put on the right track, went on collecting mechanically, as it were, and without remorse. The same thing occurred in the case of the waxwing and some other species, the eggs of which were previously unknown, or at least unauthenticated.

It must not, however, be supposed that the "Ootheca Wolleyana" is a mere list of eggs, for the notes, whether of author or editor, are copious, and both interesting and valuable, not only to collectors, but to ornithologists in general. The above calculations may serve to give some idea of the labour involved in preparing for the press this immense mass of material—a labour of love, in the words of the editor, since he regards the catalogue as largely a record of ancient friendship. Its freedom from typographical errors is remarkable, considering the constant change of type, and the number of technical names. Nor is the editor dismayed by the length of time which has elapsed since its commencement, considering that the delay has not been without its advantages, as specimens unattainable in Wolley's lifetime, and for long after his death, have been acquired, and are recorded, some in the body of the work and others in the supplement. It should also be remembered that the joint collection, of which this is the catalogue, has been given to the University of Cambridge, "in whose museum of zoology," Prof. Newton trusts, "it may long continue."

The primary object of the "Ootheca" is to record the labours of the naturalist whose name it bears, and in further fulfilment of this duty a most interesting memoir of John Wolley is added (part ii., pp. ix–xxxix) by way of introduction to vol. i. There is a good likeness of him, based on a photograph taken about a year before his death. In that likeness we recognise the calm determination which was so characteristic of a man who, in the words of Hewitson, "had become as familiar with the king of birds as others are with crows and magpies." That was in what we may call the heroic stage of his career, when he was equally prepared to scale a precipice after an eagle or to swim out to an osprey's nest in the coldest of water. Four years afterwards the birds'-nester of 1849 had made no inconsiderable progress in the study of natural history, and thus, after the example of Linnæus, as also pointed out by Hewitson, he wended his way into Central Lapland, and laid the foundation of a series of campaigns which have made his memory famous in the annals of oology. It is not so much the hardships which he endured in the quest of eggs, though these were sufficiently severe, as his powers of endurance through three winters in Lapland that astonish us. Perhaps it was this mode of life, in conjunction with his remarkable indifference to ordinary comforts, which was partly the cause of his early death, before he had time fully to work out the results of his great experience. In 1858, together with the editor, he undertook a pious pilgrimage to the last breeding-place of the great auk on Eldey, in Iceland. An abstract by the editor of Wolley's researches in Iceland respecting the great auk appeared in the third volume of the *Ibis*. The same year he became one of the original members of the British Ornithologists' Union, and contributed two classical papers to the first volume of its journal. His death, in 1859, created the first vacancy in its ranks, and it is the opinion of all who knew him that, had he been spared, he would have taken a high place amongst the leading naturalists of the second half of the nineteenth century.

As regards the collection, that portion formed by Wolley dates from the early 'forties, when he was a boy at Eton, sometimes occupied in chasing dabchicks on the Thames. The portion formed by the Newtons was commenced probably somewhat later, and continued at intervals almost to the present time. Whilst residing at Elveden, they enjoyed great advantages for working some of the best districts of East Anglia, and were not slow to profit by their opportunities. When Wolley went to Cambridge in 1843, the fens afforded very good hunting-ground, though harriers were getting scarce even then. That paradise of birds, Whittlesea Mere, was still intact, not being drained until 1850. He succeeded in obtaining eggs of all three species of harrier, though none apparently of his own taking. The other rarities of the fens, such as the grasshopper-warbler, Savi's warbler, bearded tit, &c., likewise great numbers of spotted crake and water rail, he obtained second-hand, sometimes through "Plover George" (Harvey of Baits-bight), whom he always distrusted.

It would lengthen this notice unduly if we were disposed to enter into any detail as to the eggs obtained during his famous Sutherland campaign in 1849. He succeeded in proving that it is the grey-lag goose, and not the bean goose, which breeds in the north of Scotland, whilst his success amongst the eagles was duly recorded by Hewitson, whose third edition was greatly enriched by Wolley's results, both in Scotland and in Lapland. The editor of the "Ootheca" in many cases reproduces these extracts from Wolley's letters to Hewitson, or substitutes for them the original notes from the egg-book, occasionally including passages which had been omitted.

Thus, *àpropos* of the pintail, Wolley expresses his feelings on the identification of eggs:—

"In common with some other ornithologists I had long been almost in a state of desperation about several of the ducks—about most of those, in fact, which do not, occasionally at least, breed in Great Britain. *Many a collector could produce the eggs of what ducks you please at a moment's notice, but few, very few, could give any kind of satisfactory account of them.*"

[That portion of the extract italicised was omitted by Hewitson.]

The fact is that a crisis was impending in the history of Wolley's collection. We gather from an inspection of the catalogue that many of the rarer eggs had been supplied, for the most part in single specimens, by dealers from abroad. It must in justice be said of M. Favrier, of Tangier, where Wolley paid a visit about 1845, that eggs of rare birds supplied by him were afterwards proved to be genuine on comparison with well-identified eggs obtained by Tristram's Algerian party in 1857. Subsequently to this date Wolley was enabled to supply deficiencies in his collection from the above source, partly by gifts and partly through exchange. But the problem of the nidification of birds breeding in the north of Europe he determined to solve for himself, and, as we have seen, the cream of his results went to swell the plates and pages of the third edition of "Hewitson." Those who wish to know more of this subject must consult the pages of the "Ootheca," and if we venture to deal with any particular group, by way of illustration, the Limicolæ perhaps will suit our purpose as well as any other, and a partial extract here and there must suffice. *Ex uno disce omnes.* Wolley's pæan of delight in fully identifying the eggs of jack-snipe may be quoted, partly for the purpose of illustrating his methods in Lapland.

"The next morning I went to Kharto-uoma with a good strength of beaters. I kept them as well as I could in line, myself in the middle. . . . Whenever a bird was put off its nest the man who saw it was to pass on the word, and the whole line was to stand, whilst I went to examine the eggs."

At length the expected signal was given, a nest had been discovered, and the sight of the eggs as they lay untouched raised his expectations to the highest pitch, until he succeeded in shooting "a true jack-snipe, the undoubted parent of the nest of eggs." Another most important find were the eggs of the spotted redshank, and these ultimately in considerable numbers, quite close to Muoniovara, his Lapland home. The editor doubts whether any ornithologist previous to this had ever seen a genuine specimen. Three picked eggs of this species were selected for figuring in the third edition of "Hewitson," and the editor expresses his regret that the present condition of these eggs in the collection would not justify him in figuring additional specimens. Another rare egg of this group is that of the bar-tailed godwit. A nest of four was obtained in Kittila, June 12, 1854, in time for Hewitson to figure two of them; the entire clutch is still in the collection. In 1858 and subsequently, some more complete clutches were secured, but on the whole it is probable that the bulk of these birds breed more to the eastward, as none came under Wolley's special notice. Hence eggs with "*Puna Kuovi*" in Wolley's handwriting are not to be found in many collections. Probably all the species of the Limicolæ which breed in Central Lapland were procured with their eggs, but there still remained species the nesting-places of which lie east of the White Sea, such as the grey plover, the little stint, the sanderling, the knot, and the curlew-sandpiper, the eggs of which were not added to his spoils. Their discovery is duly recorded in the "Ootheca" supplement, years after Wolley's death, and the melancholy reflection prevails that in this direction there is nothing more to be done. In the supplement the editor, *apropos* of specimens of knot and curlew-sandpiper from the New Siberian group found in 1902 and added to the collection in 1905, directs attention to an article in the *Ibis* for 1904 by Mr. Dresser. This is a translation in abstract of Dr. Walter's researches in the Taimyr peninsula, where the translator observes that

"Dr. Walter succeeded in taking eggs and young in down of the sanderling (*Calidris arenaria*), curlew-sandpiper (*Tringa subarquata*), and knot (*Tringa canutus*), the eggs of the last being especially valuable, as they are the first well-authenticated specimens yet obtained."

We presume that he is referring to eggs laid in the free state, as the editor claims to have the egg of the knot laid in the late Lord Lilford's aviary.

There are not many illustrations in part iv., but the work as a whole is sufficiently illustrated, especially part i. These illustrations are mainly of two kinds—figures principally of eggs, and lithographic landscapes. The plates of the eggs of raptorial birds by Balcombe are very successful. There are three plates devoted to eggs of the golden eagle, every one of which has a history, mainly Scotch eggs, though some came from Lapland. Nor are these all of Wolley's own taking, since both Alfred and Edward Newton personally shared in some of the Argyllshire captures. In the delineation of the eggs of the Passerines, the artist has perhaps not been quite so successful.

"Of all Mr. Wolley's discoveries," observes the editor, "the one with which his name will be especially perpetuated is his unveiling the mystery that had hitherto surrounded the breeding habits of the waxwing."

These eggs were not obtained in time for the third edition of "Hewitson," but were figured in the *Ibis* for 1861 "as Mr. Hewitson only could depict them." In the "Ootheca" an entire plate is devoted to eggs of the waxwing, which exhibit a fair amount of variety, but the figures do not compare favourably with those in the *Ibis*. One other group of eggs should be mentioned, viz., the double portraits of the seven eggs of the great auk contained in the collection, so well executed by Grönvold. The details regarding these eggs occupy about twenty pages of the catalogue, and it may interest persons who are prepared to give a high price to learn that Wolley's first great auk's egg, obtained on December 12, 1846, from Mr. D. Barclay

Bevan, cost him no more than 28s. The lithographic landscapes, especially numerous in vol. i., add greatly to the interest of this work. There are two very spirited sketches by Wolf of eagles' nests in Argyllshire, drawn to illustrate the locality previously mentioned, but the majority of these landscapes depict scenes in Lapland rendered more or less famous in connection with Wolley's exploits. The old Lapp altar near Muoniovara, the osprey's nest on the top of a Scotch fir on the Norwegian side of the watershed, and the great crane marsh, all three from original sketches by the editor, are examples of these landscapes. But perhaps the most interesting of all—certainly the most poetic—is the picture of the hooper asleep on her nest on an islet in the Patsjoki, at midnight, June 17-18, 1855; this is based on a faint sketch made by Wolley on the spot, and most skilfully interpreted by Mr. Jury. Again (Table O), there is a truly Lapland scene, where the facile golden-eye is about to deposit an egg in a *tylla*, fastened to a fir-tree, for the benefit of the wily native. A map of the country between the Gulf of Bothnia and the Arctic Ocean is added. Muoniovara occupies a fairly central position, and the district more especially exploited is comprised within the upper basins of the Muonio Elv and the Ounas Joki—a stretch of about 150 miles from S.E. to N.W. There is something very musical in the sound of many of the Finnish place-names. Those more especially associated with the great "finds" may be observed in considerable numbers in the central area of the map, and collectors who possess marked eggs from Lapland cannot fail to be interested in the topography of the district.

It is not easy to give anything like a synoptic view of a work which appears in the form of a catalogue, so that its general character can only be inferred from such extracts as we have ventured to make. There is abundance of oological lore, relating to a period when great discoveries were being made, and this matter has been carefully sifted by an editor whose critical acumen and extensive knowledge are well known. The work, therefore, cannot fail to be a valuable repertory of facts, and we are bound to admit that in the "Ootheca Wolleyana" the veteran ornithologist of Cambridge, whilst adding largely to the store of information originally acquired by Wolley, has raised a worthy monument to the memory of his long-lost friend, and we can only express our deep regret that since its completion Prof. Newton has likewise joined the majority.

W. H. H.

INDIAN MALACOLOGY.

Land and Freshwater Mollusca of India, &c. By Lieut.-Col. H. H. Godwin-Austen. Supplementary to Messrs. Theobold and Hanley's "Conchologia Indica." Vol. ii., part x. Pp. 147-238; plates ci-cxvii. (London: Taylor and Francis, 1907.)

IT is just nineteen years since the first six parts (1882-1888) of this work were noticed in these pages (NATURE, July 5, 1888, pp. 217-218), and the author is now the sole active survivor of the celebrated band of Indian malacologists that included Theobald, the Nevills, Stoliczka, Benson, Beddome, and the two Blanfords. One by one they have nearly all gone from us (Dr. W. T. Blanford's demise is still fresh in our memories), leaving, alas, no successors in the field of their labours.

This but adds to our hope that Col. Godwin-Austen may long be spared to carry on the work he has begun, but, so wide is the field, can never expect to complete, especially since of late it has been only now and then he has been able to find time for the examination of material that has come to hand. As a consequence, seven years have elapsed since the appearance of the preceding part of the work before us.

The present number is on a line with its predecessors, and like them shows no arrangement of subject, the various notes being presumably placed in the order in which they were written, and consequently deal alternately with the two families Zonitidæ and Endodontidæ, to which alone the materials treated belong.

In the former family we find one new subgenus, Dalingia, and two new genera, Sarika and Staffordia, established; while the author transfers Austenia, Girasia, and Cryptosoma from the Helicarioninæ to the Macrochlamyinæ, and places Leptodontaria and Ibycus in the Durgellinæ. He further digresses advisedly to discuss the anatomy of three Japanese species, which have been referred to Macrochlamys, but which he shows must be removed, one to a new subgenus, Petalochlamys, and the other two to Lamprocystis.

The most interesting and aberrant member of the family is Stoliczka's genus Sophina, concerning which our author has much of interest to say.

To the family Endodontidæ, which is chiefly an Australasian group, three Indian representatives are referred, namely, Thysanota, Philalanka, and Sykesia, and a new subfamily, Thysanotinæ, is created for their reception.

The wonderful similarity of these animals to Corilla (a Ceylon genus) and Plectopylis is dwelt on, but Stoliczka's idea that the latter was related to Clausilia is rejected.

To the Thysanotinæ may also possibly belong the new genus Rahula, to which the *Helix macropleuris*, Benson, with other species, some new, is referred.

Among suggestions as to topographical distribution is the hint that the fauna of the Bhutan Himalayas may possibly be rather related to that of western China than to that of India.

At the same time, the author is inclined to consider the eastern Himalayas as the centre of dispersal of the genus Macrochlamys, and points to the geological evidence as tending to show that from Sikkim eastward up to the margin of the present plains was an old land area probably coeval with that of peninsular India, and once connected with it across what is now the delta of the Ganges. The south-eastern limit of the range of the genus appears to be about Tenasserim.

So far as the Gangetic valley is concerned, there has been a natural transport southward by flood-waters of the mollusca inhabiting the mountain country, and the molluscan fauna of the great delta of the Ganges and Brahmaputra had its origin in the Himalayan slopes, although they have occupied their present quarters for sufficiently long a period to become specifically distinct. (BV)[2].

WATER AND THE PUBLIC HEALTH.

(1) *The Value of Pure Water.* By George C. Whipple. Pp. viii+84. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 4s. 6d. net.

(2) *The Bacteriological Examination of Water Supplies.* By Dr. William G. Savage. Pp. xvi+297. (London: H. K. Lewis, 1906.) Price 6s. 6d. net.

(1) THIS little book is planned on novel lines and deserves recognition. An extract will best serve to define its scope.

"Given two water sources equally available to a city for purposes of supply, both safe to drink, but one high coloured and soft, the other colourless and hard—which is the better selection? A water-works plant is to be appraised: structurally the system is a good one, but the quality of the water is unsatisfactory because of its excessive colour or turbidity—how much should be deducted from the value of the works because of the bad quality of the water? The water-works owned by a private company are to be purchased by the city; the city has a high typhoid fever death-rate, due unquestionably to the water supply—how much less should the city pay because of that fact? A city is using turbid river water—how much can it afford to pay to filter it? A city is using a water so heavily laden with Anabæna that it is nauseous to drink—how much can the city afford to pay to procure a new supply?"

An attempt is made from available data to establish formulæ which may be employed to calculate the allowable depreciation due to sanitary quality, physical characteristics (colour, odour, &c.), hardness, &c., of a water supply.

The following example is a calculation in the case of typhoid fever. The financial loss to the community for each death from typhoid fever is assumed from various data to be equal to 10,000 dollars. A proportion of the death-rate is due to the disease transmitted by means (shell-fish, flies, &c.) other than water. Assuming that all typhoid in excess of N is due to the water supply, that the daily consumption of water is 100 gallons per capita, and that T is the total typhoid death-rate per 100,000, then $(T-N)$ $10{,}000=$ loss to the community in dollars for $365 \times 100 \times 100{,}000$ gallons of water, or

$$D=\frac{(T-N)1000}{365}=2\cdot75(T-N),$$

where D stands for the loss in dollars per million gallons of water used. The author is quite alive to the fact that local and other conditions must modify his conclusions, and recognises that more data are required before finality is reached in the elaboration of the formulæ. The book is suggestive and stimulating reading, the various tables add to its value, and we heartily commend it to the sanitarian and water engineer.

(2) This book by Dr. Savage, who has made many important contributions to the subject on which he writes, gives an admirable survey of the present position of the bacteriology of water supplies. Successive chapters deal with the bacterial content of waters and the influences affecting it, excreta, sewage, and soil in relation to the bacteriological examination, the characters of the intestinal bacteria, bacterial evidences of pollution, and full details of the methods employed in the bacteriological examination of water. The chapter on the interpretation of results is particularly to be recommended. A full bibliography is appended. The medical officer of health, the analyst, and the bacteriologist will find this book a trustworthy and useful guide. R. T. HEWLETT.

THREE MATHEMATICAL TRACTS.

Quadratic Forms and their Classification by Means of Invariant Factors. By Prof. T. J. I'A. Bromwich, F.R.S. Pp. viii+100. (Cambridge: The University Press, 1906.) Price 3s. 6d. net.

The Axioms of Projective Geometry. By Dr. A. N. Whitehead, F.R.S. Pp. viii+64. (Cambridge: The University Press, 1906.) Price 2s. 6d.

The Axioms of Descriptive Geometry. By Dr. A. N. Whitehead, F.R.S. Pp. viii+74. (Cambridge: The University Press, 1907.) Price 2s. 6d.

THESE are Nos. 3, 4, and 5 of the Cambridge Tracts in Mathematics and Mathematical Physics, which are intended to help students by providing them with brief and readable introductions to mathematical theories which are important in themselves, and yet for various reasons do not appear in the ordinary text-books. If they serve their purpose they will induce their readers to follow up the paths they indicate, and try to explore still further the mazy garden of the mathematical muse.

The present state of the theory of quadratic forms illustrates very well how much interest there may be in the particular cases of a problem which, in its so-called "general form," has a trite and familiar solution. To put the matter into a geometrical shape; when there are four homogeneous variables, let $S=0$, $T=0$ be the equations of two quadratic surfaces; then in general the family $S+\lambda T=0$ will have a common self-conjugate tetrahedron, and by taking this as a tetrahedron of reference, S and T assume a well-known standard form. But there are thirteen other cases to consider, for each of which there is a distinct reduced form of $S+\lambda T$; for instance, if S and T intersect in a cuspidal quartic, the reduced form is

$$2(\lambda+a)xy+2yz+b(\lambda+a)z^2+c(\lambda+d)t^2.$$

If we consider the small oscillations of a dynamical system with four degrees of freedom, we are confronted by precisely the same analytical problem of reduction; the algebraical classification is the same, but certain cases are ruled out by the condition that the kinetic energy of the system is necessarily positive; still more, if the potential energy is a true minimum.

Prof. Bromwich has given an excellent account of the analytical theory, with various geometrical and dynamical illustrations, and he has added a very useful bibliography. As he has pointed out himself, he has selected Kronecker's method of proof of the invariance of the factors of the discriminant of $S+\lambda T$; and he has made no reference to the specially arithmetical form of the problem, where the coefficients of the forms are integers, and the equations of transformation have to be unitary and integral. For this, the student will consult Frobenius, Hensel, and H. J. Smith, whose memoirs, of course, Prof. Bromwich includes in his list of references.

Dr. Whitehead's chapters deal with a subject which, on the one hand, is more ancient than that of Prof. Bromwich, but, on the other, has changed its aspect recently in a much more remarkable way. Dr. Whitehead is one of the company of sappers who are reducing all the mathematical part of geometry to a system of abstract logic applied to a minimum number of undefinable entities, connected by a minimum number of undefinable relations. Put in this bald way, their work seems purely destructive and hateful, but in reality it is not so. In the tract on projective geometry it is shown how, with the help of Dedekind's axiom, and those of order, it is possible to make rigorous von Staudt's proof that all the points on a line are either reached by harmonic constructions starting from three given points, or definable as limiting points of a set of such points. This leads to definitions of numerical cross-ratios and of numerical homogeneous coordinates *which are independent of any theory of distance or measurement*, a very remarkable and far-reaching result. It is very encouraging to find that the magnificent genius of von Staudt is gradually gaining the recognition that it deserves; the interval between him and his predecessors is at least as great as that between Apollonius and Steiner.

By "descriptive" geometry Dr. Whitehead means "any geometry in which two straight lines in a plane do not necessarily intersect." Besides the discussion of preliminary axioms and definitions, his second tract falls into two principal parts; the first deals with the problem of enlarging a descriptive space into a projective space (the simplest example is that of adjoining the plane at infinity to Euclidean space), the second with the theory of displacements and measurement. The latter is based upon what is, perhaps, the only satisfactory method—that of Sophus Lie. The last chapter gives the formulæ of metrical geometry in the shape given to them by Cayley and Laguerre, so that, neglecting a constant numerical factor, a distance and an angle are each measured by the logarithm of a cross-ratio. The cross-ratio, of course, must be *projectively* defined, otherwise we should be in a vicious circle, and it is in the avoidance of this circle that the latest perfection of the theory consists.

G. B. M.

OUR BOOK SHELF.

Practical Agricultural Chemistry. By F. D. S. Robertson. Pp. x+210. (London: Baillière, Tindall and Cox, 1907.) Price 7s. 6d. net.

IN his introduction the author tells us that his book is intended as a course of laboratory practice for the use of students in agricultural chemistry. How much time does he suppose such students can give to agricultural chemistry to allow them to deal with subjects like the valuation of tea and coffee, or the determination of hop resin and glycerin in beer? To what class of readers is a paragraph like the following of use? "*The Bitter Used.* This is necessarily a tedious operation, and for full particulars the reader is referred to such books upon poisons as describe the processes of Dragendorff and others. The prepared and concentrated beer is subjected to a series of extractions with petroleum ether, benzene, chloroform, and amyl alcohol, each of which is examined in turn."

Even in the more properly agricultural parts of the book there is little evidence that the author possesses any working acquaintance with his subject, *e.g.* the chapter on the analysis of soils is the merest skeleton, possessing small reference to the methods in regular use, and containing actual errors, such as the attempt to estimate humus by solution in ammonia without a preliminary treatment of the soil with acid.

Again, in his description of the Reichert-Wollny process for estimating volatile acids in butter, the author says nothing of the official standardisation of the dimensions of the apparatus and other details, which, however, must be followed if figures are to be obtained comparable with those of other analysts, and indeed are absolutely essential if the analyst is doing public work. We cannot recommend Mr. Robertson's book.

An Episode of Flatland, or How a Plane Folk discovered the Third Dimension, to which is added An Outline of the History of Unaea. By C. H. Hinton. Pp 181. (London: Swan Sonnenschein and Co., Ltd.)

THESE plane people live on the edge of a disc which is their world. A third dimension exists only in their mathematics. Their astronomers find that a catastrophe will certainly happen. One cranky philosopher believes that there is a third dimension, and shows a scared people how their world may be tilted and the catastrophe averted. The author's characters act and make love much like three-dimensional people, and they talk of a higher dimension just as Mr. Hinton would himself talk of a fourth dimension. There never was an allegory, not even that of Bunyan, which was consistent with itself for one chapter, but Mr. Hinton's is more inconsistent with itself than any other allegory we have seen. J. P.

The Bernese Oberland. Vol. iii. Dent de Morcles to the Gemmi. By H. Dübi. Pp. xxiv+136. (London: T. Fisher Unwin, 1907.) Price 10s.

THIS conveniently arranged pocket-book is the most recent addition to the "Climbers' Guides" edited by Sir Martin Conway and the Rev. W. A. B. Coolidge. The southern limit of the region described is the Rhone Valley from Martigny to Leuk; and the northern is marked by the low passes leading from the Ormonts-Lessus glen to Kandersteg by the heads of the Grande Eau, the Sarine, the Simme, and the Kander valleys, which mark it off from the foothills. The preface of the book directs attention to the fact that the present is the jubilee year of the formation of the Alpine Club and of the ascents of the Oldenhorn and the Wildstrubel, and we are confident that the increase in the number of climbers during the last fifty years will ensure a wide popularity for this workmanlike volume of "marching orders."

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Layard's Beaked Whale (Mesoplodon layardi, Flower).

ON February 17 a Layard's beaked whale was found stranded on the beach a little south of Zwartkops River, north of Port Elizabeth, by Joseph G. Crawford. The following morning I dispatched my assistant, Mr. Jas. Crawford, to inspect the carcase. He brought the tusks back, when the animal was identified as Layard's beaked whale. Immediate action was taken, with the result that the skeleton is now mounted in the Port Elizabeth Museum. As the carcase was partially decomposed when discovered, it was impossible to save the skin, but measurements and drawings were taken on the spot, and the coloration of the skin noted.

FIG. 1.—Layard's Beaked Whale, from a drawing. Engraving photographed by Mr. F. W. FitzSimons director of the Port Elizabeth Museum.

So little is known of this whale that the present specimen is of considerable importance. The skull, teeth, breast-bones, the entire skeleton, and other parts have been photographed from every point of view, while photographs have also been taken from a sketch, to scale, of the animal while lying on the beach. Any institutions requiring copies of these photographs may have them on application to me if they will defray the expense connected with their reproduction.

The following are the details:—

The animal, which was a male, measured 19 feet 2 inches in length, was entire, and showed no external injury. The colour of the back was dark brown, inclining to black on the dorsal surface, gradually merging to brown on the sides and tail, and becoming whitey-brown or dirty white on the belly. In Prof. Moseley's description there is stated to be a distinct line of demarcation between the black and the white, but in the specimen under discussion the blackish of the back gradually merged to brown on the sides, and dull white on the belly.

The flippers measured 22 inches; the dorsal fin, which is situated far back, was 13 inches wide and 11 inches high; the tail, 4 feet 6 inches across at extremes; and the interval from the point of the beak to the eye was 38 inches, and to the end of the jaw 4 feet. The exposed portion of the teeth was 11 inches long and $2\frac{1}{2}$ inches wide at the base, becoming slightly narrower towards the tip, with the conical real tooth at the front of the summit. This tooth is enamelled and sharply tipped.

In the figure of the skull given by Moseley on p. 157 of "A Naturalist on the *Challenger*," there are marked differences when compared with our specimen. Thus the lower jaw shows an upward bend in front, whilst in our specimen it is straight. The proportion of the slope in the upper jaw is also dissimilar, whilst the teeth show a kind of wearing-away slope toward the middle portion. The teeth in our whale are uniform from base to tip, showing no wearing away or indication of friction. The small real tooth at the summit of each tusk is sharp, and not wart-like. Again, though the figure given by Moseley shows the teeth uniform, and not crossed, it is stated in the text that their extremities cross. The second illustration to this article distinctly shows the absence of any crossing of the tusks. This was ascertained before they were removed from the jaws. The tusks were firmly embedded in their sockets.

In Sclater's "Fauna of South Africa," vol. ii., p. 194, is an illustration of the snout of a Layard's whale with the tusks crossed, and the drawing shows important differences when compared with the photographs of our specimen. Inspection of the muzzle proved that this whale was able to open its mouth from $4\frac{1}{2}$ inches to 5 inches at the tip. The fleshy covering of the upper jaw beneath the teeth showed no mark or abrasion, indicating that the beak was opened only so far as the teeth allowed. Moseley

FIG. 2.—Upper views of skull of Layard's Beaked Whale. From a photograph by Mr. F. W. FitzSimons, director of the Port Elizabeth Museum.

states that the hollowing-out of the central part of the tusks figured by him was caused by the friction of the snout when the animal opened its mouth. The tusks of our specimen showed no such sign, and the skin of the beak displayed no indication of coming frequently into contact with a hard body. Judging from the width of the gullet, this whale does not require to open its mouth very wide; as the gullet is only from $1\frac{3}{4}$ inches to 2 inches in diameter, it indicates that the food consists of small morsels. The sharp, enamelled tooth at the summit of the tusk is probably used for tearing and rending soft-bodied animals such as cuttle-fishes, and possibly for tearing aside seaweeds when in search of food.

The tusks are 14 inches in length, $2\frac{1}{2}$ inches wide at the jaw, $1\frac{3}{8}$ inches at the summit beneath the conical real tooth, and from $\frac{3}{8}$ inch to $\frac{1}{2}$ inch thick. On the back the blubber was 3 inches thick, and $1\frac{1}{2}$ inches on the belly. The oil was of fine quality, and had great penetrating power, almost like paraffin. Owing to the advanced state of decomposition of the viscera, the contents of the stomach were not examined.

From the foregoing it is evident either that previous drawings and data in regard to Layard's whale are more or less inaccurate, or that the present specimen indicates a new species. The drawings show that the upper lip or tip of the beak covers the lower lip, while the photographs indicate that the upper jaw slightly projects beyond the lower, the reverse being apparently the case in Sclater's and Moseley's illustrations. The lips were not horny, but rather like hardish flesh. The skull is very asymmetrical, the bulk of the frontal bones inclining from the right to the left side.

The creature had apparently been injured at some previous time, as the tongue-bones and two vertebræ showed signs of having been fractured and repaired. One of the most remarkable features of this whale is the small size of the flippers as compared with that of the body. The backward position of the dorsal fin is also noticeable. With the exception of those of the skull, the bones are remarkably light and porous. Those of the beak are, however, brittle, dense, and hard.

F. W. FITZSIMONS.

Port Elizabeth Museum, May 30.

The Radio-activity of Lead and other Metals.

IN the course of some experiments that have been recently carried out in the physical laboratory at Toronto on the natural conductivity of air confined in vessels made of different metals, a wide variation was observed in the results obtained with different samples of lead. The lowest conductivity observed with air enclosed by this metal corresponded to an average production of 23 ions per c.c. per second, and the highest to a production of 160 ions per c.c. per second. The lowest value hitherto recorded for lead appears to be that quoted by Eve in his paper in the *Phil. Mag.* of September, 1906, in which he gives 96 ions per c.c. per second as the number he obtained with this metal. The sample of lead which exhibited the low activity just referred to was a sheet which had been used as a lining in a case in the laboratory for nearly thirty years.

With zinc and aluminium receivers it was found that on the average 15 ions per c.c. were generated per second in the air which they enclosed.

From measurements made with the gamma rays from radium on the ionisation produced in air confined in a lead cylinder (1) when unlined, and (2) when lined with thin sheet aluminium, due allowance being made for absorption, it was found that the ionisation in a lead cylinder due to the gamma rays was one-half that obtained with the excited secondary radiation. On the other hand, with an aluminium cylinder, the ionisation due to the secondary radiation was found to be approximately one-half that produced by the gamma rays. Assuming these results to hold for the penetrating radiation from the earth, it follows that on the average 9 ions per c.c. per second are generated in free air by this radiation. It also follows that the difference between the natural ionisation in air observed with the aluminium cylinder, viz. 15 ions per c.c. per second, and that found with the least active lead, viz. 23 ions per c.c. per second, can be wholly explained by differences in the secondary radiation excited in the two metals. This result, combined with the observed differences in the conductivity of air enclosed in vessels made of different samples of lead, goes to show that the high activity usually observed with lead is due to the presence of active impurities in it, and not to the existence of any intrinsic activity possessed by the metal. In this connection it is interesting to note that Elster and Geitel (*Phys. Zeit.*, November, 1906, and May, 1907) have recently been able to extract from commercial lead oxide and a sample of lead an active substance which they suggest may possibly turn out to be radium F.

In the experiments described above, the measurements were made with a sensitive quadrant electrometer on air confined in cylindrical vessels 60 cm. high and 24 cm. in diameter.

J. C. MCLENNAN.

University of Toronto, June 25.

Inheritance and Sex in Abraxas grossulariata.

IN February, 1906, in conjunction with the Rev. G. H Raynor, I gave a paper to the Zoological Society on the inheritance of a variety of the moth *Abraxas grossulariata* and its relation to sex (Proc. Zool. Soc., 1906, vol. i. p. 129). We found that when the var. *lacticolor* (*flavofasciata*) was crossed with the type it behaved as a Mendelian recessive, disappearing entirely in generation F. When two heterozygotes were mated together, var. *lacticolor* reappeared, but only in the female sex, roughly half the females and all the males being typical. When a heterozygous male was mated with *lacticolor* female, the variety appeared in both sexes in the offspring, viz. in about half the males and half the females. When, however, a *lacticolor* male so produced was paired with a heterozygous female, we found that all the males were typical and all the females *lacticolor*. This result was given in our paper with some hesitation, since it was founded on a rather small number of specimens (29 ♂, 11 ♀), but this year it is amply confirmed. I have reared 116 males and 74 females from six families of this mating, and every male is typical, every female *lacticolor*. Mr. Raynor has also reared equally large numbers with the same result. From a family of the converse cross, on the other hand (*lacticolor* ♀ × heterozygous ♂), I have reared 24 type ♂, 22 *lacticolor* ♂, 17 type ♀, 18 *lacticolor* ♀, a fair approach to the expected equality in each sex.

I think it may be concluded definitely that in this case

(1) The type is completely dominant.
(2) DR♀ × DR♂ gives DD♂ + DR♂, DR♀ + RR♀.
(3) R♀ × DR♂ gives DR♂ + R♂, DR♀ + R♀.
(4) DR♀ × R♂ gives DR♂, R♀.
(5) R♀ × R♂ gives R♂, R♀.

(In [2] above the absence of DD females has not been proved.)

This confirmation of our previous results seems to me to lend some support to the provisional hypothesis of sex-determination outlined in the paper referred to.

L. DONCASTER.

University of Birmingham, July 2.

THE DOUBLE-DRIFT THEORY OF STAR MOTIONS.

THE problem of determining the motion of the sun amongst the stars has undergone a great change in consequence of Prof. J. C. Kapteyn's investigations, which have recently become known. These researches indicated that the stars surrounding us do not form a simple system, but a dual one. From a discussion of the motions of the stars of Bradley's catalogue, Prof. Kapteyn demonstrated the existence of two great streams of stars passing through one another, and found the directions of motion of these streams relative to the sun and to one another. The Bradley stars, numbering about 2600, are mainly stars visible to the naked eye; they cover nearly three-quarters of the celestial sphere, and throughout the whole of this area Prof. Kapteyn found the same two streams prevailing, and it seemed probable that all the stars he examined belonged to one or other of the two streams.

The investigations with which this article more particularly deals are based on the proper motions deduced by Prof. Dyson and Mr. Thackeray from their re-reduction of Groombridge's Catalogue. The number of stars included is 4200, all confined to a region within 52° of the North Pole. About 1100 Carrington proper motions were also examined; these were all within 9° of the Pole. These two catalogues contain a large proportion of stars much fainter than those of Bradley, and enable the inquiry to be extended as far as magnitude 9·5. The same two streams are found to prevail among these faint stars, and it seems a fair conclusion that all the stars down to at least magnitude 9·5—more than half-a-million in number—are within the scope of the theory. It should, however, be remembered that only *samples* have been taken, in limited regions of the sky, for these fainter stars, so that there is a possibility of unexpected deviations from theory in the at present unexplored regions.

To indicate how it is possible to distinguish whether the stars in a given region of the sky belong to a single system or to a double system, or to something still more complex, it will be well to take an actual instance. In Fig. 1 the curve P has been drawn to

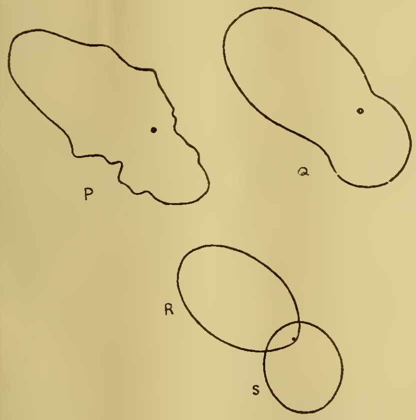


FIG. 1.—Showing the analysis of the observed motions into two simple drifts.

summarise the proper motions of the stars in a region of the sky comprising parts of the constellations Draco, Boötes and Hercules. The radius drawn from the dot to the curve in any direction represents (by its length) the number of stars moving in that direction, or rather within 5° on either side of that direction. Now the distribution of proper motions indicated by this figure cannot possibly be due to a system of stars forming a single "drift," that is, a system in which the motions of the stars *inter se* are haphazard, though the system as a whole may be in motion relative to the sun (or, as it is more usually expressed, the sun may be in motion relative to the system). The type of curve resulting from such a drift can be calculated mathematically; R and S are such curves. It is not difficult to see that, having regard to the position of the origin, no curve of this symmetrical type could be chosen which would at all approximately coincide with the observed curve P. The hypothesis of one drift, therefore, does not give even an approximation to the observed distribution of proper motions. But by combining the two drifts R and S, we obtain the curve Q, which agrees very closely with the observed curve. The differences between P and Q are, in fact, insignificant, and of a purely accidental character.

For each of seven regions into which the Groombridge stars were divided, as well as for the Carrington stars, the observed distribution of proper motions allowed itself to be dissected in this way, and exhibited as the result of two simple drifts intermingled. The agreement between the observed distribution and the theoretical distribution was not always quite so perfect as in the case illustrated. For instance, in one region the observed curve showed twenty-four stars moving where they ought not to have been; presumably they formed a local system; but such an irregularity is small compared with the two main drifts, which in that region each included more than 400 stars. Most of the regions, however, did not show even such a small irregularity as this.

The shape of the simple drift curve depends on the velocity of the drift (relative to the sun) as compared with the mean velocity of the stars of the drift relative to one another. Naturally, for high drift-velocities the curve becomes more elongated, for the tendency then is for all the stars to move nearly in the direction of the drift, the individual motions being relatively

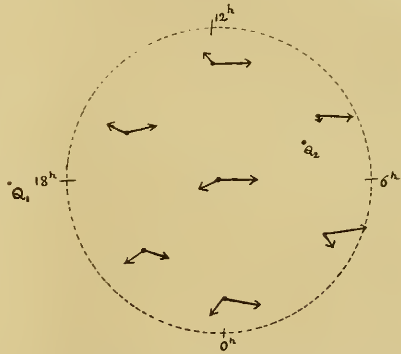


FIG. 2.—The region within 52° of the North Pole. The arrows show the magnitudes and directions of the drift velocities.

small; for low drift-velocity the curve is rounder, approaching the form of a circle about the origin for the limiting case of zero drift-velocity. The curves R and S correspond to drift velocities 1·20 and 0·45 respectively (the unit is 0·886 of the mean peculiar speed of the stars). The analysis, therefore, not only shows the directions in which the two systems of stars are moving, but also their velocities.

Fig. 2 is a diagram of the part of the sky covered by the Groombridge catalogue. At seven points (the centres of seven regions into which the area was divided) are drawn pairs of arrows representing the velocities of the two drifts in magnitude and direction, determined for each region independently, as explained above; but in each case the shorter arrow of the pair has been drawn on twice the scale of the longer one, so that the difference in velocity of the two drifts is even greater than appears from the figure. This attempt to represent a considerable portion of the sphere on a plane surface is necessarily imperfect, but it is sufficient to show that each set of arrows is directed approximately from a point, viz., the longer arrows from the point Q_1 (R.A. 18h., Decl. + 18°) on the left of the figure, and the shorter arrows from the point Q_2 (R.A. $7\frac{1}{2}$h., Decl. $+58°$). It will be convenient to refer to the two systems as Drift I. and Drift II.; Drift I. accordingly is a group of stars in rapid motion from the point Q_1, and Drift II. a group in comparatively slow motion from the point Q_2, its velocity being, in fact, not quite one-third that of Drift I. Fig. 2 also shows that the speed of Drift I. appears smaller in the regions nearest Q_1, and of Drift II. in the regions nearest Q_2. This is because that part of the drift motion which is in the line of sight has no effect on the proper motions, and cannot be detected by examining them. The component of the drift motion *across* the line of sight decreases as the apex of the drift is approached, and vanishes at the apex itself.

Another result from the mathematical analysis is that the stars are nearly equally divided between the two drifts, Drift II. having, perhaps, a slightly greater proportion. It is rather remarkable that although some parts of the sky are more than twice as rich in stars as others, the approximately equal division between the two drifts is maintained in every region.

It is natural to inquire whether there may not be some other distinction between stars of the two drifts besides their motions. The fact that the sun moves comparatively slowly relative to Drift II. rather suggests that the sun belongs to this drift. In that case it might be expected that the Drift II. stars would be nearer on the average than those of Drift I., the latter forming a sort of background. The magnitudes of the proper motions (which have up to this point not been considered) afford data for testing this point. Due allowance having been made for the fact that the true Drift II. motion has already been found to be very much less than that of Drift I., the apparent motions indicate the same mean distance for the two drifts. In fact, a mathematical calculation showed less than 5 per cent. difference between the mean distances of the two drifts (though it is improbable that the data can be trusted quite so far as this). Remembering that the two drifts divide the stars in nearly the same proportion in all the regions, it would seem that they are as completely mixed as it is possible to imagine.

One point of great interest is the distribution of the stars of different spectral types among the drifts. It has been customary to regard Secchi's two types as forming to a certain extent two systems, for Type II. stars are very evenly distributed throughout the sky, whereas those of Type I. tend to congregate in the plane of the Milky Way. It is, however, quite certain that the division into two spectral types and the division into two drifts do not correspond. If we examine Type I. stars alone, both drifts are evident; and so also if Type II. stars are examined alone. Nevertheless there is a systematic difference between the distribution of the proper motions of the Type I. and Type II. stars, which manifests itself in every region examined (including the Bradley stars). It may perhaps be interpreted as being due to a higher percentage of Type II. stars in Drift II. than in Drift I., but it now appears more probable that the difference consists in Type II. stars having larger "peculiar" motions (the haphazard individual motions) than Type I. stars. In addition to some satisfactory direct evidence, this latter explanation is supported by the fact that nearly all the "runaway" stars are of Type II., and it also agrees with the difference in distribution of Type I. and Type II. stars; the former mainly congregate in one plane, whilst the latter, perhaps originally in the same plane, would have become more uniformly distributed in consequence of their greater individual velocities.

There is no indication of any relation between magnitude and drift, except possibly in the case of the very bright stars (brighter than magnitude 4·0). These latter seem to belong principally to Drift I., but they are so few in number (in the area examined) that the result may very well be accidental.

Having determined the motions of the two drifts of stars relative to the sun, and knowing also that the stars are nearly equally divided between them, it is easy to determine the motion of the sun relative to the combined drifts—in fact, to determine the *solar apex*. In this way the solar apex is found to be at R.A. 17h. 45m., Decl. $+31°$; it is naturally fairly close to Q_1, since the velocity of Drift I. predominates. From the same stars, by Airy's method, Dyson and Thackeray found the solar apex to be at R.A. 18h. 20m., Decl. $+37°$. The somewhat greater R.A. of their determination (and of most other determinations) is probably the result of using the magnitudes of the proper motions. This position, deduced by means of the two-drift theory from the directions of the proper motions only, has the advantage of being free from all assumptions as to the distances of the stars, but the probable accidental error is large. The two-drift theory further directs attention to the true nature of the "solar motion" so determined; it is in no sense an *absolute* motion, and there is now no justification for confounding it with the motion relative to the æther, as has sometimes been done.

In conclusion, whilst Prof. Kapteyn's theory accounts in a simple manner for the very anomalous and unsymmetrical way in which the directions of motion of the stars are distributed, it is still awaiting the verdict of the spectroscopic determinations of line-of-sight velocities. The material exists in plenty for applying this test; it simply awaits examination by those who have access to it. The investigation of the motions of still fainter stars, and of regions of the sky which have not yet been explored, offers a large field for further research.

A. S. EDDINGTON.

SEVENTH INTERNATIONAL ZOOLOGICAL CONGRESS.

THE arrangements for the seventh International Zoological Congress, which will be held at Boston, August 19–23, under the presidency of Mr. Alexander Agassiz, are now well advanced. The congress will open formally on the afternoon of August 19 in the Harvard Medical School, and arrangements will then be made for the meetings of the sections. The subdivision proposed is rather elaborate, for there are to be sections on general zoology, systematic zoology, experimental zoology, marine zoology, evolution, heredity, and so on. There will be three general meetings; the International Committee on Zoological Nomenclature, under Prof. R. Blanchard, will continue its arduous labours; and numerous addresses, communications, and exhibits have already been arranged for. It need hardly be said that the arrangements for hospitality are generous. On each day of the strict congress week there will be luncheon at the invitation of the Boston local committee, and the evenings will be occupied with receptions and dinners.

On the afternoon of August 22 there will be an excursion to Wellesley College; August 24 will be devoted to a visit to the museums of Harvard University; August 25 is Woods Hole Day; August 26 Columbia University Day; August 27 the American Museum Day. On August 28 the members of the congress will visit the marine laboratory of the Brooklyn Institute of Arts and Sciences, and the Carnegie station for experimental evolution at Cold Spring Harbour. On August 29 the New York Zoological Society will receive in the morning in the New York Aquarium, and in the afternoon in the Zoological Park; in the evening there will be a reception in Columbia University library.

On Friday, August 30, Prof. Henry Fairfield Osborn invites the congress to an excursion up the Hudson to West Point and Garrison. Saturday will be devoted to the Universities of Yale and Princeton.

On Monday, September 2, the congress will move from New York to Philadelphia; there will be luncheon at the Academy of Natural Sciences, followed by inspection of the library and museum; there will be an afternoon drive to the Zoological Gardens and Fairmount Park; in the evening there will be supper at the Philadelphia Country Club.

On September 3 there will be visits to the American Philosophical Society, Independence Hall, Girard College, the University of Pennsylvania, and thereafter the congress will move on to Washington. On September 4 there will be a general meeting in the assembly hall of the Cosmos Club, Washington, at which addresses of welcome will be given by the secretary of the Smithsonian Institution, the president of the Carnegie Institution, and the president of the Washington Academy of Sciences. This will be followed by a visit to the National Zoological Park, the Congressional Library, the United States Department of Agriculture, the Hygienic Laboratory, and other points of zoological interest. In the evening there will be a reception by the Cosmos Club.

On September 5 the congress will proceed by boat on the Potomac River to Mt. Vernon, the home of George Washington, and to the United States Navy Proving Station at Indian Head. There will be dinner at Marshall Hall, and an evening reception at the United States National Museum.

On Saturday, September 7, an excursion has been arranged to Niagara Falls and across Lake Ontario to Toronto, returning to New York on Monday night or Tuesday morning.

If fifty members agree to go, there will be an excursion to Bermuda, which will give the members of the congress an opportunity of becoming acquainted with a very interesting semitropical zoological region. Members will have facilities in collecting and preserving zoological material. The expenses of the expedition for each participating member will be thirty-two dollars for return passage and about two dollars a day hotel charges while in Bermuda. After the party lands in Bermuda, the local committee will supply, free of charge, all transportation, carriages, steamers, &c., and such other incidentals as will ensure a successful expedition. It is to be hoped that this very attractive part of the programme will be carried out. The inclusive dates fixed for the expedition are September 14–22.

It may be noted that the executive committee of the Boston meeting consists of Profs. G. H. Parker (chairman), Samuel Henshaw (secretary), L. O. Howard, J. S. Kingsley, E. L. Mark, and H. F. Osborn.

If two suggestions from experience might be ventured, we would submit that outside each sectional meeting there should be a time-table board showing what precisely is going on, and that each member should wear in his button-hole a number corresponding to a printed list, so that strangers to one another may know at once who's who!

THE LEICESTER MEETING OF THE BRITISH ASSOCIATION.

Provisional Programmes of Sections.

ARRANGEMENTS for the work of the various sections are now approaching completion, and we are able to give the provisional programmes. It is evident from this list of papers and discussions, incomplete thought it is, that many matters of wide scientific interest will be brought forward at Leicester.

Among the foreign representatives who have accepted invitations to be present are the following:—Section A.: Prof. L. Natanson, Prof. D. J. Korteweg, Prof. H. G. van de Sande Bakhuyzen, Dr. Oskar Backlund, Prof. Donner, M. Ch. Féry; Section B.: Prof. R. Abegg, Prof. A. Tschitschibabin, Prof. T. W. Richards, Prof. A. Werner, Prof. F. M. Jaeger; Section C.: Prof. H. Sjögren, Prof. F. Frech, Prof. C. Diener, Prof. J. P. Iddings; Section D.: Prof. H. Simroth; Section E.: Prof. P. Vidal de la Blache, Prof. Max Eckert; Section H.: Prof. E. Naville; Section I.: Prof. N. Zuntz; Section K.: Prof. J. P. Lotsy, Prof. R. Chodat, Prof. H. Conwentz, Prof. O. Uhlworm; Section L.: Dr. Otto Anderssen, Dr. F. Rönning, Prof. M. L. Morel. Corresponding members Baron D. Kikuchi, Prof. P. H. Schoute, Prof. R. Nasini, and Prof. George F. Barker have also expressed their intention of being present.

The address of Prof. A. E. H. Love, F.R.S., the president of Section A (Mathematical and Physical Science), will be delivered on the morning of Thursday, August 1. Several discussions have been arranged. On Friday, August 2, there is to be one on the constitution of the atom, which will be opened by Prof. E. Rutherford, who will be followed by Sir O. Lodge, Mr. G. A. Schott, and others. On Monday, August 5, Dr. L. Holborn, of Charlottenburg, will open a discussion on radiation-pyrometry; he will be followed by M. C. Fery, of Paris. On August 6, a paper by Mr. W. Palin Elderton on modern methods of treating observations will consist of an exposition of the methods of Prof. Karl Pearson, chiefly as applied to meteorological phenomena. It is hoped that all will attend who are interested in the reduction of observations of any kind, and assist to make the discussion useful. The following papers have also been promised:—On the nature of ionisation, Prof. H. E. Armstrong; an analytical study of the meteorological observations made at the Glosson Moor kite station during 1906-7, Miss M. White, Mr. T. V. Pring, and Dr. J. E. Petavel; recent developments of the methods of forecasting by means of synoptic charts, Dr. W. N. Shaw; ether density, Sir O. Lodge; sæcular stability, Prof. H. Lamb; modern work on the calculus of variations, Prof. A. R. Forsyth; exhibition of models of three-dimensional sections of the regular hypersolids in space of four dimensions, Mrs. Stott; a method of obtaining the chief properties of the exponential function, Prof. A. E. H. Love; operational invariants, Major MacMahon; a property of Abelian groups, Mr. Harold Hilton; factorisation of the Pellian terms, Lt.-Col. Cunningham; on the theory of integral equations, Mr. H. Bateman; a mountain observatory in India, Prof. C. Michie Smith. The various committees connected with the section will also present their annual reports.

Section B (Chemistry) has made the following provisional arrangements:—August 1: Presidential address, Prof. A. Smithells; discussion on valency, to be opened by Prof. W. J. Pope, and in which Prof. Werner (Zürich), Prof. Abegg (Breslau), Prof. Richards (Harvard), Prof. Jaeger (Amsterdam), Prof. J. J. Thomson, Mr. W. Barlow, and others will take part. August 2: Joint discussion with Section G on explosion temperatures. The following members will take part:—Dr. Boudouard (Paris), Prof. Haber (Karlsruhe), Mr. Dugald Clerk, Prof. B. Hopkinson, Prof. H. B. Dixon, and others. August 5: Reports will be received from the research committees:—(1) The transformation of aromatic nitramines; (2) the study of hydroaromatic compounds; (3) preparation of a new series of wave-length tables of the spectra of the elements; (4) dynamic isomerism; (5) the study of isomorphous sulphonic derivatives of benzene. The following papers will be read:—The applications of Grignard's reaction, Dr. A. McKenzie; paper by Prof. Tschitschibabin (Moscow); fluid crystals, Prof. Jaeger; atomic weights, Prof. T. W. Richards; carbon suboxide, Dr. Boudouard; carbonyl compounds, Dr. H. O. Jones. August 6: Discussion on the chemistry of wheat and flour with special reference to strength, to be opened by Mr. A. E. Humphries, president of the National Association of British and Irish Millers. The following will take part:—Messrs. R. H. Biffen, T. B. Wood, A. D. Hall, Horace Brown, J. L. Baker, A. J. Banks, E. F. Armstrong, and E. S. Watkins.

The following papers, among others, will be read in Section C (Geology):—Prof. W. W. Watts and Mr. Fox Strangways will give addresses on the geology of the country round Leicester. These will be followed by papers dealing with local geology by Drs. Bennett and Stracey and Messrs. Horwood, Bosworth and Keay. A discussion on the origin and extent of the iron ores of Britain will be opened by Mr. Bennett H. Brough; and other authorities on the subject are expected to take part in it. Among other subjects to be brought forward are:—Earthquakes, Prof. Milne; pisolitic iron ores, Mr. W. G. Fearnsides; desert forms, Mr. H. Ferrar; the ancient volcanoes of Basutoland, Rev. S. S. Dornan; a remarkable occurrence of strontia near Bristol, Mr. H. Bolton; the gravels of Holderness, Messrs. Stather and Sheppard; and the occurrence of a marine peat near Liverpool, Mr. J. Lomas. Reports of various committees will be presented. On the fauna and flora of the Trias, Mr. J. Lomas; Carboniferous faunas and zones, Drs. A. Vaughan and Wheelton Hind; Anglesey Rocks, Mr. E. Greenly; terms used in geography and geology, Mr. W. G. Fearnsides; erratic blocks, Prof. P. F. Kendall; Pre-Devonian rocks of the Mendips, Prof. S. H. Reynolds; and the Kirmington Drifts, Mr. Stather. Excursions will be made to places of geological interest every afternoon during the meeting, and longer excursions have been arranged for the week-end and at the close of the meeting.

The following items have been arranged for Section D (Zoology):—Presidential address, Dr. W. E. Hoyle; discussion (in conjunction with Section of Botany) on the physical basis of heredity, to be opened by Prof. S. J. Hickson; discussion (in conjunction with the Sections of Botany and Education) on the teaching of biology in schools, to be opened by Mr. O. H. Latter, of Charterhouse; afternoon lecture by Dr. C. W. Andrews, adaptation to aquatic life in reptiles and mammals; problems in the sexual organisation of the Crustacea, Mr. G. W. Smith; Pycnogonida, Mr. T. V. Hodgson; demonstration of models, Protozoa, &c., Mr. F. R. Rowley; experiments on seasonally dimorphic forms of African Lepidoptera, Dr. F. A. Dixey; (1) classification of the Haplosporidia, (2) the movements of Spirochætes, as seen in *S. balbianii* and *S. anodontae*, Mr. H. B. Fantham; the rise and recognition of economic biology, Mr. Walter E. Collinge.

The papers offered to Section E (Geography) include the following:—The surveys of British Africa, Major C. F. Close, R.E.; the maps and methods of the present-day explorer, Captain T. T. Behrens, R.E.; the geographical evolution of transport, Prof. Vidal de la Blache (Paris); commercial geography from the modern standpoint, Prof. Max Eckert (Kiel); the hinterland of the Port of Manchester, Mr. J. McFarlane (Manchester); the Jäderin district of southern Norway, Mr. O. J. R. Howarth; Shotover Hill, a study in morphological causation, Rev. C. E. Spicer; regional geography of the Land's End peninsula, Mr. A. W. Andrews; physical geography of the Etbai desert of Egypt, Mr. H. T. Ferrar; travels in the Andes of Peru, Mr. C. R. Enock; the British Museum expedition to Ruwenzori, Mr. R. B. Woosnam; explorations in Labrador, Mrs. Leonidas Hubbard. Afternoon lectures: The Kurds, Mr. Mark Sykes; the Jamaica earthquake, Dr. Vaughan Cornish; the preservation of "Naturdenkmäle," or natural monuments, Prof. Conwentz (Danzig) (joint meeting with Sections C and K).

The programme of Section G (Engineering) is as follows:—August 1: Presidential address, Prof. S. P. Thompson; the present position of gas and petrol engines, Mr. Dugald Clerk. August 2: Joint meeting with Section B to discuss gaseous explosions with special reference to temperature. August 5 and 6: Pupin's compensated cable for telephone transmission, Sir W. H. Preece; modern machinery and its future development, Mr. H. I. Brackenbury; a machine for weighing the forces on a cutting tool, Mr. J. F. Brooks; ferro-concrete and examples of construction, Mr. J. S. E. de Vesian; examples of ferro-concrete, Mr. W. Noble Twelvetrees; the equipment of the engineering laboratory at the Finsbury Technical College, Prof. E. G. Coker; the ice problem presented in engineering work in Canada, Prof. Barnes; notes on the governing of hydraulic turbines, Mr. R. S. Ball; submarine signalling, Mr. Millet. A practical demonstration of boot and shoemaking machinery will be given by Mr. C. Bennion.

The programme of the proceedings of Section H (Anthropology) is even longer than usual, and many of the communications promise to give rise to interesting discussion. The greater part of the time of the section will be taken up by papers of an archæological character, but the communications in general ethnography, though less numerous than usual, include a number of considerable importance. On August 1 a meeting will be held in conjunction with the Section of Educational Science for the discussion of anthropometrics in schools. In archæology, Prof. W. M. Flinders Petrie will describe the results of his excavations in Egypt during the past season, and Dr. E. Naville will deal with the beginnings of Egyptian civilisation. A discussion on the early Iron age, and the different dates of inception in different areas, in which Sir John Evans has promised to take part, will be opened by Prof. W. Ridgway, and Mr. J. L. Myres will contribute a paper on the Sigynnæ of Herodotus and Cyprian spears. Prof. R. C. Bosanquet will read a paper on the scourging of the Ephebi at Sparta. Accounts of the work of the British Schools of Archæology at Athens and Rome during the past year will be given by their respective directors, Mr. R. M. Dawkins and Dr. T. Ashby. The former will deal chiefly with the excavations in Sparta. In addition, Dr. Ashby, in a paper on the ethnology of Sardinia, will urge the need of archæological and ethnographic investigation in that island for the elucidation of problems of Mediterranean ethnology, and in connection with the report of the Roman Sites Committee will describe the excavations of the past year at Caerwent. A paper by Mr. F. Newberry and Dr. T. H. Bryce deals with the "doorstep art" of Scotland, Mrs. Hobson will give the results of an examination of a large number of souterrains in Ulster, and Dr. G. A. Auden will describe a number of Scandinavian antiquities found at York. Dr. L. R. Farnell, in a communication on the development of Greek religion, will criticise Dr. Usener's theories concerning Sondergötter and Augenblick-Götter. Among the communications in general ethnography may be mentioned :—Education and evolution, the Rev. A. E. Crawley; a paper by Messrs. T. A. Joyce and E. Torday on the ethnography of the south-west Congo Free State, dealing with the migrations of the inhabitants of the territory drained by the Kwango and Kwilu Rivers; a paper by Dr. W. H. R. Rivers on Morgan's Malayan system of relationship, which adduces evidence against his concept of the "consanguineous family" as the earliest stage of the development of human society. Prof. R. J. Anderson, in a paper on racial types of Connaught, describes the chief physical types of that province, and discusses the chief influences by which they are, or have been, modified; a study of the condition of the Maoris in 1907, by Miss B. Pullen-Burry, after describing their religion and social organisation, deals with their economic and social condition. Among papers of a technical character, considerable interest attaches, in view of the present lack of agreement as to the use of anthropological terms, to a communication by Dr. Rivers in which he attempts to define the use of certain sociological terms, and to a communication by Mr. J. L. Myres on the use of the triangle in decorative art.

The provisional programme of Section I (Physiology) is as follows :—August 1: Presidential address and miscellaneous papers. The president, Dr. A. D. Waller, has been studying chloroform of late, and his address will probably take the form of a general statement on the position of anæsthetics at the present time. August 2: The morning will be devoted to papers on the electrophysiology of animals and plants. Dr. Alcock, Dr. Waller, and others will read papers. August 5: A discussion on the physiological and therapeutical uses of alcohol will be opened by Prof. Cushny. Other speakers will include Sir Victor Horsley, Dr. Dixon, Dr. Rivers, and Dr. Waller. August 6: A discussion on antitoxins will be opened by Prof. Sims Woodhead. The afternoons will be in part given to the reading of reports. There are three committees which should report, the subjects being :—(1) The investigation of the effect of climate upon health; Sir Lauder Brunton, the president of this committee, will read the report; (2) the determination of the metabolic balance-sheet of the individual tissues, president, Prof. Gotch; (3) the ductless glands, Prof. Schäfer. These reports will be presented on the afternoons of August 1, 2, and 6 respectively.

In Section K (Botany), Miss Fraser (of the Royal Holloway College) and others will communicate the results of recent investigations on the cytology of fungi, particularly in relation to sexuality and the reduction division. Mr. V. H. Blackman will take part in the discussion on this subject. Prof. F. O. Bower will communicate the results of his recent work on the embryos of Pteridophytes. Prof. Conwentz, the Prussian State Commissioner for the preservation of natural monuments, will deliver a lecture, illustrated by lantern slides, at a joint meeting of Sections C, E, and K, on the care of natural monuments. Prof. F. W. Oliver is expected to communicate the results of some recent investigations of Palæozoic seeds. Prof. Weiss will give the semi-popular lecture on pollination in recent and fossil plants. There will be a joint meeting with Section D to discuss the physical basis of heredity (opened by Prof. Hickson), and with Sections D and L to discuss the teaching of botany in schools. Prof. Armstrong will communicate a paper on the theory of enzyme-action. There will be a visit to Mr. Hurst's nurseries at Burbage to inspect his experiments in hybridisation, and a botanical excursion to Charnwood Forest.

Discussions on several important subjects have been arranged by the organising committee of Section L (Educational Science); and among the authors and speakers are leading representatives of every grade of educational activity. The chief educational associations have appointed delegates to attend the meeting. After Sir Philip Magnus's presidential address on August 1, there will be a discussion at a joint meeting with Section H (Anthropology) on anthropometrics in schools, with particular reference to the recommendations of the Physical Deterioration Committee. Among the expected speakers are Sir Victor Horsley, Mr. R. C. Lehmann, M.P., Dr. F. C. Shrubsall, Mr. J. Gray, Mr. E. Meyrick, Prof. M. E. Sadler, Dr. J. Gow, Mr. Cecil Hawkins, and Mr. S. R. Brown. Friday, August 2, will be occupied with a discussion of the scholarship system in all its aspects from the primary school to the university, with papers by Miss J. Cleghorn, Mr. A. R. Pickles, president of the National Union of Teachers; Mr. W. A. Brockington, Miss S. Heron, Mr. J. L. Paton, Mr. G. Gidley Robinson, Rev. A. A. David, Dr. H. B. Baker, Prof. H. A. Miers, and Prof. M. E. Sadler. The curricula of secondary schools will form the subject of discussion on the morning of August 5, in connection with the report of a committee appointed at the York meeting last year. Mr. R. E. Thwaites will state the results of an inquiry into science teaching in secondary schools. In the afternoon there will be a joint meeting with Sections D and K on the teaching of biology in schools, to be introduced by Mr. O. H. Latter. Other speakers will be Prof. S. J. Hickson, Prof. J. B. Farmer, Miss Lilian Clarke, Miss Laurie, Mr. M. D. Hill, Mr. E. Meyrick, and Mr. Hugh Richardson. August 6 will be devoted to scientific teaching in relation to trade classes and industrial requirements, this general description to include the consideration of domestic subjects in girls' schools, day trade schools for girls, preparation for technical training in day and evening schools, and the qualifications of teachers. Papers dealing with these subjects will be contributed by Mrs. Ramsay MacDonald, Mr. C. T. Millis, Mr. J. G. Legge, and Mr. J. H. Hawthorn.

THE KING AND HIGHER EDUCATION IN WALES.

THE foundation stone of the new buildings of the University College of North Wales was laid by the King on Tuesday, July 9. The King was accompanied by the Queen, and the ceremony was performed in the presence of a large and brilliant assembly. In his response to an address of welcome, presented by the Lord Lieutenant, the King said that the main object of his visit to Wales was to express again his belief in the necessity of affording the youths of the country the most complete educational equipment possible, both for their self-improvement and in order to enable them to acquire success in life. The King also remarked, in the course of a reply to an address presented by the Mayor and Corporation of Bangor, that "Education, and especially secondary education, is a subject the importance of which cannot be over-estimated, and which engages my cordial interest and encouragement." Replying on behalf of the Queen and himself to an address from the governors of the college, the King again referred to his interest in higher education in the following words :—

The admirable work performed by the college in its temporary buildings has been widely recognised and was well known to me when I held the office of Chancellor of the University of Wales. I feel confident that increased efficiency will result from the facilities afforded by the commodious premises of which I have to-day laid the first stone. The competition in every branch of industry, especially in those branches which depend largely on science and art, is in these days severe, and it must be met by increased application and improved methods. The world is, I believe, better for such competition, but it behoves individual nations to use every possible effort to hold their own in the struggle. For this purpose higher education is an absolute necessity. However brilliant a man's natural talents may be, he is greatly hindered by the want of early training, and as a rule only those who have enjoyed a good education are capable of acquiring such proficiency in any branch of study as will enable them to succeed. The University College of North Wales will offer to its students exceptional opportunities of instruction. Time and money, energy and perseverance, will, I am sure, not be spared in the endeavour to afford every facility to the acquirement of knowledge, and I have had sufficient opportunities of judging the intelligence of the Welsh people and their eagerness in the pursuit of knowledge to know that your young men and women will take every advantage of the instruction which is offered them.

At the close of the ceremony of laying the foundation stone, the King conferred the honour of knighthood upon Dr. H. R. Reichel, the principal of the college.

NOTES.

We regret to announce that Sir William H. Broadbent, Bart., F.R.S., physician in ordinary to the King and to the Prince of Wales, died on Wednesday, July 10, at seventy-two years of age.

The Nettleship gold medal of the Ophthalmological Society of the United Kingdom has been awarded to Dr. J. Herbert Parsons, for his work on "The Pathology of the Eye."

The council of the Institution of Civil Engineers has appointed Sir William Matthews, K.C.M.G., president of that institution, to succeed the late Sir Benjamin Baker, K.C.B., K.C.M.G., as one of their representatives on the main committee of the Engineering Standards Committee.

The annual meeting of the Victoria Institute will be held at Burlington House, Piccadilly, on Wednesday, July 17. The chair will be taken by the president, the Earl of Halsbury, F.R.S.; and an address will be given by Bishop Welldon.

The Women's Agricultural and Horticultural International Union will hold an exhibition and sale of farm and garden produce, and of nature-study teaching apparatus, in the gardens of the Royal Botanic Society, Regent's Park, on Wednesday, July 17. For the convenience of teachers, the nature-study room will be kept open until Saturday, July 20.

The vacancy in the tidal and optical departments of the National Physical Laboratory, occasioned by the appointment of Mr. J. de Graaf Hunter to the post of mathematical expert on the Indian Survey, has been filled by the appointment of Mr. T. Smith, formerly scholar of Queens' College, Cambridge.

The recent death of M. Charles Trépied, director of the Algiers Observatory, inflicts yet another severe loss on the ranks of French astronomers. In the organisation of the work of the Astrographic Catalogue and Chart he played an active and prominent part from the beginning, and it is to be deplored that he was not spared to see the completion of his labours. M. Trépied became director of the observatory at Algiers in 1880, and in the following year carried out a scheme of reorganisation. In 1883 the observatory was removed from its temporary site at Kouba to its present position at Bondzavéah, eleven kilometres from Algiers, and was further equipped with an equatorial *coudé*, and later with a photographic instrument of the standard photographic pattern. Since 1875 M. Trépied was a prolific writer on all branches of astronomy, and gave much study to the physical condition of the sun and to cometary spectra, while the observatory under his charge was always most active in observational work of all kinds. On the occasion of the solar eclipse of 1900, he extended the most generous hospitality and assistance to the foreign astronomers who visited Algiers. He was a corresponding member of the Paris Academy of Sciences.

Prof. W. J. Sollas, F.R.S., professor of geology and palæontology at Oxford, and his assistant, Mr. M. Allorge, have just taken the geological class to Belgium to study the structure of that country. In the Easter expedition of the students, Dr. Vaughan and Prof. Reynolds explained the zoning of the Carboniferous limestone in the Bristol district; and the object of the present expedition is to bring the results then obtained into comparison with the facts furnished by the Belgian limestones. The leading Belgian geologists, MM. Mourlon, Gosselet, Halet, Simoens, Lohest, Formarié, and Rutot, are acting as guides for the various visits and excursions which have been arranged. The expedition thus provides facilities for geological observations under the best conditions.

The retirement is announced of Prof. G. Lunge, at the age of sixty-eight, from the chair of technical chemistry at Zurich, a position which he has held during the past thirty-one years. Prof. Lunge's name is intimately associated with the development of chemical industry in Germany, not only on account of the influence he exerted on his many students, but more directly owing to his inventions and treatises on applied chemistry. At the time when he, as a young man, completed his studies at Heidelberg, chemical industry had hardly come into existence in Germany, so that in order to gain practical experience he found it necessary to proceed to England. In this country, in which he spent the twelve years 1864–1876, he was first actively engaged in studying the problems connected with the distillation of coal tar, but subsequently acted as manager of a large soda works at Tyneside. He was one of the founders of the Newcastle Chemical Society, a precursor of the Society of Chemical Industry. In 1876 Prof. Lunge received a call to the professorship of technical chemistry at Zurich, a position which, in spite of many inducements to pass to other universities, he continued to occupy until this year. His books on coal-tar distillation and on the manufacture of acid and alkali have, since the publication of the first volume in 1879, become almost classics in chemical technology.

An influentially signed appeal was published in the *Times* of July 5 for donations to a fund which is being raised to ensure the preservation of characteristic examples of the "grey wethers" on Marlborough Downs. These boulders are locally known as "Sarsen Stones," and are geologically the solidified boulders of a stratum of Eocene sand formerly covering the chalk which in the course of time has been denuded of the softer portions. For many generations these stones have been broken up and used for building and other purposes, but the breaking up has not been on such a scale as to make any appreciable difference in the appearance of the downs. A recent change of ownership has made it likely that the process of destruction will be greatly extended. In these circumstances representations have been made to Mr. Alec Taylor, the present owner, by the National Trust and the Wiltshire Archæological Society, who has stated that he intends to preserve the dolmen known as the Devil's Den, and has given the National Trust an option to purchase for 500*l.* about eleven acres in Pickle Dean and about nine acres in Lockeridge Dean, both of which areas are rich in "grey wethers." We trust the sum required will be forthcoming, so that examples of a unique geological phenomenon may be preserved to the nation. It is not too much to say that if British statesmen understood more fully the value and full significance of nature's "monuments," these and similar natural objects of scientific and educational importance would have been secured for the nation long ago. Donations to the fund which is being raised may be sent to Mr. Henry E. Medlicott, Potterne, Devizes; the Rev. E. H. Goddard, Clyffe Vicarage, Swindon; Mr. E. Meyrick, Thornhanger, Marlborough; or to Mr. Nigel Bond, 25 Victoria Street, Westminster.

THE thirty-sixth annual meeting of l'Association française pour l'Avancement des Sciences will be held at the lycée in Rheims on August 1–6. The president for the year is Dr. Henrot, honorary director of l'École de Médecine at Rheims. The work of the meeting will be divided among nineteen sections. The presidents in each case are as follows:—Sections 1 and 2 (Mathematics, Astronomy, Geodesy and Mechanics), Prof. C. Bourlet; Sections 3 and 4 (Navigation and Civil and Military Engineering), M. Bourguin; Section 5 (Physics), Prof. Blondin; Section 6 (Chemistry), Prof. Hugounenq; Section 7 (Meteorology), M. Luizet; Section 8 (Geology and Mineralogy), M. Peron; Section 9 (Botany), Prof. Lecomte; Section 10 (Zoology, Anatomy and Physiology), Prof. Caullery; Section 11 (Anthropology), Dr. Guelliot; Section 12 (Medical Science), Prof. Landouzy; Section 13 (Medical Electricity), Prof. Guilloz; Section 14 (Odontology), M. Francis Jean; Section 15 (Agronomy), M. Armand Walfard; Section 16 (Geography), M. Richard; Section 17 (Political Economy and Statistics), Dr. Papillon; Section 18 (Pedagogy), Dr. Bérillon; Section 19 (Hygiene), Dr. Calmette. M. Jadart is the president of the subsection dealing with archæology. On August 5 an evening lecture will be delivered by Dr. S. Leduc, his subject being "Diffusion and Osmosis." A very full programme has been arranged, and it is possible here to refer to a few of the subjects only. In the physics section the properties of the electric arc will be dealt with, and their application to the production of (*a*) luminous rays, (*b*) electric waves for use in ordinary and in wireless telegraphy, (*c*) nitric acid and nitrates from the oxygen and nitrogen of the air. In the chemistry section the progress made in the study of sugars and the action of soluble ferments on gums will be discussed. In the geology section the classification of the Tertiary beds in the neighbourhood of Rheims will be considered. Visits to places of interest have been arranged, and these include Verzenay, Épernay, Laon, Coucy, Charleville, Dinant, and the Han grottoes. Full particulars of the meeting can be obtained from the secretary to the council, 28 rue Serpente, Paris.

ACCORDING to a paper by Mr. H. Elias, published in *Gegenbaur's Morphologisches Jahrbuch*, vol. xxxvii., part i., the shrill cries of bats are, as might be expected, intimately connected with the structure of the larynx in those animals. Special features are the powerful musculature and the shortness of the glottis, the latter being the main cause of the shrillness of the cry. Details of the variation in structure of the larynx in different groups of insectivorous bats are given. In the same issue Dr. O. Brian gives an illustrated account of the so-called horny teeth on the tongue of the porcupine. These teeth form two isolated oval patches near the tip of the tongue, and although their existence has been long known, the author of the paper claims that he is the first to describe their histology.

FROM a natural history point of view, the *National Geographic Magazine* for June is an unusually interesting number. Among its contents is an article by Prof. A. Heilprin on the Guiana wilderness, in the course of which reference is made to the statement that the tropical American forest is characterised by the absence of flowers. "The picture," observes the author, "does not seem to apply to the forest of the river-banks of the Guianas. . . . The streamers of purple, red, and white which hang down over the forest-curtain easily recall in profusion and wealth of colour the flowers of the north. . . . Indeed, it would be difficult to recall in forests of the north, even as rare instances, that display of flowers which so frequently repeats itself here." Another article to which attention may be directed is one by Mr. H. M. Smith, Deputy Commissioner of U.S. Fisheries, on fish immigrants. It deals largely with the objects and results of fish-acclimatisation in the United States.

"SELECTION and Cross-breeding in Relation to the Inheritance of Coat-pigments and Coat-patterns in Rats and Guinea-pigs" is the title of a paper by Messrs. H. MacCurdy and W. E. Castle recently published by the Carnegie Institution of Washington. After a general discussion on continuous and discontinuous variation as factors in evolution, the authors point out that partial albinism displays itself in rats in a fashion quite distinct from that obtaining in guinea-pigs. In the one group the dark areas tend to become restricted to certain definite parts of the body, while in the other they become irregularly distributed everywhere. In rats pigment-reduction produces a regular series of coat-patterns, each of which breeds true within certain limits. In the case of guinea-pigs regression appears to be indicated by a reduction in the number of pigmented areas; but its occurrence could not be definitely determined in rats. If regression does occur in both groups, the main question is whether we can "with propriety consider the effects of selection permanent. . . . We consider the selection question still an open one."

AMONG several articles in the *Zeitschrift für wissenschaftliche Zoologie*, vol. lxxxvi., part iv., reference may be made to one by Mr. Hermann Jost, of Göttingen, on the developmental history of the larva of the ox-warble fly, *Hypoderma bovis.* From the absence of any reference to it in his list of literature, the author appears to be unacquainted with the paper on the same subject by Mr. A. D. Imms in vol. i., part ii., of the *Journal of Economic Biology*, of which a brief notice appeared in our columns some months ago. Mr. Imms was unable to obtain satisfactory evidence as to the manner in which the larvæ effect entrance into the bodies of the host, that is to say, whether they do so by perforating the skin or by way of the mouth. Dr. Cooper Curtice in an earlier paper came, however, to the conclusion that the young larvæ are licked up by the cattle, and thus conveyed to the alimentary canal. According to Mr. Jost, this is not quite the true explanation, as his observations lead to the conclusion that the eggs are never hatched on the exterior of their host, but are licked off from the skin by the tongue to undergo their final development in the alimentary canal. Estimates of the enormous commercial losses due to ox-warbles are given in the course of the paper.

THE rind disease of the sugar cane caused by the fungus *Melanconium sacchari* forms the subject of Bulletin No. 7 prepared by Mr. L. Lewton-Brain, of the division of pathology and physiology, and issued from the experiment station of the Hawaiian Sugar Planters' Association. The fungus can only penetrate the cane by wounds due to borers or other agents, but, having penetrated, readily forms fruiting masses from which arise the conidia that are extruded in long black threads. Reference is also made to the "red-rot" fungus, *Colletotrichum falcatum* and to the pine-apple disease induced by *Thielaviopsis ethaceticus*, a fungus that is sometimes regarded as a stage in the life of the Melanconium.

THE introduction of rubber cultivation into the Malay Peninsula has brought the Federated Malay States and the Straits Settlements into prominence, and with the view of supplying information as to their status and resources Mr. H. C. Belfield has prepared a third edition of the "Handbook of the Federated Malay States." The handbook contains much practical information, both for the settler and the tourist; an estimate of the cost of starting a rubber plantation is provided for the planter. As to other crops, the west coast from Perak to Negri Sembilan is well suited to the cultivation of cocoa-nuts, but coffee plantations will cease to exist as the interplanted rubber trees come into bearing, and owing to the wasteful methods adopted, tapioca cultivation is being discouraged. Measures are being adopted to conserve the trees yielding gutta-percha.

TWO curious substances, n'hangellite and coorongite, that have been described as mineral india-rubber or elastic bitumen, the former discovered in Portuguese East Africa, the latter in Australia, are the subject of an article in the Kew Bulletin (No. 5). After examination, Mr. L. A. Boodle arrives at the conclusion that they have been derived chiefly from masses of a gelatinous blue-green alga, and that the bituminous character is due to chemical changes. An account of the method of preparing amber-coloured biscuits of Funtumia rubber in Uganda is based upon a communication by Mr. H. Hesketh-Bell. On the subject of mud-binding grasses that might be utilised to reclaim sand and mud-flats, information is provided with regard to the growth of species of Spartina in Southampton Water. A long list of moths collected during the season of 1906, supplementary to the species recorded in the special volume of the Kew Bulletin on the wild fauna and flora of the gardens, is contributed by Mr. A. L. Simmons.

THE University of California, from funds supplied by Mrs. P. A. Hearst, has added to its series of monographs on American ethnology an account of the language of the Yokuts in the south central region. This tribe, the name of which means "men," inhabits the southern portion of the San Joaquin basin. It includes some forty sub-tribes, each with a distinct dialect, differences of vocabulary being probably due, partly, as among the Nagas of Assam, to inter-tribal feuds, and partly to the taboo of words connected with the dead. The Yokuts are now gradually disappearing, and the author of this monograph, Mr. A. L. Kroeber, has found much difficulty in collecting the materials for a comparative grammar and chrestomathy, the latter including some interesting tribal legends and folk-lore, more complete versions of which he proposes to publish in a subsequent volume.

THE weather still continues most persistently cold for the time of year over the whole of the British Islands, and, indeed, over nearly the whole of western Europe. Rain is falling with considerable frequency, but the measurements are not generally large. The principal feature is the large amount of cloud and the consequent small amount of sunshine. According to the summary of the weather issued by the Meteorological Office for the week ended July 6, the maximum temperature recorded anywhere in the British Islands was 68°, in the Midland counties. The defect of temperature on the mean for the period was mostly from 6° to 8°, whilst the bright sunshine was deficient over the whole of Great Britain. At Greenwich the highest shade temperature for the first nine days of July was 68°, and the observations since 1841 fail to show any other year for the same period with so persistently low a temperature, the previous years always having had a temperature of 70°, and commonly a temperature of 80° or even 90°. The mean highest temperature for the first nine days is rather below 65°, which is in agreement with the average conditions in the middle of May or the end of September. The aggregate rainfall at Greenwich for the first nine days of July is less than 0·2 inch, but rain has fallen on six days. The aggregate rainfall at the London reporting station of the Meteorological Office since the commencement of the year is 8·8 inches, which is about 1·5 inches less than the normal, and April is the only month with an excess of rain. The present outlook promises a further continuance of cool and unsettled weather.

THE Deutsche Seewarte has just published vol. xiv. of *Deutsche Ueberseeische Meteorologische Beobachtungen*, containing summaries of the meteorological observations made at thirty-eight foreign stations for various periods between 1892 and 1904. The first part includes the records from twenty-six stations where the observations were made three times a day, the stations being well scattered over the globe. Labrador, West Indies, Brazil, Morocco, Liberia, Siberia, China, Corea, and the Pacific Islands are all represented. The value of these otherwise good observations is marred by the fact that only from eight of the stations can a continuous record be got for so short a period as three years. The second part contains the results of hourly observations at stations which are all in German East Africa, and deals with the period 1900–4. Here again is the same trouble of discontinuity.

"DISTRIBUTION of Temperature and Air Pressure over the Globe in the 'Polar Year' 1882–3" is the title of the inaugural dissertation chosen by S. B. Ehrhart on obtaining his doctor's degree at Erlangen. It was a gigantic undertaking, and the results of observations at 924 stations have been utilised in preparing isothermal and isobaric charts for each month from September, 1882, to August, 1883; the charts for January and July, 1883, accompany the dissertation. The author states that, on the whole, the charts for this particular year exhibit the same general features as those drawn from means for a series of years, and show that the temperature conditions of any one month influence the pressure conditions of the following month, *e.g.* areas of high temperature favour the development of barometric minima, and *vice versâ*. We fail to find any reference to the synchronous weather charts of the North Atlantic published by the Meteorological Office for that year, which, although not dealing with mean values, constitute the greatest investigation of synchronous meteorology ever undertaken by any country.

THE paper on the theory of thermoelectricity contributed by Shizuwo Sano to the Proceedings of the Tokyo Mathematico-Physical Society, iv., 1 (February number, recently received), cannot fail to throw light or suggest ideas in connection with this difficult and controversial subject. It is usual to apply to thermoelectric phenomena the equations of reversible thermodynamics which would hold good in the absence of such irreversible phenomena as the Joule effect or conduction of heat, but the author, following on the lines indicated by Boltzmann in 1887, considers that the reversible and irreversible effects may be mutually interdependent. The paper does not claim to be free from assumptions which are not altogether justified, and in particular the deduced property of potential difference in relation to temperature may be open to question. The theory deserves careful consideration; but would it not be possible to throw it into a less analytical form?

THE first part has appeared of the *Rivista di Scienza*, of which a preliminary notice has been already given in these columns. It is an international journal somewhat similar in appearance and arrangement to the present series of *Science Progress*. From the nature of the case the articles necessarily take a somewhat broader view of the progress of science than is possible in a journal published in a country specially characterised by its national apathy to scientific work, and the expectations that were raised by the prospectus have been more than realised in the present number. The character of the journal will best be inferred from the following table of contents:—E. Picard, "La mécanique classique"; W. Ostwald, "Zur modernen Energetik"; G. Ciamician, "Problemi di chimica organica"; F. Raffaele, "Il concetto di specie in biologia"; H. E. Ziegler, "Die natürliche Zuchtmahl"; C. Scipino, "Il carattere delle leggi economiche"; W. Cunningham, "Impartiality in History"; J. Tannéry, "Questions pédagogiques, l'Enseignement secondaire"; in addition to a large number of reviews, notes on physics and physiology, a "review of reviews," and notes. The price of each part is 7*s*. 6*d*. net; Messrs. Williams and Norgate are the London agents. The editorial office is at Milan, 16 Via Aurelio Saffi. The list of forthcoming articles is sufficient to fill a large number of volumes, and nearly every nationality is represented among the contributors.

OF all the numerous publications issued by the United States Geological Survey, none is of greater interest than the volumes dealing with the "mineral resources of the United States," a series of which we have just received the twenty-second annual issue (Washington: Government Printing Office, 1906). Each chapter in this report is a census of the production of the industry under discussion during the calendar year 1905. Although printed in smaller type, the volume is considerably larger than that of the previous year, covering as it does no less than 1403 pages. The publication of the volume has been anticipated to a great extent by the issue in advance, in pamphlet form, of the several chapters which compose it. The volume is edited by Dr. D. T. Day, and the various chapters are written by different statistical experts. The figures dealt with are stupendous. In 1905, for the seventh time, the total value of the United States mineral production exceeded the enormous sum of 200,000,000*l*. The exact figures for 1905 are 324,775,422*l*., iron ore and coal being, as heretofore, the most important of the minerals produced. The arrangement and scope of the volume are practically the same as in previous issues. The production of carbonic acid, especially at Saratoga Springs, New York, is, however, discussed for the first time, and statistics are given of the production and consumption of water-gas. A report is also included directing attention to peat in the United States, and to its great possibilities as a source of fuel. There is, too, a chapter devoted to tin, although, as a matter of fact, during 1905 no metallic tin was made in the United States, and merely an insignificant quantity of ore was obtained from the placers of Buck Creek, Alaska.

IN a paper published in the *Verhandlungen* of the German Physical Society (No. 8, p. 175), Messrs. P. Nordmayer and A. L. Bernoulli give the results of a series of determinations of the specific heat of a large number of substances, both elementary and compound, between the temperatures $-185°$ C. and $+20°$ C. The method used was to ascertain the weight of liquid air evaporated on adding a known weight of the substance in question, the heat required to evaporate 1 gram of liquid air being taken as 50 calories. The results obtained show that, whereas the specific heat of a compound substance such as water or benzene in the solid state diminishes very rapidly as the temperature falls, the specific heat of most solid elements is subject to a much smaller variation. The change of specific heat with temperature is most marked in the case of elements of low atomic weight, for example, sodium and magnesium. For the metals molybdenum, tungsten, and tantalum, the specific heat is almost constant for all temperatures between $-200°$ C. and $+250°$ C.

THE conditions which are essential in order to obtain accurate results in the estimation of potassium by the well-known method based on the precipitation of the metal in the form of its chloroplatinate are studied in a paper by M. J. Morozewicz in the Bulletin of the Cracow Academy of Sciences (1906, No. 9, p. 796). Fresenius recommended that in presence of sodium the chloroplatinate should be precipitated in 70 per cent. to 80 per cent. alcohol, but subsequent workers have advised the use of absolute alcohol instead; it is, however, shown that if absolute alcohol be used, a much larger proportion of platinum chloride is required to ensure the complete transformation of sodium chloride into its chloroplatinic salt. The results obtained are, moreover, generally high, owing to the co-precipitation of some of the sodium chloride. It is therefore advisable to adhere to Fresenius's original procedure.

IN NATURE of June 20 (p. 184) Prince B. Galitzin's experimental verification of Doppler's principle for light rays was briefly noted; and the paragraph stated that use was made of "the graduated spectroscope (Stufenspektroscope)." Mr. J. Twyman, of Messrs. A. Hilger, Ltd., writes to point out that "Stufenspektroscope" is the accepted designation of a spectroscope wherein a "Stufengitter" or echelon diffraction grating is employed.

THE British Sports Publishing Company, Ltd., have issued in their Spalding's Athletic Library the "Lawn Tennis Annual for 1907," edited by H. R. M., and "Spalding's Golfers' Annual for 1907," edited by Mr. Henry Leach. Both books are illustrated by reproductions of action photographs depicting well-known players. The price of the annuals is 6*d*. net each.

WE have received from Marconi's Wireless Telegraph Company, Ltd., a copy of a catalogue dealing with

Röntgen ray and high-frequency apparatus, instruments, and accessories. The list provides full particulars as to a variety of induction coils made by the company, interrupters, fluorescent screens, portable accumulators, and high-frequency sets. The information given as to light baths, vibration apparatus, the Finsen lamp and light, and the orthodiagraph, should appeal specially to medical men. The list is conveniently arranged and admirably illustrated.

A new edition of "Bradshaw's Through Routes to the Chief Cities of the World" has just been published. This comprehensive handbook of colonial and foreign travel, besides giving descriptive routes of the chief railways, ocean lines, and caravan tracks, supplies an abundance of maps and plans and some useful vocabularies. The volume has been edited by Prof. A. H. Keane and Mr. Stanley Read, and its price is 5*s*. net. The route numbered 50, dealing with tours round the world, is of special interest, showing as it does the increased facilities for travel since Jules Verne wrote "Round the World in Eighty Days." The actual minimum time required for an all-round journey from London, provided no delay occurred in missing train or boat connections, is 38 days 10 hours, and Lieut.-Colonel Burnley-Campbell recently completed the circuit of the world in 40 days 19·5 hours, following the route Liverpool, Quebec, Vancouver, Yokohama, Tsaruga, Vladivostok, Harbin, Irkutsk, Moscow, Warsaw, Berlin, Ostend, Dover; but the usual quick rate of travel is still 53 days. The book may be commended to teachers as an interesting example of applied geography.

OUR ASTRONOMICAL COLUMN.

Transits of Saturn's Satellite Titan and Shadow.—In the Publications of the Astronomical Society of the Pacific, vol. xix., p. 125, Hermann Struve gives the following central transits of Titan and shadow during ensuing months:—

1907		G.M.T. h. m.	Distance from centre ″	Semi-duration of transit h.
July 17	Shadow	8 16	0·5 S.	3·0
July 17	Titan	13 48	7 0 N.	1·6
Aug. 2	Shadow	7 30	0·2 N.	3·0
Aug. 2	Titan	12 6	6·3 N.	2·0
Aug. 18	Shadow	6 43	0 9 N.	3·0
Aug. 18	Titan	9 51	5·0 N.	2·5
Sept. 3	Shadow	5 59	1·6 N.	3·0
Sept. 3	Titan	7 42	3·2 N.	2·8
Sept. 19	Titan	5 14	1·3 N.	3·0
Sept. 19	Shadow	5 15	2·3 N.	2·9
Oct. 5	Titan	2 48	0·7 S.	3 0
Oct. 5	Shadow	4 33	2·9 N.	2·9
Oct. 21	Titan	0 31	2·2 S.	2·9
Oct 21	Shadow	3 49	3 6 N.	2·8
Nov. 5	Titan	22 32	3·1 S.	2·8
Nov. 6	Shadow	3 5	4·3 N.	2 6

Saturn Rises at Greenwich.

	h. m.
July 1	11 28 p.m.
Aug. 1	9 28 ,,
Sept. 1	7 24 ,,
Oct. 1	5 22 ,,
Nov. 1	3 16 ,,
Dec. 1	1 18 ,,

Comet 1907*d* (Daniel).—A new set of elements and a daily ephemeris for comet 1907*d* are published by Dr. Strömgren in No. 4187 (p. 191, June 29) of the *Astronomische Nachrichten*. A part of the ephemeris is given here; and, in order to facilitate the location of the object, the daily positions, with respect to the surrounding stars, are marked on the accompanying chart:

Ephemeris 12h. (M.T. Berlin).

1907	α (true) h. m.	δ (true) ° ′	log *r*	log Δ	Brightness
July 10	1 39·0	+ 7 35·1	0·1318	0·0216	3·50
12	1 49·0	+ 8 16·7			
14	1 59·5	+ 8 58·8	0·1133	9·9977	4·25
16	2 10·5	+ 9 41·2			
18	2 22·0	+10 23·6	0·0942	9·9756	5·14
20	2 34·1	+11 5·9			
22	2 46·7	+11 47·8	0·0744	9·9558	6·17

According to Dr. Strömgren's elements, perihelion will occur on September 9·4.

Apparent path of Comet 1907*d*, July 5–22, 1907.

As will be seen from the above ephemeris, the comet is brightening rapidly, and may yet become a faint naked-eye object. At present it is an easy object, when found, in a 3-inch refractor. It has a distinct stellar nucleus which, according to Dr. Zappa, of Rome, was centrally placed and of magnitude 8·5 on June 16. A faint fan-shaped tail was seen on June 21.

Mars: the Duplication of the Solis Lacus.—In Bulletin No. 28 of the Lowell Observatory, Prof. Lowell records that the Solis Lacus showed double on May 18, this being the first time that it has appeared divided since the summer of 1894. This is not a case of gemination, for the two portions are not alike either in shape or size, nor were they in 1894. Among the canals which emerge from the eastern part, a new one was detected for the first time on May 18, and has been designated Ichor. The South Polar cap has retreated southward since the last presentation, leaving dark ground behind it, and it is noticeable that the canals connecting with the Solis Lacus on the south are darker and more easily seen than those proceeding from it towards the north, although the tilt of the planet's axis should render the former the more difficult to detect. As the snow has left dark ground behind it, darker than is the case in this region in the later part of the Martian year, Mr. Lowell argues that water, and not CO_2, is concerned. As a consequence, it follows that the temperature in this region—lat. 42°–52°—was already higher than 0° C. on May 18, or, in the Martian year, on a date corresponding to March 13 of our calendar.

Variable Stars.—*Astronomische Nachrichten*, No. 4186 (June 28), contains several important communications concerning variable stars. The first is by Messrs. Müller and Kempf, of the Potsdam Observatory, on the peculiar variable X Persei, which they have now observed regularly for twenty years. The present paper gives the observational record since September, 1899, and is accompanied by a light curve showing the peculiar fluctuations of magnitude which this star undergoes.

In the second paper M. Luizet records some maxima and minima of several long-period variables, among the stars dealt with being *o* Ceti, R Leonis, and S Coronæ.

The third communication is from the Harvard College

Observatory, and gives the designations, positions, magnitudes, magnitude ranges, and spectral classification of fifteen new variable stars discovered in the regions covered by the Harvard maps Nos. 31 and 62.

NAMES FOR THE THREE JOVIAN ASTEROIDS.—Drs. Wolf and Kopff have chosen the three names Achilles, Hector, and Patroclus, respectively, to designate the three important minor planets (588) [1906 TG], [1907 XM], and [1906 VY] discovered by them at Heidelberg. Readers of these columns will remember that the orbits of these three bodies have been found to extend as far from the sun as that of Jupiter (*Astronomische Nachrichten*, No. 4187, p. 192, June 29).

THE MIRA MAXIMUM OF 1906–7.—From a series of observations made at Utrecht, and extending from July 25, 1906, to March 4, 1907, Prof. Nijland found that the maximum brightness of Mira occurred on December 7, when the magnitude was 2·0. The preceding minimum was recorded on August 7, and, as seen from the curve, was a very flat one, from which a sharp rise to an exceptionally bright maximum took place. The previous maximum took place on January 3, 1906, so that the period between these two successive maxima was 338 days (*Astronomische Nachrichten*, p. 113, No. 4183, June 14).

SOLAR PROMINENCE OBSERVATIONS IN 1906.—The annual summary of the results of the prominence observations made at Catania, for 1906, is published by Prof. Riccò in No. 5, vol. xxxvi. (p. 73), of the *Memorie della Società degli Spettroscopisti Italiani*. The daily record is reproduced, and then analysed, under the heads of the extension, height and frequencies of the prominences, in the two hemispheres for each month and quarter and for the year. The similarity of the size and distribution of the prominences recorded to those of the previous year indicates a stationary point characteristic of the maximum, whilst the greater frequency during March points to that month as being the actual month of solar prominence maximum.

CONGRESS OF THE ROYAL INSTITUTE OF PUBLIC HEALTH.

THE congress of the Royal Institute of Public Health, held this year at Douglas, Isle of Man, from June 29 to July 5, was presided over by Lord Raglan, the Lieutenant-Governor of the island, who, in the course of his presidential address, gave a cordial welcome to the members of the congress. He referred to the progress of sanitation during the Victorian era, but pointed out that England was handicapped in the hygienic struggle as compared with Continental nations owing to our exaggerated ideas of personal liberty.

Sir James Barr, in the course of his presidential address in the preventive medicine section, urged medical practitioners to take as deep an interest in sanitation as sanitarians. The health of a nation was its most valuable asset, and he would like to see all his adult countrymen able to handle a rifle and take part in the defence of their country should occasion arise, and he would encourage the military spirit as the best means of developing the moral and physical qualities of the nation. He urged that there should be State aid if needed for every child under sixteen to be properly fed and cared for. Huge trusts and millionaires were a danger to society, and part of their wealth should be appropriated by the State.

Prof. Sims Woodhead, in the section of bacteriology and chemistry, delivered an address on the subject of "anti-bodies," in which he traced the rise and development of bacteriology, and adduced statistical evidence on the value of diphtheria anti-toxin. Dr. Warrington, of Liverpool, introduced a discussion on cerebro-spinal fever, in which he advocated the isolation of cases and the disinfection of places in which the disease had occurred. Dr. Prudence Gaffitien read a paper on the causes of infantile mortality. She said the high infant death-rate was due to the ignorance of mothers, and advocated the prohibition of the use of soothing syrups, &c. The Infant Life Protection Act was worse than useless; the State should provide for the inspection of foster or nurse children.

Prof. Hele Shaw delivered an address in the engineering and architectural section on road locomotion and the public health. He dealt chiefly with the new conditions occasioned by the advent of motor-cars; he admitted that the public had grievances arising from dust, odour, noise, and vibration, but claimed that much was being done to lessen these.

Dr. Sergeant, of the Lancashire County Council, opened a discussion on the milk supply, and a resolution was passed affirming the desirability of dairy regulations being made compulsory by the Local Government Board.

Many valuable papers were read on notification, tuberculosis, and sanatoria.

The social part of the congress was all that could be desired, and many excursions were made to the places of interest in the beautiful island. The congress dinner was presided over by Lord Raglan, and there was a garden-party at Government House.

RECENT CONTRIBUTIONS TO ELECTRIC WAVE TELEGRAPHY.[1]

PROF. FLEMING said that the achievements of electric-wave telegraphy had not yet ceased to interest the public mind. In little more than eight years from the time when Mr. Marconi sent his first messages across the English Channel, it had become an indispensable implement in naval warfare, and also a means of communication between ships and the shore, greatly adding to the safety of life and property at sea. At the present time practically the whole of the first- and second-class battleships of the British Navy are equipped with apparatus for electric-wave telegraphy, and about 130 cruisers and smaller craft as well. The Marconi Company alone have fitted with their instruments nearly 100 Atlantic liners and other mercantile vessels, and have an elaborate organisation by which all these ships are constantly in communication with the mainland during their voyage from port to port. Concurrently with this, an immense amount of scientific investigation has been carried on having for its object further improvements and the quantitative study of the phenomena. The object of the discourse was to make known some of these recent additions to knowledge.

A cardinal feature of electric-wave telegraphy is the vertical wire or wires at the transmitting and receiving stations, called the antenna. At the transmitting station high-frequency electric currents are set up in the sending antenna, and these create rapidly alternating electric and magnetic forces in the space around, which are propagated outwards from point to point with the velocity of light. Hence at certain distances, called a wave-length, these forces are reversed in the same way at the same instant. In electric-wave telegraphy the wave-lengths used lie between 200 feet and 20,000 feet or so, covering about eight octaves. The measurement of this wave-length is important. Prof. Fleming described an instrument of his own invention, called a cymometer, used for this purpose. It consists of a spiral of wire in series with a sliding tubular condenser, the circuit being completed by a copper bar. Across the terminals of the condenser is placed a neon vacuum tube. If the bar of the cymometer is placed near the transmitting antenna and the handle of the instrument moved, its capacity and inductance can be altered until it comes into tune with the antenna circuit. When this is the case the oscillations in the antenna create violent sympathetic oscillations in the cymometer, and the neon tube glows brilliantly. An index pointer moving over a scale then shows the wave-length of the waves radiated. The same instrument may be used to measure the wave-length of the arriving waves. Also it can be used to determine the decay of the oscillations in a train.

In spark telegraphy the oscillations are set up in the antenna by an electric discharge, and at each spark a group of oscillations takes place. These may come at the rate of ten to fifty groups per second, and each group may contain from ten to 100 decadent oscillations. The cymometer can be used to draw a resonance curve by which the rate of decay and the number of the oscillations in a

[1] Abstract of a discourse delivered at the Royal Institution on Friday, May 24, by Prof. J. A. Fleming, F.R.S.

train are determined. Methods have now been devised for creating undamped or nearly undamped oscillations. One method suggested is by the use of a high-frequency alternator, but the difficulty of constructing such a machine for a sufficiently high frequency is very considerable, and as yet only machines of small power have been made.

Prof. Elihu Thomson in 1892 patented a plan for producing a continuous current electric arc between metal terminals which was acted upon by an air jet or magnetic field. He found that when the metal poles or spark balls were connected by a condenser in series with an inductance high-frequency oscillations were created in the latter circuit.

Mr. Duddell showed in 1900 that continuous undamped oscillations could be obtained when using, in place of the spark balls, an electric arc made between solid carbons. In 1903 Mr. Poulsen went a step farther. He formed the arc between a carbon terminal (negative) kept in rotation and a cold metal terminal (positive), and enclosed them in an atmosphere of hydrogen or coal gas and placed a strong magnetic field across the arc. The arc terminals being then shunted by a small condenser and an inductance, we have undamped high-frequency oscillations suitable for wireless telegraphy created in this latter circuit. Prof. Fleming gave an explanation of the reason for this effect, and showed that it was due to the form of the characteristic curve of the metal carbon arc. He compared the action to that of an organ pipe in which the energy is supplied by a steady jet of air corresponding to the continuous current arc, and this is made to set up aërial vibrations in the resonant organ pipe, equivalent to the condenser circuit, the vibrations in the pipe controlling and drawing their energy from the air jet. In applying the Poulsen method to wireless telegraphy, an antenna circuit is connected either inductively or directly with the condenser circuit.

Experiments were shown illustrating the production of high-frequency undamped electric oscillations in a long wire wound on an ebonite rod. Incidentally it was proved by an ingenious experiment with a neon vacuum tube that the oscillations are not really continuous, but cut up into irregular groups. In reference to the application of the Poulsen method to wireless telegraphy, Prof. Fleming said that the apparatus was more complicated and less easy to use than that for spark telegraphy. It was not true that undamped waves could not be picked up or tapped, and he proved that such advantages as the use of undamped waves in telegraphy might present were not due only to the transmitter, but to the conjoint use of a slightly damped receiver circuit.

Prof. Fleming did not agree with the opinion, confidently expressed in some quarters, that telegraphy by undamped waves would destroy spark telegraphy. Further, he pointed out that the electric arc was not the only method for producing undamped waves. He said that for some months past Mr. Marconi had been working out a purely mechanical method of producing continuous trains of electric waves suitable for wireless telegraphy, and had obtained considerable success. The method was exceedingly simple, and by means of it any existing station for spark telegraphy could be converted easily into a station sending out undamped electric-wave trains instead of intermittent damped trains.

The lecturer then passed on to explain some recent forms of electric-wave detector. When the waves sent out from the sending antenna fall on a receiving antenna they create in it secondary high-frequency oscillations, and these are detected by the use of some device called a wave detector. In addition to the coherer and the Marconi magnetic detector, the latter exclusively used in long-distance work, a receiver called an electrolytic detector is now much used. It consists of a vessel containing nitric acid in which is placed a platinum plate and an exceedingly fine platinum wire as the pair of electrodes. This cell is connected in series with a telephone and a voltaic battery, and when electric oscillations are passed through the cell they annul more or less the polarisation of the small electrode and create an increase of current, which in turn makes an audible signal in the telephone.

Signals are thus sent on the Morse code by interrupting the oscillations in the sending antenna. It has, however, recently been found that this electrolytic detector, in conjunction with undamped-wave trains, affords a means of transmitting, not merely *dots* and *dashes*, but articulate speech sounds, and hence we have now electric-wave wireless telephony as an accomplished fact. Between Nauen and Berlin, a distance of about sixteen miles, successful experiments were recently carried out. From the transmitter continuous undamped waves of constant wave-length are sent out. The antenna is shunted by a microphone, so that words spoken to its diaphragm vary the intensity of the wave train, but not its wave-length. At the receiving station an electrolytic detector is used, and the words spoken to the transmitter are reproduced at the receiving telephone. It is almost practicable at the present moment to speak audibly across the English Channel by wireless telephony, and within the bounds of possibility that at some time we may telephone without wires to a ship in the middle of the Atlantic.

Another new form of electric-wave detector is a glow-lamp detector. A small carbon filament glow lamp has a metal cylinder placed in its bulb so as to surround, but not touch, the filament. This cylinder is connected to third terminal by a wire sealed through the glass. When the filament is rendered incandescent by a continuous current it throws off negatively charged corpuscles or electrons. The space between the filament and the cylinder will pass negative electricity from the filament to the cylinder, but not in the opposite direction. If, then, the oscillatory current in the receiving antenna, or secondary currents induced by them, are passed through the bulb from the carbon filament to the cylinder, only one constituent of the oscillation passes, or the bulb rectifies the oscillations. We can then insert in series with the bulb either a telephone or galvanometer sensitive only to continuous currents and cause it to be affected.

This glow-lamp detector or oscillation valve has already proved itself to be a most sensitive long-distance receiver for wireless telegraphy. It is of great use in connection with undamped electric waves, as it affords a ready means for converting the high-frequency alternating current created in the receiving antenna into a continuous current detectable by a galvanometer or telephone. Prof. Fleming showed by an experiment that it enabled him to revive in another form electromagnetic induction telegraphy.

In the form in which this older system of wireless telegraphy was practised by Trowbridge, Preece, Lodge, and others, a closed primary circuit was traversed by a rather low-frequency alternating current, viz. one of which the frequency lay within the limits of audible sound. In the modification proposed, a closed primary circuit earthed at one point is traversed by a very high-frequency current produced by the electric arc or other mechanical method. With high frequencies, say of 100,000 or so, no disturbance would be created in other earthed neighbouring telephonic or telegraphic circuits. The receiving circuit is a similar closed and syntonised circuit having a glow-lamp detector or oscillation valve and telephone inserted in it. The primary circuit affects the secondary circuit by magnetic induction, and also acts like a Fitzgerald closed magnetic oscillator, and throws off magnetic waves. With these modifications it is possible that induction telegraphy may be extended in range and free from the objection of disturbing neighbouring telephonic circuits.

The lecturer then passed on to consider some advances made in directing electric waves in any required direction. All methods employing mirrors or reflectors are out of the question when long telegraphic electric waves are under consideration. Two methods at the present time presented practical advantages. In one, due to Mr. Marconi, the vertical upright antenna wires are replaced by antennæ having a short part vertical and their greater part horizontal. Such a bent antenna radiates best in the opposite direction to that in which its free or insulated end points. Hence, in accordance with the law of exchanges, which applies to electric radiators, a bent antenna absorbs best electric waves coming from a direction opposite to that to which its free end points. Making use of such bent receiving and transmitting antennæ, Mr. Marconi has been able to limit the radiation in undesired directions, and also to locate the direction of invisible sending stations.

Another method, different in principle, has been devised by Prof. Braun, of Strassburg, who employs three vertical antennæ placed at equal distances, and sets up in these oscillations having certain assigned differences of phase. Hence, by the interference of these oscillations, the resultant radiation is made a maximum in a certain direction and zero in an opposite one.

In conclusion, some questions were dealt with concerning the varying opacity of our atmosphere to long electric waves and the effects of sunlight and radio-active matter in hindering their transmission. Although much valuable invention and discoveries in connection with this subject have rewarded the labours of workers in many lands, a glance round shows innumerable unsolved problems still remaining. Having regard to its importance for naval and maritime communication, scientific research in connection with wireless telegraphy is not merely desirable, but a positive duty, and it is to be hoped that the tendency to legislate for it by Acts of Parliament or international conferences will not impose shackles upon the freedom of investigation or of commercial work which alone can conduct us to the satisfactory solution of the difficulties and problems which yet remain.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—Mr. S. S. Dawson has been appointed to the chair of accounting vacated by Prof. Dicksee.

A sum of about 1000*l*. has been given by the Birmingham Chamber of Commerce to found a scholarship in the faculty of commerce.

MANCHESTER.—During recent years, with the increasing number of students who come from other parts of the country and from abroad, the accommodation in the two halls of residence for men students has had to be extended on several occasions. The opening of the new buildings of Hulme Hall in Victoria Park on July 6, which are to displace the older buildings in Plymouth Grove, marks an important advance, and rooms are immediately available for forty students, whilst this hall will later be extended to accommodate sixty.

ST. ANDREWS.—An important addition to the equipment of the Gatty Marine Laboratory has just been made by the presentation of the late Mrs. Alfred Gatty's extensive collection of British and foreign marine algæ by her daughter, Mrs. Horatio Eden, of Rugby. Begun in 1848 at Hastings, this important collection was constantly added to during the life of the accomplished author of the "British Seaweeds." Moreover, Miss Catherine Cutley, of Exmouth, a well-known algologist, Prof. W. Harvey, Prof. Agardh, and others, largely increased its value by liberal donations. The collection is arranged, though not completely, according to Prof. Harvey's "Index Generum Algarum," and is accompanied by a valuable series of books of reference, many of them finely illustrated, by Greville, Harvey, Turner, Agardh, J. E. Gray, Frauenfeld, Mrs. Gatty, and others. The foregoing, with the collections of algæ by Mrs. McIntosh, Charles Howie, W. Knight, Dr. Drummond, &c., previously in the laboratory, will, with the rich living series in the bay, give workers in algology facilities of no ordinary kind.

THE King will open the new buildings of University College School, in Frognal, Hampstead, on Friday, July 26.

THE Right Hon. Ailwyn Fellowes will distribute the diplomas and prizes on Wednesday, July 24, at the South-Eastern Agricultural College, Wye, Kent.

DR. S. G. RAWSON has been appointed principal of the Battersea Polytechnic in succession to Mr. Sidney H. Wells, who has been principal since the foundation of the institute in 1893, and is resigning to take up the position of director-general of the Department of Agriculture and Technical Education for Egypt. Dr. Rawson is at present director of education for Worcestershire, and was formerly principal of the Technical College, Huddersfield, and lecturer at Liverpool University.

A COMMITTEE has been appointed by the Treasury to inquire and report upon the character of the work accomplished by the University of Wales and its constituent colleges, the financial position and lines of development of the colleges, and their probable requirements for staff or otherwise. The members of the committee are:—Sir T. Raleigh, K.C.S.I. (chairman); Sir John Rhys, Principal of Jesus College, Oxford; Principal D. MacAlister, Glasgow University; Mr. F. G. Ogilvie, C.B.; Prof. W. S. McCormick; and Dr. Alexander Hill, Master of Downing College, Cambridge. Mr. G. L. Barstow, of the Treasury, will act as secretary to the committee.

THE Board of Education has issued its regulations for next session in connection with the work of technical schools, schools of art, and other day and evening schools and classes for further education. A prefatory memorandum directs attention to the changes introduced; but, before enumerating these, some remarks are made on the general condition of the work of the schools concerned. The experience of towns which have provided systematic and graded courses of instruction shows that a good supply of well-considered educational facilities may be made to foster a demand for these advantages without the application of compulsion in the matter of attendance. Another interesting fact is to find it specifically stated that it is regarded as one of the functions of the Board's inspectors to advise educational authorities, where evening and other schools are not so popular as they might be, as to the changes which would probably lead to improvement and to inform them where successful schools may be found. A note has been added to the regulations with the object of making clear to local authorities that the classification of subjects and courses is in no sense a restriction upon the free adjustment of the subject-matter and methods of instruction in any class to the particular circumstances of the students. The necessity for keeping rural interests well in view throughout all educational work in country districts is now fully recognised, and the continuing need for Saturday and holiday courses for teachers who desire to improve their qualifications for duty in such areas is again pointed out.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 2.—"The Spontaneous Crystallisation of Binary Mixtures. Experiments on Salol and Betol." By Prof. H. A. **Miers**, F.R.S., and Miss F. **Isaac**.

The authors have inferred from their experiments upon certain salts that a cooling supersaturated solution can at first only be made to crystallise by inoculation with a crystal of the solute, until a perfectly definite temperature is attained at which a mechanical stimulus, *e.g.* shaking or friction, will suffice to produce crystallisation. The temperature of this "spontaneous crystallisation" depends upon the strength of the solution as determined by a curve which they name the "supersolubility curve." They have now traced the complete freezing-point curve, and also the supersolubility curves for mixtures in all proportions of salol and betol, choosing these substances merely because they melt at convenient temperatures and do not form compounds or isomorphous mixtures. Salol melts at $42\frac{1}{2}°$, betol at 92°. The eutectic contains 78 per cent. salol, and freezes at $32\frac{1}{2}°$ by inoculation only.

Salol freezes spontaneously at 33°, betol at 79°; the supersolubility curves of their mixtures meet in the "hypertectic" mixture, containing 74 per cent. salol, for which the two substances freeze together spontaneously at 15°.

The freezing-point curve was determined by immersing a minute crystal in the cooling liquid and noting the temperature at which it just ceased to dissolve and began to grow.

The temperatures of spontaneous crystallisation were determined (1) by the crystallisation of the liquid on shaking or scratching when enclosed in a sealed tube, and also (2) by the dense shower of crystals which appears at the same temperature when the liquid is stirred in an open vessel.

The actual change of constitution of the liquid in the crystallising mixture was traced by means of the refractive index.

These experiments show that a binary mixture has, in general, four freezing points. For example, the mixture containing 90 per cent. salol may yield crystals of salol by inoculation at 38°, and by stirring at 28°; crystals of betol by inoculation at $17\frac{1}{2}$°, and by stirring at $10\frac{1}{2}$°.

The actual temperatures of crystallisation in binary mixtures are given by the supersolubility curves.

May 23.—"Studies on Enzyme Action. X.—The Nature of Enzymes." By Henry E. **Armstrong** and E. Frankland **Armstrong**.

The study of enzymes has now reached a stage at which it appears to be desirable to consider what is established and to direct attention to some of the principal issues which remain to be elucidated. The action which each enzyme exercises is clearly specific and limited to compounds of a particular type; the apparent exceptions to this statement in the case of sucroclastic enzymes have been investigated and eliminated: there is little doubt that maltase is capable of hydrolysing α-glucosides alone, whilst emulsin hydrolyses only β-glucosides. Further experiments have been made with carefully purified materials to ascertain what substances control the action of each sucroclastic enzyme; the evidence that enzyme and hydrolyte must be in complete correlation appears to be little short of absolute.

A special study has been made of the hydrolysis of cane sugar by invertase: apparently, glucose and fructose alone retard the action of this enzyme; it would seem to follow that it is so constituted that it can adapt itself to both sections of the biose. Cane sugar, though a derivative of α-glucose, is not a simple α-glucoside, nor is it an α-fructoside: consequently there is little room for doubt that the action of invertase is altogether peculiar and that the enzyme extends its influence over the whole of the cane-sugar molecule. Maltose and lactose differ from cane sugar in that they are hydrolysed by enzymes which also act on the corresponding simple glucosides.

It is conceivable that the enzymes themselves are subject to hydrolysis and simplification—in other words, that a biose may give rise to a monase. The existence of monases in admixture with biases is therefore to be expected. There can be little doubt that the sucroclastic enzymes are products of hydrolytic changes in the protoplasm conditioned by enzymes—mainly proteoclasts.

"Studies on Enzyme Action. IX.—The Enzymes of Yeast: Amygdalase." By R. J. **Caldwell** and S. L. **Courtauld**.

Amygdalin, which on complete hydrolysis yields two molecular proportions of glucose, is only partially hydrolysed by the enzymes extracted from dried yeast, mandelonitrile glucoside and glucose being formed:—

$$C_6H_5CH(CN)O—C_{12}H_{21}O_{10}+H_2O \rightarrow C_6H_5CH(CN)O—C_6H_{11}O_5+C_6H_{12}O_6.$$

The enzyme which effects this decomposition is specific, but being accompanied by *maltase* has been generally supposed to be identical with it. This conclusion, however, appears unwarrantable in view of the evidence recently advanced by the authors that amygdalin is not a derivative of maltose, and in the light of recent work on the specific character of the enzymes (E. F. Armstrong).

Systematic experiments with yeast extracts led to the conclusion that true maltase is without action on amygdalin, for the maltase could be destroyed by heating at 50°, whilst the activity towards amygdalin was unimpaired. Proof was thus obtained of the existence of a specific enzyme not hitherto recognised as a constituent of yeast, which is the active agent in the separation of glucose from amygdalin. This enzyme, "*amygdalase*," is present in larger proportion in top yeasts than in bottom yeasts, and appears to be equally well extracted at all temperatures from 15° to 45°, whereas for the extraction of maltase there is a distinct optimum temperature depending on the variety of yeast.

Although completely freed from maltase by heating at 50°, yeast extract retains not only its power to hydrolyse amygdalin, but also a diminished activity towards methyl-α-glucoside, and unaltered activity towards cane sugar. The inference that methyl-α-glucoside is attacked by the two enzymes maltase and amygdalase cannot well be disputed, particularly as amygdalin is more slowly hydrolysed in presence of methyl-α-glucoside, whereas maltose has no influence. The alternative explanation is that there is yet another *α-glucase* existing side by side with maltase and amygdalase. The enzyme which attacks amygdalin is not identical with *invertase* as Marino and Sericaro have recently declared, for a high temperature (60°) quickly destroys amygdalase, leaving active invertase in solution.

Amygdalase, like maltase and invertase, is present in the yeast in the form of a "*zymogen*" or more complex proteid molecule. This zymogen can be dissolved out at 0°, and its hydrolytic activity developed by heating the solution for a short time at 45°. Unlike maltase, amygdalase is not destroyed during autolysis of yeast, but may be precipitated with the invertase by means of alcohol.

June 20.—"Studies of the Processes operative in Solutions."

(2) The Displacement of Chlorides from Solution by Alcohol and by Hydrogen Chloride. By H. E. **Armstrong**, Dr. J. V. **Eyre**, A. V. **Hussey** and W. P. **Paddison**.

(3) The Sucroclastic Action of Nitric Acid as Influenced by Nitrates. By R. **Whymper**.

(4) The Hydrolysis of Methylic Acetate in Presence of Salts. By H. E. **Armstrong** and J. A. **Watson**.

(5) The Discrimination of Hydrates in Solution. By H. E. **Armstrong** and R. J. **Caldwell**.

(2) The effect of different proportions of the non-electrolyte alcohol and of the electrolyte (in solution) hydrogen chloride in displacing ammonium, sodium and potassium chlorides from their saturated solutions has been determined and the proportion of water calculated which it may be supposed is withdrawn by the precipitant in each case. The results afford an interesting picture of the state of the salts in the various solutions; in particular, they show that sodium and potassium chlorides are present in saturated solutions in an easily precipitable, slightly hydrated form and that they pass into a more soluble and more hydrated form as the amount of precipitant is increased. Except that alcohol has less dehydrating power than hydrogen chloride, no distinction can be drawn between the two as precipitants of chlorides.

(3) The method developed in part i. of these studies by R. J. Caldwell has been applied to nitrates, *i.e.* the average concentrating effect which a number of these salts produce has been determined by hydrolysing cane sugar with nitric acid in their presence and ascertaining the extent to which the solution must be diluted in order to reduce the rate of change to the value which it has when the salt is not present. The average degree of hydration deduced for the various salts is as follows:—

$AgNO_3.5H_2O.$
$NH_4NO_3.7H_2O.$
$KNO_3.8H_2O.$
$NaNO_3.11H_2O.$
$LiNO_3.13H_2O.$
$Sr(NO_3)_2.18H_2O.$

(4) To ascertain whether the method followed in (1) and (3) of these studies can be applied to hydrolytes other than cane sugar, the investigation has been extended to the hydrolysis of methylic acetate by chlorhydric acid in presence of various chlorides. The results arrived at are as follows:—

$NH_4Cl.5H_2O.$
$KCl.8H_2O.$
$NaCl.10H_2.$
$BaCl_2.18H_2O.$
$CaCl_2.20H_2O.$

These values are slightly lower than those deduced with the aid of cane sugar. It is suggested that the chlorides enter to some extent into competition with the acid for the ethereal salt and that, consequently, they partially prevent hydrolysis. Nitrates have a still greater effect in competition with nitric acid, the apparent hydration values being $NH_4NO_3.2H_2O$, $LiNO_3.0H_2O$, $KNO_3.1H_2O$ $NaNO_3.3H_2O$.

(5) The results arrived at in these studies and in those

on enzyme action carried out at the Central Technical College are discussed with reference to the general problem of chemical interchange in solution. It is argued that not only is the ionic dissociation hypothesis irrational and unsupported by chemical evidence which compels its acceptance but that proof is not wanting that it is untenable; that the selective action of enzymes as hydrolysts, the action of salts and other dehydrants in promoting hydrolysis by acids and the similar behaviour of non-electrolytes and electrolytes in precipitating substances from solution are all cases of change which it is easy to explain on the assumption that association takes place, although incompatible with the view that dissolution involves separation into free ions. The importance of the part played by hydrates in solution is considered and the evidence bearing on their composition is analysed—especially that to be derived from the change in the solubility of gases produced by salts, &c. It is contended that the values deduced by the cane-sugar hydrolysis method are rational values. Finally, reference is made to the nature of electrolytes and it is argued that it is incumbent on physicists to reconsider the arguments which lead them to accept the hypothesis of ionic dissociation, in order that they may substitute some more suitable hypothesis.

Royal Microscopical Society, June 19.—Lord Avebury, F.R.S., president, in the chair.—A slide of cow's hair presented by J. E. **Lord**. The hair, which showed a wool-like structure, was taken from the flank of the cow. Hair of this description is used in the manufacture of felt for exportation to a foreign port, where, owing to the prohibitive tariff, it has to be free from wool. The felt was refused admittance, except on a higher scale of tariff, on the ground that it contained wool. This led to an examination of the constituents of the felt, and the wool was traced to the cow. Hair is found on many goats, the llama, and the camel, which is commercially known as wool.—Slides of fluid crystals: Dr. **Hebb**. An intermediate physical state exists between the solid and liquid forms of matter, *i.e.* some substances present themselves as liquids whilst retaining certain characteristics of their solid state. This intermediate state has been found to occur in animal tissues, and it is to Adami and Aschoff that we owe the demonstration of potential fluid crystals in certain organs, *e.g.* the adrenal gland. The slides exhibited were sections cut from the fresh tissue of the adrenal gland. In one illuminated by ordinary light the sphero-crystals were indistinguishable from common fat globules, but in one illuminated by polarised light they evidently possessed the power of double refraction, and exhibited a well-marked black cross.—A slide of a group of six specimens of Stephanoceros, mounted: Mr. **Rousselet**.—Eye-pieces for the microscope: E. M. **Nelson**. The paper had reference to a new eye-piece calculated by Mr. Nelson and described by him in his presidential address in 1900. The author said that in his own work these eye-pieces have quite superseded those of the compensation form. There is no reason why they should not be produced at a price only slightly in excess of that of the ordinary Huyghenian, as they are composed of only two biconvex lenses. In these eye-pieces the refractions are equally divided between the two lenses, and the equation for achromatism given by Coddington and others is also satisfied.—The life-history of the tiger beetle: F. **Enock**.

Royal Meteorological Society, June 19.—Dr. H. R. Mill, president, in the chair.—Weather and crops, 1891–1906: F. C. **Bayard**. An analysis was given of the agricultural and horticultural tables which are included in the annual phenological reports. The author had sorted out the various crops into "good," "average," or "bad" for each district, and against each he had placed the temperature, rain, and sunshine for the four seasons, and whether these statistics were above or below the average. Tables were given showing the general results with regard to wheat, barley, oats, beans, peas, potatoes, turnips, mangolds, hay, clover, apples, pears, plums, raspberries, currants, gooseberries, and strawberries.—The relation of the rainfall to the depth of water in a well: Dr. C. P. **Hooker**. The author gave the weekly measurements of the depth of water in a well 101 feet deep at Further Barton, Cirencester, compared with the weekly rainfall for the years 1903–6. The results included the remarkably wet year 1903, and the droughty summer and autumn 1906.—The "step" anemometer, an instrument designed to obviate the "sheltering" error of the Robinson's cups: W. **Child**.

Royal Anthropological Institute, June 25.—Mr. F. W. Rudler, ex-president, in the chair.—A series of lantern-slides illustrating aboriginal rock paintings discovered by him in Western Australia: F. S. **Brockman**. The subjects depicted consist of human figures, animals, and hands, the former being the more interesting. The figures, which are dressed in a long jacket and trousers, are very crudely drawn and painted in red, black and white pigment. A peculiar feature is that the mouth is not shown. There is some difficulty in determining whom the figures represent, but it is clear that they are not Australians, and it seems most probable that a party of shipwrecked Europeans served as the original model.—A collection of so-called Kanaka skulls from the south of New Caledonia: Dr. David **Waterston**. The skulls were very varied in type, but some showed distinct Polynesian and others Melanesian features, while one was of Australoid and another of negroid character.—Instruments employed to obtain contour tracings of the different aspects of the skull: Prof. **Cunningham**. The instruments included Broca's original stereograph, Lissauer's instrument, Rudolf Martin's Kubuskraniophor, and an American periglyph.

Challenger Society, June 26.—Sir John Murray in the chair.—Dr. **Calman** exhibited and made remarks on some plates of tropical Cumacea, followed by a discussion on the comparative rates of growth of the fauna in warm and cold seas.—The secretary reported on the commencement of the society's "Bibliography of Marine Zoology, 1846–1900," of which Mr. L. A. Borradaile has been appointed editor; the bibliography will enable a worker to find readily the faunistic papers on any area or of any group in which he is interested.

DUBLIN.

Royal Dublin Society, May 21.—Prof. S. Young, F.R.S., in the chair.—Some devices for facilitating the study of spectra: Prof. W. N. **Hartley**. The author described the infusible materials used as supports instead of platinum in high-temperature flames, such as carborundum points and quartz fibres. For solutions, quartz tubes with a capillary orifice were used. The use of the Mecke burner was shown both with and without the air-blast. For the production of chloride spectra, an arrangement was shown by which a bye-pass carried a portion of the gas supply through a bottle containing sponge saturated with chloroform. The Mecke blast burner was shown with the blast produced by a water-blower; the pressure should be 2 kilos. per sq. cm. Photographs were shown of spectra of lime and calcium chloride taken with two hours' exposure.—Note on the spectra of calcium and magnesium: Prof. W. N. **Hartley**. In photographing the spark spectrum of metallic calcium in an atmosphere of hydrogen, and also in a vacuum, without a jar in circuit, it was found always very difficult to obtain precisely the same spectrum with the same exposure. The principal features were the bands in the red, orange, and green, with the line λ 4226; also in one instance there appeared the lines at 3968·6 and 3933·8, but these were very feeble. At pressures less than 5 mm. there was no distinct passage of the spark between the electrodes. They glowed with a violet light; bright stationary spots of white light were seen on the negative electrode, and a great number of scintillations, less bright on the positive electrode, not in one spot, but all over it. At intervals there was a small flame of red light lasting a few seconds, evidently due to the calcium, which apparently passed from the positive electrode; but this ceased after a few seconds. Similar observations were made on magnesium electrodes under the same conditions. The phenomena are believed to be connected with discharge of negative electricity from hot calcium and from lime, described by Dr. F. Horton at the meeting of the Royal Society on January 31.—The free gases contained in monazite: R. J. **Moss**. The gas liberated when Norwegian monazite is ground *in vacuo* consists chiefly of hydrogen and helium, with atmospheric gases. One volume of helium so obtained is associated with about six volumes of hydrogen. It is shown that this evolution of gas is not due to the heat mechanically produced; the gases are probably present in the free state. When the mineral is heated very little hydrogen can be detected in the gas at first evolved, but at a temperature of about 600° C. nearly half the gas evolved is hydrogen. It was found that at temperatures as low as 275° C. some of the oxides present in the mineral were reduced by hydrogen, with the production of water, hence the relatively small quantity of hydrogen in the gas at first evolved in heating the mineral. Hydrogen in other radioactive minerals may escape detection for the same reason.

PARIS.

Academy of Sciences, July 3.—M. Henri Becquerel in the chair.—Some formulæ relating to the number of classes of quadratic forms: G. **Humbert.**—The *rôle* of the spleen in trypanosomatous diseases: A. **Laveran** and M. **Thiroux.** Among animals the spleens of which have been removed, the development of the disease is not sensibly modified.—The direct hydrogenation of the anhydrides of formenic acids: Paul **Sabatier** and A. **Mailhe.** The general method of hydrogenation over finely divided nickel can be systematically applied in this case.—The synthesis of secondary isoamyl alcohol,

$$(CH_3)_2{=}CH{-}CHOH{-}CH_3:$$

Louis **Henry.**—A prehistoric syphilitic skull: L. **Lortet.**—A mineralogical study of the silicated products of the eruption of Vesuvius (April, 1906), and conclusions to be drawn therefrom: A. **Lacroix.**—Finger-prints as a method of identification: M. **Dastre.** The finger-prints of any particular individual, from the youngest age to the most advanced, are invariable, and the concordance of the impressions of the ten digits would constitute practical certainty of identification, the calculable chance of error being less than one part in sixty-four billions.—The evolution of forces: Gustave **Le Bon.**—The integrals of the differential equation $y^1+A_2y^2+A_3y^3=0$: Pierre **Boutroux.**—A mechanism which allows the maintenance of a train of prisms rigorously at minimum deviation: Maurice **Hamy.**—The ionisation of air: L. **Bloch.** A current of air across ordinary or, better, distilled water acquires a negative charge, which is, however, a difference between two unequal charges. The intensity of the ionisation thus implied is greatly augmented with increased pressure.—The electrolysis of very dilute solutions of silver nitrate and oxide: MM. **Leduc** and **Labrouste.** There is little doubt but that silver liberated by electrolysis under a sufficient voltage behaves as an alkaline metal reacting upon water to produce an oxide.—The absolute atomic weight of chlorine: G. D. **Hinrichs.**—The volumetric estimation of phosphorous acid: C. **Marie** and A. **Lucas.**—The action of chlorine and sulphur chloride on some oxides: F. **Bourion.**—The atomic weight of hydrogen: Daniel **Berthelot.** The mean result as deduced from the densities of nitrous oxide, nitric oxide, and nitrogen is calculated to be 14·005.—The specific heat and cryoscopic constants of mercuric iodide: M. **Guinchant.**—Diglycollic acid and its homologues: E. **Jungfleisch** and M. **Godchot.**—Synthesis by means of mixed organometallic derivatives of zinc. Unsaturated $\alpha\beta$-acyclic ketones: E. E. **Blaise** and M. **Maire.**—Some new bromo-derivatives of pyridine: L. **Barthe.**—The action of some γ and δ-bromo-ethers on cyanoacetic, malonic, and methylmalonic ether: G. **Blanc.**—The alkaline rocks of Central Africa: A. **Chudeau.**—A new Myxosporidia parasite in the sardine: L. **Léger** and E. **Hesse.**—The genital organs of the *Taenia nigropunctata*: Pasquale **Mola.**—The action of low temperatures on the eggs of *Paralipsa gularis*, Zeller: J. **de Loverdo.**—Calcification and decalcification in man: P. **Ferrier.** There exists naturally in certain organisms an epoch in life when an elimination of chalk is necessary. This can be brought about by the use of inorganic acids, sodium and magnesium sulphates, sodium phosphate, and alkaline sulphides.—Artificial serums: C. **Fleig.**—A new method of measuring the surface of the human body: M. **Roussy.**

NEW SOUTH WALES.

Linnean Society, May 23.—Mr. A. H. Lucas, president, in the chair.—Special meeting to mark the occasion of the bicentenary of Carl von Linné (1707–1778).

May 30.—Mr. A. H. S. Lucas, president, in the chair.—Studies in Australian entomology, No. xiii., new genera and species of Carabidæ, with some notes on synonymy (Clivinini, Scaritini, Cunipectini, Trigonotomini, and Lebiini): T. G. **Sloane.**—Dimorphism in the females of Australian Agrionidæ (Neuroptera: Odonata): R. J. **Tillyard.** In *Ischnura heterosticta* the male is bronze and blue; of the females, form A (ordinary) is dull black, and form B (dimorph) imitates the male; and the proportion of form B to total number of females is 30 per cent. to 40 per cent. In *I. delicata*, ♂ red and blue; ♀ form A, dull black or olive-green; form B, imitates ♂; 10 per cent. in S.W. Australia. In *Agriocnemis pruinescens*, ♂ black with grey bloom; ♀ form A (wanting); form B, orange; 100 per cent. In *A. splendida*, ♂ bronze and blue; ♀ form A, similar to ♂; form B, red; 40 per cent. In *A. argentea*, ♂ silvery-white (ground colour black); ♀ form A, black; form B (wanting); 0 per cent. In *A. velaris*, ♂ bronze with red tip; ♀ form A (wanting); form B, red; 100 per cent.—The Lake George Senkungsfeld: a study of the evolution of Lakes George and Bathurst, N.S.W.: T. G. **Taylor.** Lake George, situated twenty-five miles south-west of Goulburn, is the largest lake in New South Wales. It is bounded on the west by a *fault scarp* nearly thirty miles long and about 400 feet above the level silt-bed of the lake. The rivers running into the lake originally entered the Yass River, but have been blocked by the fault. The old outlet, 300 feet above the lake, is represented by alluvial boulders up to 2 feet in diameter, which can be traced for three miles across the fault scarp. The second portion of the paper deals with the origin of Lake Bathurst. This is a broad valley probably blocked by the talus and débris carried down by the Mulwaree River.

CONTENTS.

THURSDAY, JULY 18, 1907.

AN INTRODUCTION TO THE COMPARATIVE ANATOMY OF VERTEBRATES.

Einfuhrung in die Vergleichende Anatomie der Wirbeltiere. By Prof. Robert Wiedersheim. Pp. xxii+471; illustrated. (Jena: Gustav Fischer, 1907.) Price 11 marks.

THE fatalities which may overtake standard text-books are numerous and complex in their action, but on the whole, overgrowth, the result of repeated editions, is one of the commonest causes of extinction. With the incorporation of new material in each edition, the scientific merit of a work may rise, but unfortunately its commercial value will certainly decline; from an examination book with a wide circulation amongst students it becomes a reference book, used only by experts. This is a difficulty which faces every author in the preparation of a new edition of a standard text-book; he may do his duty at the expense of circulation, or he may throw overboard older work to make room for the new, and thus maintain or even increase the circulation, or he may do as Prof. Wiedersheim has done—allow the work to increase with the growth of knowledge, and issue another book altogether, into which are condensed the merits and essentials of the older work.

The volume under review is a condensation of Prof. Wiedersheim's well-known text-book on comparative anatomy. It will be widely used, no doubt, by medical and by science students in Germany, but it will also prove of the greatest service to those who wish to obtain a summary of our modern knowledge of this subject. The author has the incomparable advantage of a first-hand knowledge of the whole length and breadth of vertebrate anatomy; as colleagues and advisers in the University of Freiburg he has Gaupp, Keibel, and E. Fischer, each eminent in his own field of work. He possesses a simple, easy diction, a judicious eye for the selection of his facts, and a very open mind. His attitude perhaps is too cautious, too non-committal; difficult and unsettled problems are simply mentioned or brushed aside.

It is a curious fact that no British anatomist has ever produced a systematic treatise on comparative anatomy of the type so common in Germany—the type best represented by the works of Gegenbaur and Wiedersheim. Huxley's classical work on vertebrate comparative anatomy is arranged on quite different lines; there the anatomical facts are so grouped as to throw light on the relationship of one class of animals to another; clearly, in Huxley's opinion, the chief object of the anatomist is to ascertain the evolutionary history of *the animal*, whereas the German anatomist seeks the evolutionary history of *the organ*. English anatomists set their facts under a zoological classification, whereas, in the book under review, the classification is strictly anatomical. Prof. Wiedersheim may make incidental allusions to the bearing of a fact on the position of one group of animals to another—such as the impossibility of deriving the mammalian lung from the reptilian—but such allusions are few and far between. Clearly he has no immediate object in view saving that of bringing together in an orderly arrangement all that is known of the form and variation of each organ. Strictly speaking, the classification adopted in German works on comparative anatomy is essentially physiological; the structures subserving circulation are dealt with in one chapter, those of respiration in another, and it may be at once admitted that this method of classification has an overwhelming advantage over any other. Yet such a treatise is the last one in the world one would consult for physiological information, because the correlationship between function and form has never appealed very strongly to the German anatomist. As knowledge increases, it becomes more and more certain that the key to comparative anatomy is comparative physiology—a subject yet in its infancy.

This statement, however, is less true of Prof. Wiedersheim than of his compeers; one rejoices to see occasional allusion to function in his work; he rightly describes the functional significance of the air sacs attached to the lungs of birds; his allusion to the function of the accessory sexual organs will probably assist the student to understand their structure and relationship; mention is made of the effects of the substance secreted by the suprarenal body in raising the arterial blood-pressure, although nothing is said of its equally important action on the musculature of the alimentary canal. There is a frank, engaging honesty in the manner with which Prof. Wiedersheim deals with structures of obscure meaning. As regards the descent of the testicle, he says it is a "schwer erklärbare Vorgang"; unlike Metschnikoff, he does not conclude that the hymen at the entrance of the vagina has neither function nor meaning, because in the present state of our ignorance regarding sexual organs generally we have not as yet discovered any function or meaning attached to it. He frankly admits that the significance of the abdominal pores is unknown. On the other hand, he concludes that the lobulation of the lung has no physiological significance—an inference which will not be supported by a closer knowledge of the mechanism of respiration.

There are certain minor blemishes in this work. The index is not nearly full enough. For instance, on taking the book up for the first time, the reviewer wished to ascertain what was taught regarding the fate of the cloaca in higher mammals, but found no reference to that structure in the index. But in the text he discovered, from incidental remarks rather than from any special description, that Prof. Wiedersheim regards the anus of the higher mammals as the cloacal orifice, and that the urogenital aperture is a new opening. The research of Dr. F. Wood Jones leads to a diametrically opposite conclusion, namely, that the urogenital orifice is the cloacal orifice, and that the anus is a new opening, and hence the frequent occurrence of *atresia ani* in children. There are other statements, too, with which English anatomists will not agree, such as those regarding the nature of the sternum, the origin and nature of the temporo-maxillary joint, the origin and nature of the diaphragm, the homology of the muscles of the body wall, and the retrograde nature of the appendix vermiformis. These, however, are all contentious matters, which the author purposely has left undiscussed, preferring evidently to state the older view until the truth of the newer has been more firmly established. A. K.

THE PRINCIPLES AND PRACTICE OF FOOD PRESERVING.

Les Industries de la Conservation des Aliments. By X. Rocques. Pp. xi+506. (Paris: Gauthier-Villars, 1906.) Price 15 francs.

M. ROCQUES'S aim in writing the present work has been to explain, for the benefit of manufacturers and others, the scientific principles upon which the preservation of foodstuffs is based.

At first sight it is somewhat curious that in dealing with the problems of food-preservation no large measure of success should have been met with until comparatively recent times. To retain the fruits of the earth against periods of scarcity must always have been a desirable object. Hence such operations as the garnering of grain and the drying and salting of flesh were practised ages ago; but afterwards there was a gap of many centuries—one might almost say from prehistoric times until yesterday—during which no considerable advance was made in devising means of preventing the progress of decay. It was a question of the infinitely little. Against club or sword of human despoilers a man might match club or sword in defence of his store of foodstuffs, but he was very nearly powerless against the microscopic agents of putrefactive change.

Nevertheless, in a groping, tentative sort of way, some steps were beginning to be made during the eighteenth century. On the theoretical side Van Helmont, Boyle, Becher, Pringle, Macbride, Black, and others studied the allied questions of fermentation and putrefaction, whilst Lavoisier gave the first touches of quantitative exactitude to such inquiries by his experiments upon the alcoholic fermentation of sugar. On the practical side Gaefer and Eisen tested the possibility of preserving vegetables and fruits by desiccation. Then in the early part of last century came Appert, who practised what is essentially the process of sterilisation employed at the present day on an immense scale in the preservation of every sort of comestible. But it was only with the victory of Pasteur in his famous controversy with Liebig that the true nature of fermentative and putrefactive change became clear. It was the micro-organism, and not the air (*per se*), nor spontaneous generation, nor chemical instability, that was responsible for the decay of organic tissues. Henceforward the steps become firm. It is now the aim of all preservative processes to prevent the development of the micro-organism, whether by exclusion of its presence, or by its destruction, or by the inhibition of its growth. Hence it is that either heat or cold may be used for the required purpose: canned peaches are edible because the putrefactive organisms had been destroyed by heating; ice-embedded mastodons, ages after their death, have furnished well-preserved carcasses because the development of micro-organisms has been inhibited by cold.

After touching upon these and other points in an interesting historical sketch, the author deals, shortly but comprehensively, with the phenomena and products of putrefactive change in alimentary substances. He passes then to the consideration of the practical processes employed in preventing these changes. Preservation by means of heat is first described. To give an idea of the general plan of the book we will outline this section. First comes a sketch of the development of the industry, with notes of localities, products, and some statistics of production—not very recent, by the bye—then the general technique is described, including the manufacture of tins and bottles, and the different methods of closing and sterilising these vessels after they are filled. Afterwards the various classes of foods—vegetables, fruits, meat, fish, and milk—are dealt with in detail, the quantity of material, preliminary treatment, and time of sterilisation being given where necessary for each individual article. Numerous illustrations of machinery and operations elucidate the text.

This thorough and practical style of treatment is continued in the remaining sections of the book, dealing respectively with preservation by means of cold, by desiccation, and by the use of antiseptics. M. Rocques laments the fact that France has lagged behind other countries in the use of cold storage, which in the opinion of M. Muntz is the method having the greatest future. In connection with this an interesting parallel may be noted. Just as Lister's antiseptic surgery has been largely replaced by aseptic processes, so in the case of foodstuffs sterilisation by heat is being to a considerable extent obviated by the practical asepsis of refrigeration.

We can cordially endorse the closing words of M. Brouardel's preface: M. Rocques has written a good book and done a good deed at the same time, since in all probability the health of his fellow-men will benefit from using the information he summarises and applying the principles he explains.

C. SIMMONDS.

THE THEORY OF PLANT BREEDING.

Le Transformisme appliqué à l'Agriculture. By Prof. J. Costantin. Pp. 300. (Paris: Alcan, 1906.) Price 6 francs.

BY "transformism" Prof. Costantin understands the passage from one species to another or the creation of new species—Lamarckianism or Darwinism in contradistinction to the older theories of men like Jordan concerning the absolute fixity of species. The book in the main deals with plants, and consists of a general discussion of the meaning of a species and of such phenomena as garden varieties, bud sports, and graft hybrids, the effects of climate and soil on type, together with a summary of the work of de Vries on mutations and of Nilsson and the Svalöf station on the improvement of cereals. It is a difficult and complex country, and as so much of the progress of agriculture must depend on the creation of improved varieties, the importance of a survey of the known and the unknown cannot be exaggerated. For example, if one may judge from the variation in yield among existing varieties of wheat, an increase of 10 to 20 per cent. in the maximum yield is not beyond the reasonable expectation of the raiser of new varieties. This increase involves the cultivator in no extra expense to speak of, whereas if he obtained it by means of fertilisers or more intensive cultivation, the added cost might easily consume all the extra return for the crop.

In the creation of new varieties of horticultural or agricultural plants the guiding principle in the past has been selection. In many cases this has consisted in the skilled observer picking out "mutations," new forms which have arisen *per saltum* and show some essential and transmissible difference from the type. In other cases a process of slow amelioration has gone on through persistently breeding only from the best. For example, the percentage of sugar in the sugar beet has been doubled in about fifty years by selecting for seed purposes only those roots which were richest in sugar, a little core having previously been bored out for analysis. It is necessary, however, to distinguish here; richness in sugar is a congenital condition of the root, transmissible with variations to its descendants, whereas mere size or other temporary factors due to culture cannot be so passed on and do not in consequence form material for selection. Thus it is probable that an immense amount of work that has been done to improve cereals by sowing only the largest or the heaviest grains, or, again, the grains from the longest ears, has been wasted; there is no evidence of the permanent amelioration of any variety by this method. The advances have all been acquired by "pure culture" methods; a desirable type of ear or grain is seen, and a pure strain is created by propagating from that alone.

It is with these questions of mutation and selection that Prof. Costantin's book mainly deals, but though such methods have had the field very largely to themselves in the past, they are not likely to retain their position in the future. Until recently the raiser of new varieties was rather shy of cross-breeding; he obtained thereby such an extraordinary and unstable set of mixtures that it was only by a lucky accident he could select anything tractable from it. Thanks, however, to the Mendelian hypothesis, we are now able to handle with some precision the varied hybrid forms which result from a cross, and the work of the Cambridge school of biologists, of Bateson among sweet-peas, and of Biffen among wheats, has shown what a remarkable practical tool Mendel has placed in the hands of the plant-breeders. Mendel's work has revolutionised the whole point of view, and in consequence Prof. Costantin's book, which, though dated 1906, contains no mention of Mendel and his theories, is hardly of service to the plant-breeder of to-day. Doubtless we may have to come back to a consideration of many of the facts therein, facts which lie outside the scope of Mendel's hypothesis, but just at present the current is setting so strongly the other way that Prof. Costantin's book will not meet with much acceptance.

SCIENCE FOR ARTISTS.

Modern Painters. By John Ruskin. 5 vols.
The Stones of Venice. By John Ruskin. 3 vols.
Unto this Last, and Other Essays on Art and Political Economy. By John Ruskin. Everyman's Library. (London: J. M. Dent and Co., n.d.) Price 1s. net per volume.

A CHEAP edition of Ruskin's works, clearly printed, and with the author's illustrations well reproduced, is a boon which will be keenly appreciated in many directions. The world of art already owes a heavy debt to "The Stones of Venice" and "Modern Painters," but for many years these have been accessible to the young student only through the agency of the public library or some such place. The great critic, whose watchword was "truth," thus failed to see the full fruits of his teaching. Now it is possible for anyone to enjoy the benefit of his writings, and the training of an artist must be regarded as incomplete until he has mastered, at least, the principles of his calling as laid down by Ruskin in "Modern Painters."

It has always, ever since the days of ancient Greece, been fully recognised that no representation of the human form can be even passable unless it is anatomically correct. Every muscle, every sinew, must be in its proper place, and correctly proportioned; even the attitude and expression of each figure must be correctly fitted to the subject, or the result will be unmercifully condemned. But how many a landscape is defaced with impossible clouds, trees which grow nowhere on this earth, and even rocks and mountains such as no eye has ever seen. In truth, nature has an anatomy as real as that of the human body, and the man who knows turns from such parodies with exactly the same feeling of contemptuous disgust as is inspired by a figure with misshapen limbs, or poised in an impossible attitude.

Misrepresentation of nature has been endured by the public from ignorance bred by lack of observation. As Ruskin says, it is not easy to discern the truth. The eye has to be trained to see correctly, and a picture should contain just that amount of fact which would be visible in the circumstances represented, and no more. It is useless for men who would be regarded as scientific Philistines to urge such things upon artists. Only the great ones would listen for a moment, and they are just those who need the advice least of all. They have always known, more or less, how to combine truth of visible detail with those qualities of breath and feeling which are involved in the idea of a "picture." But the rank and file too often palm off on ignorant buyers works which are wrong in drawing, wrong in colour, and ridiculous as representations of nature.

No one can regard Ruskin as a mere man of science, and he should command the attention of all who aspire to be his brother artists. His magnificent chapters on clouds, on plant forms, and on mountain sculpture are admirable alike in conception and execution. They are an excellent beginning. An artist who has studied them with care cannot but go to nature with an opened eye, and a little correct seeing must surely inspire him with the desire to understand, and to know nature as the sculptor knows the human body. The anatomy of scenery can only be fully grasped by industrious study, and every landscape painter should be put, as a prime essential, through properly devised courses of meteorology, botany, and geology, since they are the only clues to the working of the bones and muscles of the world.

OUR BOOK SHELF.

The Hills and Valleys of Torquay: a Study in Valley-Development and an Explanation of Local Scenery. By A. J. Jukes-Browne. Pp. viii+104. (Torquay: Published by the Author, Floriston, Torquay, 1907.) Price 3*s.* 6*d.*

THIS is a pleasantly written but withal scientific explanation of the sculpturing of the land which forms the Torquay promontory. The natural attractions of the region are great, and Torquay itself is said to spread over eight hills. Among these, Lincombe and Warberry Hills, formed of red Devonian grits, rise from 400 to nearly 500 feet; while the coast scenery is diversified by the limestone crags and cliffs of Torquay and Babbacombe, the slates of Ilsham, the dark igneous rock of Black Head, and the red conglomerates, sandstones, and clays of Watcombe and Livermead.

In describing the various stages and processes that have led to the present scenery, the author has endeavoured to make his work as simple as possible, but the reader who has hitherto paid no attention to geology must give earnest application to the introductory geological chapters in order to understand the subject.

The author shows how the present features were gradually developed after the Bovey Beds of Eocene age had been spread over an eroded surface of older rocks. The rivers then took their courses over soft strata, and cut channels through this covering into the Permian and Devonian rocks beneath. In process of time all traces of Bovey Beds have been removed from the area, and there have been revealed the remnants of old rock-platforms like that of Babbacombe, trenched in places by river action, before the present outlines of the coast were shaped.

The work, which will be of special interest to residents and visitors, is illustrated by a number of excellent pictorial views, and by a series of maps, based on those of the Geological Survey. The student may with advantage colour by hand the different geological formations represented on these maps. The author would have done well to mention the Geological Survey memoir on the country around Torquay by Mr. W. A. E. Ussher, a work which must form the basis of future research in the area.

Ammonia and its Compounds. By Dr. J. Grossmann. Pp. x+151. (London and New York: Harper and Bros., 1906.) Price 2*s.* 6*d.* net.

THIS is the first volume of a series of handbooks on chemical technology which, so the preface informs us, are not intended to be highly elaborated treatises, but are rather to afford a general survey of the subject and to serve as guides to the larger standard works. Although the author of the present volume disclaims either originality in the subject-matter or completeness in the compilation of his materials, the careful reader will soon realise that whatever defects the book may possess, it is written by one who is not only familiar with his subject, but combines a full knowledge with the power of clear and concise exposition. A more comprehensive treatise may possess the advantage of a work of reference for specialists, but a small volume like this will no doubt attract a wider circle of readers, and should find its way to the shelves of the student of general chemistry. We can only express a hope that the succeeding volumes may maintain the high standard of excellence attained by the pioneer volume of the series.

But if the publishers are to be congratulated on their new venture, we must candidly express regret that so admirable a little volume should have been printed on such inferior paper. It may be desirable to buy a good book at a low price, but no one would grudge a small additional cost if it enabled him to decipher the lines of the illustrations. We would specially direct attention to the figure on p. 85, in which, owing to the character and surface of the paper, all the fine lines are obliterated, and the drawing rendered quite worthless as an illustration.

J. B. C.

Ventilation, Heating, and Lighting. By W. H. Maxwell. Pp. vi+151. Second edition, revised and enlarged. (London: The Sanitary Publishing Co., 1907.) Price 3*s.* net.

THE simple principles and practice of ventilation, heating, and lighting are described in this volume from the point of view of the sanitary engineer. It would be to the advantage of the community if every architect and sanitary engineer were not only familiar with the physical laws upon which successful ventilation, heating, and lighting depend, but also based their work upon them. Usually, the provision made to ventilate and heat a building is quite inadequate; and when any means are provided they are constructed according to rule-of-thumb methods, with little consideration for the possibly peculiar nature of the building to which they are adapted. A few new devices and systems are described by Mr. Maxwell, and the views of authorities on requirements and efficiency are freely cited. The student and the practical man will find the book easy to understand, and a useful guide to success in examinations or in building construction.

Practical Physiological Chemistry. By Dr. Philip B. Hawk. Pp. xiv+416; illustrated. (London: J. and A. Churchill, 1907.) Price 16*s.* net.

DR. HAWK'S name is well known as an investigator in the subject of physiological chemistry. The present volume testifies to his ability as a teacher of the subject. Although there is nothing strikingly original in his presentation of the subject, the book he has produced is free from error, is clearly written, is practical, and sufficiently full for most purposes. The recent work published by Fischer and his colleagues on the question of protein cleavage products is given with special fulness; the urine, also, is naturally a subject which occupies considerable space; indeed, nearly half the book is devoted to this important secretion. The volume is admirably illustrated and well printed.

W. D. H.

Résistance des Carènes. By M. Fricker. Pp. 170. (Paris: Gauthier-Villars; Masson et Cie., 1907.)

THIS latest addition to the series of little volumes known as "Encyclopédie scientifique des Aide-Mémoire," to which attention has often been directed in these columns, deals with the propagation of waves and questions of resistance of liquids to motion through them, with particular reference to the motions of ships. The problems considered are treated theoretically and experimentally, and the student of naval architecture with some knowledge of the calculus should find the book useful.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Radium Emanation.

IN 1903, it was shown by Mr. Soddy and myself that the spontaneous change of the emanation from radium results in the formation of helium; this observation has been confirmed by Indrikson, by Debierne, by Giesel, by Curie and Dewar, and by Himstedt and G. Meyer. Debierne has shown that actinium chloride and fluoride also develop helium. I have also once detected helium in the gases evolved continuously from a solution of thorium nitrate, and hope soon to confirm this observation.

When the emanation is in contact with, and dissolved in water, the inert gas which is produced by its change consists mainly of neon; only a trace of helium could be detected.

When a saturated solution of copper sulphate is substituted for water, no helium is produced; the main product is argon, possibly containing a trace of neon, for some of the stronger of its lines appeared to be present. The residue, after removal of the copper from this solution, showed the spectra of sodium and of calcium; the red lithium line was also observed, but was very faint. This last observation has been made four times, in two cases with copper sulphate, and in two with copper nitrate; all possible precautions were taken; and similar residues from lead nitrate and from water gave no indication of the presence of lithium; nor was lithium detected in a solution of copper nitrate, similarly treated in every respect except in its not having been in contact with emanation.

These remarkable results appear to indicate the following line of thought:—From its inactivity it is probable that radium emanation belongs to the helium series of elements. During its spontaneous change, it parts with a relatively enormous amount of energy. The direction in which that energy is expended may be modified by circumstances. If the emanation is alone, or in contact with hydrogen and oxygen gases, a portion is "decomposed" or "disintegrated" by the energy given off by the rest. The gaseous substance produced is in this case helium. If, however, the distribution of the energy is modified by the presence of water, that portion of the emanation which is "decomposed" yields neon; if in presence of copper sulphate, argon. Similarly the copper, acted upon by the emanation, is "degraded" to the first member of its group, namely, lithium; it is impossible to prove that sodium or potassium are formed, seeing that they are constituents of the glass vessel in which the solution is contained; but from analogy with the "decomposition-products" of the emanation, they may also be products of the "degradation" of copper.

A full account of this research will shortly be communicated to the Chemical Society. WILLIAM RAMSAY.

July 11.

Effect of Pressure on the Radiation from Radium.

I HAVE, during the last eighteen months, been engaged in an investigation on the effects of pressure on radio-active phenomena. In designing the apparatus necessary for the purpose, it was necessary to consider that if any change in the rate of production of the emanation occurs, through pressure, effects would not be noticeable at once, as a new state of equilibrium would only be reached after several days. Similar considerations hold if any of the slowly decaying products is affected. A special pressure pump was therefore constructed according to the designs of Mr. J. E. Petavel, and this pump allowed me to keep up a pressure of about 2000 atmospheres almost indefinitely without sensible leak. The time of the experiments was not, however, extended beyond four or five days. The results have been entirely negative, and I estimate that a change in the activity of one-third per cent. would have been noticed.

During the course of the investigation several fictitious effects made their appearance, and it was the elimination of these which necessitated a gradual improvement in the methods of observation and took up the greater part of the time occupied in the experimental inquiry.

In addition to the help of Mr. Petavel which has already been mentioned, I have had the assistance of Mr. Makower in the early stages of the work. The final experiments were conducted by my assistant, Dr. Hans Geiger.

ARTHUR SCHUSTER.

Victoria Park, Manchester, July 12.

IN order to ascertain if the rates of disintegration of radium and its successive products (the emanation, A, B, and C) are affected by high pressure, we have placed about 1 gram of barium chloride, containing 1·04 mg. of radium, completely sealed beneath lead, in a thick-walled cylinder of nickel steel, and compressed the radium by a tight-fitting chromium tungsten steel piston 1 cm. in diameter. The greatest pressure applied has been $3{\cdot}2\times10^5$ lb. to the square inch, which is the estimated pressure at a depth of fifty miles beneath the surface of the earth. The penetrating radiation arising from radium C was observed by two large electroscopes placed on either side of the radium, and at a distance of about 30 cm. from it. The γ rays produced a deflection of about twenty-eight divisions a minute in an electroscope, the natural leak of which was 0·4. The pressure on the radium was gradually increased from zero to that at ten, twenty, thirty, forty miles beneath the earth's surface, and was maintained for four days at about the forty-mile value. The pressure was then taken off, and observations were continued for three days more. During all these variations of pressure, no change was detected in the γ radiation, although a variation of 1 per cent. could have been observed without difficulty.

The pressure was then rapidly carried from zero to the fifty-mile value and back, and also maintained at fifty miles for two hours. Again there was no change, certainly not 1 per cent.

It is therefore clear that the transformation from radium to radium C continues in a normal manner at pressures equal to those at forty to fifty miles beneath the earth's surface; and this important conclusion seems inevitably to follow—that *radium generates heat by disintegration equally at the surface of the earth and at pressures which obtain at depths forty to fifty miles beneath the surface.*

The Hon. R. J. Strutt has proved that the quantity of radium in rocks near the earth's surface is greatly in excess of that required to compensate for the loss of heat by conduction and radiation from the earth's surface. Dr. Bronson has proved that the disintegration of radium is unchanged by wide variation of temperature. It appears from our experiments that the transformations take place in the usual manner even under a pressure of 160 tons to the square inch. If radium were distributed throughout the earth in the same amount as at the surface, a higher temperature gradient than that actually found would be expected. A possible explanation of the paradox has been put forward by Strutt and supported by Milne. He supposes that the constituents of the earth some twenty to forty miles beneath the surface are different in character from those near the earth's surface, and that they do not contain radium, or contain it to a smaller extent. This seems to carry with it the conclusion that igneous rocks, which contain considerable quantities of radium, have their origin nearer the surface of the earth than some geologists have supposed.

A. S. EVE.
FRANK D. ADAMS.

McGill University, Montreal, June 28.

The Æther and Absolute Motion.

THE particular objection to identifying magnetic force with velocity of the æther, which has been discussed recently in the columns of NATURE by Prof. O. W. Richardson, Sir Oliver Lodge and Prof. W. M. Hicks, Dr. C. V. Burton and Mr. E. Cunningham, must depend on some point of view which is foreign to my ways of thinking. Such a hypothesis involves, of course, that the all-pervading æther shall be at rest under normal conditions; the effect of any local disturbance due to matter must thus be a local effect, and the distant regions of æther will remain unmoved. There can be no question of ascribing a uniform motion to the whole of the æther, extending to the remotest infinity, because there is no conceivable means of producing or altering such a motion. In other words, an infinitely extended æther postulates absolute motion as a fact, in the only real sense of that term, namely, motion relative to the remote quiescent regions of the æther; and once that determination is made, arguments from relativity of motion must lapse.

The interesting point raised by Prof. Richardson, that the steady field of a uniformly moving electron would contain an infinite amount of moment of momentum, requires detailed consideration; but it is not without parallel in more familiar departments of abstract physics. Its scope may be illustrated by the steady motion of a solid sphere in infinitely extended viscous fluid. The sphere, even when in steady motion, experiences resistance, and must be pushed along in order to maintain its motion. This steady push must impart momentum to the fluid, which increases in amount without limit as the time is prolonged; and it is, in fact, well known that the field of flow around the sphere when it has reached its ultimate theoretical steady state contains an infinite amount of linear momentum. But this circumstance does not vitiate the dynamics of fluid resistance. For, in fact, the steady state of motion is very soon set up throughout the neighbourhood of the moving sphere, while the continued supply of momentum simply diffuses away into the distant regions where the velocity is so slight that it does not react sensibly upon the resistance to the sphere. Similar considerations apply to the case of an electron set into steady translatory motion through æther. Here it is rotational momentum that is steadily imparted to the surrounding æther as time goes on, and is carried away into the distant regions by wave-motion. This requires that the æther exerts a torque on the moving electron, the reaction of which on the æther is the source of the angular momentum communicated to that medium. The possibility of permanent adjustment to a torque of this kind is not here anomalous; it is provided for in the fundamental hypothesis of elastic resistance to absolute rotation of the parts of the æther. There is, however, a fundamental difference from the previous illustration of a solid sphere moving through infinite viscous fluid. In that case the force continually does work, leading to continued dissipation of energy into the viscous fluid. But in the electric case the energy in the æther settles down to a steady value, and no further energy is put into it, although a constant stream of angular momentum is put into it so long as the motion of the electron goes on.

The validity of illustrating the nature of magnetic force by velocity of the æther rests on an application of the Principle of Least Action. The power of that principle resides in its allowing dynamical inferences to be drawn without requiring detailed scrutiny of the mechanism through which the forces operate. But the exceptional character of the hypothesis of rotational elasticity, or the possibility of some flaw in the argument, might conceivably have put the application of the principle at fault. It is thus essential, both for verification and for clearness of view, to scrutinise in detail the circumstances of the motion as determined by the Principle of Action, so far as possible. It would appear that, as regards the interesting feature discussed by Dr. Richardson, nothing has gone amiss.

Even in the case of a sphere set in motion in frictionless fluid, it may be said in the same way that when the steady motion has become absolutely established by propagation outward, an infinite amount of momentum has been transferred from front and rear to the sides.

Cambridge, July 8. J. Larmor.

In Nature of July 4, Mr. E. Cunningham discusses my statement of an objection to identifying the magnetic vector with translational velocity of the æther. Mr. Cunningham says:—" If it were definitely stated that the magnetic force in the free æther was proportional to the velocity of the æther relative to the observer the objection would be valid"; and certainly any theory which embodied such a doctrine would stand self-condemned. My argument, however, was not directed against this obviously untenable view.

If, for the free æther, we assume that magnetic force is, within a constant factor, identical with æthereal velocity, then we can determine the velocity of the æther at any point by measuring the magnetic force at that point. For the value of the magnetic force there is a perfectly definite physical criterion, which is independent of any arbitrarily chosen frame of reference, and hence we should have the means of determining *absolutely* the velocity of the æther. Thus, on our assumption, absolute motion attains to a definite physical significance which has no counterpart in the postulates of ordinary dynamics; and, this being so, dynamics must fail to give a true account of electromagnetism.

Accordingly, when we identify the magnetic vector with translational æthereal velocity, and at the same time assume that we are dealing with a dynamical system, we should expect to be led to results inconsistent with known electromagnetic relations. Consider, in fact, the unaccelerated motion of a charged body (or of an electron) through a space where there is no magnetic intensity. Then pass to the case where the space in question is uniformly pervaded by magnetic force in a direction transverse to the motion of the charged body, while at the same time a new component is added to the motion of the body, identical in direction and magnitude with the æther-drift which we assume to constitute our magnetic field. We have thus impressed a uniform velocity on the whole system considered, and if the system is fundamentally a dynamical one, no new acceleration will thus have been introduced: that is, the charged body will move without acceleration across the lines of magnetic force. C. V. Burton.

Cambridge, July 12.

Root Action and Bacteria.

In Nature of June 6 (p. 126), Mr. S. Pickering has a note on "Root Action and Bacteria" in which he concludes that the proper functioning of roots depends on the presence of bacteria.

Experiments I have made here both in the field and in water culture with a large number of varieties of plants do not lead directly to the same conclusion. Water cultures have been made on a fairly large scale, three harvests of ninety plants being taken in a large number of dishes, each containing two litres of water. After the third harvest, the water was allowed to stand and evaporate to half its volume. On attempting to use this water for further water cultures, all the plants sown in it died within two days and some within half an hour, the time varying with the variety of plant that was transplanted into the water, and with the variety that had previously been grown in the water.

Further, boiling this water neither increases nor diminishes its toxicity to plants. It is, moreover, immaterial whether the nutrient solution is such as to become acid or alkaline after use; neutralisation in either case does not make it possible to grow plants in it.

My experiments lead to the conclusion that the roots of all the plants so far tried excrete a substance that is toxic to all plants (including that by which it is excreted), but in different degrees.

Similarly, in the field *Sesanum indicum* will not grow (on stiff black soil) within 2 feet of *Sorghum vulgare*; all the plants tried appear to decrease the yield of neighbouring plants *of the same variety* by about 50 per cent.

The effect of the toxic substance both in the field and in water culture is completely neutralised by tannic and pyrogallic acids, carbon black, and other substances.

It is, of course, possible that bacteria in the soil have a beneficial action by elaborating antitoxins similar to those mentioned.

I have not yet been able to isolate the toxic substance contained in the polluted water of my cultures.

F. Fletcher.

Poona, June 21.

THE NATURAL HISTORY OF THE CEYLON PEARL BANKS.[1]

PROF. HERDMAN is to be congratulated on the completion of his report on the pearl fisheries and marine biology of Ceylon. It fills five large volumes, which, besides containing much information of direct practical importance in regard to pearls and pearl fishing, form a broad and firm basis for further study of the biology of the Ceylonese region of the Indian Ocean. The report speaks volumes as to Prof. Herdman's genius as a collector—we doubt if any single worker ever made such large collections over the whole field of zoology in so short a time; he has also done his share of the descriptive studies, and he, along with Mr. Hornell, is responsible for the parts that deal directly with the pearl oyster itself.

It is very interesting to find that since Prof. Herdman's expedition there have been four successive fat years of pearl fishing—the most profitable, so far as is known, that have ever been. In 1905, eighty-one and a half millions of oysters were fished, and the revenue brought in was upwards of two and a half millions of rupees; in 1906, more than sixty-seven millions of oysters were fished, and the total proceeds amounted to 1,385,000 rupees. This should surely convince the Philistines that there is something in biology after all! Prof. Herdman predicts a moderate fishery for this year, and a good fishery for 1908, adding that "after 1908 the prospects depend upon further careful scientific inspecting, transplanting and culching, upon the lines which have been laid down in successive sections of the report." As is well known, the fisheries have been leased by the Government to a company, and it is a matter for congratulation that Mr. Hornell is retained on the spot, and that, in terms of the lease, the necessity for a scientific treatment of the pearl banks during the next twenty years has been duly recognised and provided for.

Vol. v. begins with an interesting essay on pearl production. The authors (Herdman and Hornell) examine the three main theories—(1) that the pearl is the result of a reaction to a grain-of-sand irritation, (2) that the pearl is a pathological secretion, and (3) that the stimulation caused by the presence of a parasitic worm, which acts as a nucleus, results in the deposition of successive layers of pearly material within an epithelial sac. It seems that the grain-of-sand method is occasionally found operative in the causation of true pearls, and it is possible that some of those that appear to have no nuclei may have been deposited around very minute inorganic particles; some pearls not of the finest quality are probably formed as calculus-like growths independently of known parasites; but most and the best pearls are deposited around the larva of a Platyhelminth. In the Ceylonese pearl oysters (*Margaritifera vulgaris*) it seems likely that the parasite is a larval Tetrarhynchus. Apart from pearly excrescences on the interior of the shell, due to the irritation caused by Clione and other boring animals, the authors distinguish (1) ampullar pearls, where the nucleus and resulting pearl lie between the shell and the body, or in an ampulla of the ectoderm projecting into the mantle; (2) muscle pearls, formed around minute calcareous concretions (calcospherules) near the insertions of the muscles; and (3) cyst pearls, formed around encysted parasites. As to the proposal to secure artificial infection of oysters, the authors think that this is probably quite unnecessary on the Ceylon pearl banks. There seem to be plenty of parasites to go round, and every pearl oyster in the Gulf of Manaar, or, for that matter, around the coast of Ceylon, runs a fair chance of becoming infected. It is to be hoped that further investigation will make our knowledge of the pearl parasite and its life-history more precise.

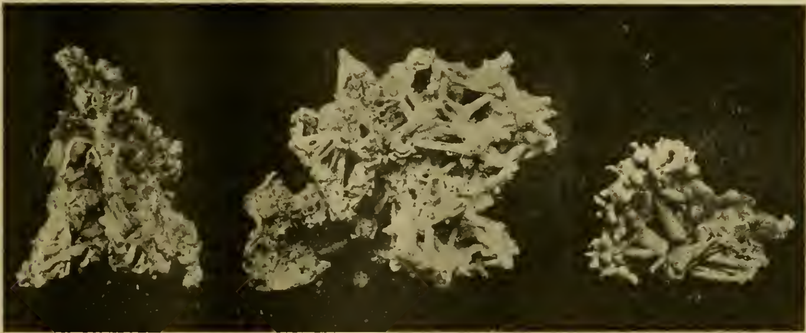


FIG. 1.—*Ramulina herdmani*, Dakin. Natural size.

In their report on Cestodes from Ceylonese fishes, Messrs. A. E. Shipley and J. Hornell have some notes on *Tetrarhynchus unionifactor*, which they described in vol. ii. Some of the larval forms entering the oyster arrive in the mantle and other tissues, acquire an ectodermic sac, and there encyst, finding "a costly grave in the developing pearl." Others reach the alimentary canal, and, after growing there, encyst on the outer surface of the intestine. "They are too big for enclosure in a pearl, and they can wait without anxiety for the advent of their second host (*Rhinoptera javanica*), within whose intestine they rapidly become sexually mature."

The late Prof. M. Stossich made notes on a few Nematodes in the collection, and Dr. Max Lühe describes seven new species of Trematodes from fishes. The first part of the volume ends with a very valuable general summary of practical conclusions and recommendations, which we may hope will find application not only in Ceylon but elsewhere. One cannot but

[1] Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar. By W. A. Herdman, D.Sc., F.R.S., P.L.S., with Supplementary Reports on the Marine Biology of Ceylon by Other Naturalists. Part v. Pp. viii+452; 38 plates. (London: Published at the request of the Colonial Government by the Royal Society, 1906.)

admire Prof. Herdman's wide scientific outlook—the true naturalist's point of view—which may be inferred, for instance, from this sentence, "It is impossible, until a careful study has been made of each case, to say which members of the fauna and flora of an oyster bed are of most importance to its prosperity—probably none are wholly without influence for good or evil, so closely interwoven in past history and present function is the web of living nature." If this wise saying were as widely accepted as it is certainly true, biological science would find more generous public support, and we should hear no more of impatient criticisms of scientific investigations which do not yield an increase of rupees so rapidly as Prof. Herdman's study of the Ceylonese oyster beds has done. It is fitting that the practical recommendations should end with a beautiful plate of the life-history of the pearl oyster.

The second half of the volume is occupied with eleven supplementary reports (xxxi–xli). Dr. Nelson Annandale reports on the Cirripedia (11 species); Prof. G. H. Carpenter on a new species of Halobates;

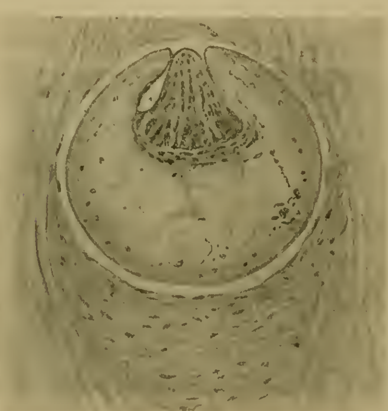


FIG. 2.—Young larval Cestode (Tetrarhynchus, sp.) encysted in connective tissue of pearl oyster.

Mr. W. M. Tattersall on the Leptostraca, Schizopoda, and Stomatopoda; Mr. C. B. Wilson on an interesting series of parasitic Copepods, including two new genera; Mr. T. Southwell on the Anomura (48 species, 2 new); Mr. W. J. Dakin on the Foraminifera (131 species and varieties), which include *Ramulina herdmani*, n.sp., forming masses of calcareous tubules varying in size from a hazel-nut to a small apple; Prof. G. C. Bourne on Jousseaumia, an interesting new genus of Eulamellibranchs commensal with the corals Heterocyathus and Heteropsammia; Messrs. R. Standen and A. Leicester on a large number of Molluscan shells; Prof. Herdman on the Tunicates (64 species); Mr. R. Douglas Laurie on the Brachyura (208 species, 15 new, three of which are referred to new genera).

The volume ends with a general discussion of the faunistic results by Prof. Herdman. His expedition has made known 2615 species of marine animals from the coasts of Ceylon. Of these 575 are described as new to science, and have required the formation of 65 new genera and three new families. About 250 of the Ceylonese species extend into the Malay region and 300 on into the Pacific. At least 240 are known from the Red Sea, and 130 from the Mediterranean. About 280 species extend southwards to the Australian coasts, and a few are found elsewhere in southern latitudes. Finally, 90 Ceylon species are found also in the West Indian region, and may indicate a closer connection by sea in a former period than exists at the present day. Prof. Herdman makes an interesting comparison of his collections with those of the *Investigator*, with those from the Mergui Archipelago and off the coast of Lower Burma, and with those from the Maldive and Laccadive Archipelagoes.

After reviewing his rich collection, Prof. Herdman concludes in the following words:—

"Such are the animate surroundings, including both friends and foes, amid which the pearl oyster habitually lives in the Gulf of Manaar, and seems, if left in comparative peace, able to hold its own in the struggle for existence; but the balance, as we have shown in previous parts of this report, is liable to be seriously disturbed by three all-powerful factors: devastating hordes of voracious fishes which come up from the deeper waters and leave crunched shells and torn byssus in their wake; storms, currents, and overwashes of sand which may sweep away or bury a promising bed; and lastly man, who comes periodically from above on his diving stone and clears the bank of tens of millions of oysters, old and young. The carnivorous fishes and the monsoons cannot be controlled; but to show that much can be done by man to mitigate their influence, and to compensate for the decimation necessarily caused by his own operations, has been the chief object of the present report."

THE DESERT AND THE SOWN.[1]

SOME of the best books of travel nowadays seem to be written by women. We may instance Mrs. Bishop, Miss Durham, and now Miss Lowthian Bell, who, in "The Desert and the Sown," has given us a most delightful description of a wandering undertaken by herself alone with native servants from Jerusalem across Jordan to the Haurân and Jebel Drûz, thence to Damascus and on by Homs, Hama, and Aleppo to Alexandretta. Miss Lowthian Bell's route is, of course, not new. She has seen nothing that has not been seen before, and has contributed nothing new to our archæological knowledge beyond one or two short Arabic inscriptions. But this we do not expect, nor had she any archæological intent in the shaping of her travels beyond the desire to see the famous ruins of Roman Syria. The reason for her journeyings is frankly set forth by her as pure delight in the life of the Near East, and more especially that of the desert. To "travel on where travels above him the Mother of all the clustered stars," deeming "the wild the sweetest of friends," in the words of the Arab poet prefixed by the author to her book ("*yeraya al-wahshaha al'ansha al-anisha, wa yahtadi behayithu ahtadat Umm en-nejumi esh-shawabîkî*"), was her desire, and she has given us a good book describing what she saw in her wandering. As she says at the beginning of the book, "To those bred under an elaborate social order few such moments of exhilaration can come as that which stands at the threshold of wild travel."

Of all wild travel, surely the most exhilarating is that in the Syrian desert. Here the Druze, with his strange religion, descendant of the Old Man of the Mountain and his "Assassins," still reigns in

[1] "The Desert and the Sown." By Gertrude Lowthian Bell. Pp. xv + 347. (London: W. Heiremann, 1907.) Price 16s. net.

his "mountain" and lords it over Moslem and Christian alike, despite the suzerainty of the Turk. Here the wild Arabs, 'Anêzeh, Ghiâth, and Shammar, still live as they did in the days of old, rearing their horses and camels, raiding and stealing those of the neighbours, murdering each other, and praising God and his prophet daily. Here is the desert, whether stony waste or bare waste of volcanic débris and lava like the Safa or Harra,[1] or steppe like the Ruhbe and the greater part of the Hammada, or high desert. The yellow Egyptian desert of limestone and sand is not that of Syria. Except in such districts as the Harra, the Syrian desert is not a desert as the Egyptian is, except for the fact that its inhabitants are nomads and have no fixed home in it. Of this steppe its inhabitants know every inch; as one of Miss Bell's guides said to her: "By God" (Wallâh), "the plain is covered with places wherein I rested." "He had struck the note," she goes on; "I looked out beyond him into the night and saw the desert with his eyes, no longer empty but set thicker with human associations than any city. Every line of it took on significance, every stone was like the ghost of a hearth in which the warmth of Arab life was scarcely cold, though the fire might have been extinguished this hundred years."

FIG. 1.—Kala'at el-Husn, walls of the inner enceinte. From "The Desert and the Sown."

Out of this waste, tenanted now only by the nomad and his flocks, and knowing now no habitation but the tents of goats' hair, rise the ruins of the great cities of the Ghassanides, like Kanawat or Bosra Eski-Sham, in the Haurân, wonderful relics of the civilisation of Syria in the sixth and seventh centuries of our era, in which we see Roman forums with great pillared courts next door to the square towers of the oldest mosques of the Muslim, the last monuments of the "Age of Ignorance" and the oldest of the "Age of Enlightenment" side by side. And apart from the towns we see what are indeed remarkable monuments of Roman civilisation in the Near East, private houses, country-seats of the fifth and sixth centuries, such as the "Sheikh's House at Hayât" (illustrated on p. 103), which is still occupied as a dwelling-house, or the stone houses at el-Bārah and Serjilla (pp. 245, 252), and the "Kaṣr el-Benât" (p. 256), in northern Syria. Miss Bell's photographs of these and other remains of ancient civilisation, including Kala'at el-Beida, Baalbek, Ruwêihâ, the canopied tomb at Dâna (p. 298), are all very good and very interesting.

Miss Bell's route from Jerusalem was taken by way of Jericho and the Jordan ford to es-Salt, in the Belka', where she deliberated as to the way of reaching the Haurân and the Mountain of the Drûz, since the Turkish authorities are by no means friendly to English visitors east of the Jordan, especially to those who wish to visit the Jebel Drûz. However, by avoiding the Turks at 'Ammân and the neighbourhood of the railway, which was crossed north of Mshitta, Miss Bell reached Salkhad in safety. Of Mshitta Miss Bell gives a photograph taken "before the Germans had sliced the carved façade from that wonderful building." It seems regrettable that the "stone lacework" of Mshitta should no longer be seen in its own place under the Syrian sky; now it is cooped up in a dark and low corridor, where it is difficult to see it, in a museum on the banks of the Spree. But with the advent of the railway its removal was perhaps advisable, in view of the possibility of vandalism on the part of some Turkish official.

At the castle of Ṣalkhad the traveller was received with the traditional hospitality of the Drûz, and witnessed an extraordinary scene, very well described on p. 91, a sort of savage war-dance to inaugurate a *ghazu* or raid on the Arabs of the Beni Ṣakhr, as revenge for a previous raid by the latter. This she instances as an "example of the freedom with which the Druzes control their own affairs."

North of Damascus Miss Bell again met with the Drûz, the members of that faith who live in the Lebanon, cheek by jowl with their old enemies the Maronite Christians. And members of the mystical sects of Western Asia, who are half Muslims, half pagans, such as the Nosairis, Meta-

FIG. 2.—Kala'at Sim'ân, the west door. From "The Desert and the Sown."

[1] The vulcanological researches of the late Dr. Alphons Stübel, of Dresden, in the Harra and among the mountains of the Lejâ are well known.

wīlehs, Beha'is, and Ismailis, were also encountered by the way.

In northern Syria two of the most interesting places visited by Miss Bell are the castle of Kala'at el-Husn, near Homs, and the church of Kala'at Sim'ân, between Aleppo and the Bailan Pass. Kala'at el-Ḥusn is the northern Kerak, the "Crac des Chevaliers" of Crusading times, and is one of the finest examples of the military architecture of the Crusaders in existence. Fig. 1, a photograph by Miss Bell, gives an idea of the walls with their French round towers and Saracenic sloping walls. The castle belonged to the Hospitallers, and the Grand Master of the Order lived there, until it was taken by the Egyptian Sultan Malek edh-Dhaher. This, then, was the first stronghold of the Order of St. John, to be succeeded by Rhodes, always associated with the name of de l'Isle Adam, and by Malta, the scene of the heroism of la Valette and the cowardice of Hompesch.

Kala'at Sim'ân (Fig. 2), the scene of the fakir-life of St. Simon Stylites on his pillar, is a fine example of a Byzantine church of the sixth century. Kalb Lōzeh (p. 302) is just such another. Many of these splendid specimens of Syrian stone architecture have been studied by the recent archæological expedition of Princeton University.

At beautiful Antioch and Seleucia Miss Bell's Syrian journey ended.

It is a pity that her map is not better than it is. It is based on Kiepert's map in Oppenheim's "Vom Mittelmeer zum Persischen Golf," with additions and Miss Bell's route marked in red. All the German spellings of Arabic names seem to be retained unaltered, with the result that the British reader is confronted with such words as "Meschetta," "'Ijun," "il-Kreje," "Riat," "Dimaschk Ischscham," and so on, which he will hardly recognise as the "Mshitta," "Ayun," "el-Kreyeh," "Ghiath," and Damascus "Esh-Shām" of Miss Bell's text. This is a bad fault, but one often committed when German maps are copied in England. By the average British reader "Ijun" and "Kreje" will be pronounced "Eyejūn" (Germ. "Eidschan") and "Kreege" (Germ. "Kridsch"). It is too often forgotten that the German pronunciation of consonants and vowels is not yet the world-standard, and that the English pronounce the letters "j," "sch," "ch," quite differently from the Germans. We certainly will not have the German "j" thrust down our throats, at any rate. Miss Bell and her publishers must share the blame for this serious blot on her otherwise admirable book.

H. R. HALL.

HAVE ALL EYES THE POWER OF FORMING IMAGES?[1]

SOME animals, such as the earthworm, have no eyes, and yet they are phototropic either in a positive or negative sense, according as they move towards or away from light. Others, such as planarians, have remarkably simple eyes, consisting of one or several sense elements, behind which is a pigmented cup, composed of one or more cells. Such eyes cannot form an image, and they have been called "direction eyes" because light from only one direction can affect such an eye at a given time. Higher in the scale we find the "compound" or "mosaic" eye, as in insects and other animals. The question arises, To what extent is an image or images formed by such an eye composed of many ocelli? There can be no doubt that the compound eye forms an image or images. Exner has taken a photograph through the eye of a fire-fly, and Parker has shown that the compound eyes of Astacus form a single image. Lastly, we find in vertebrates the "simple" eye, the optical construction of which leads to the formation of an image on the retina. The image of a distant object can readily be seen on the retina of a fresh eye removed after death from an albino rabbit, and if a lighted candle be placed in front of the isolated eye of a frog, a beautiful little inverted image of the flame may be visible on the sclerotic.

Mr. Leon Cole recently investigated the question as to the formation of images by different kinds of eyes by a new and ingenious method. It is obvious that it would be almost impossible to make a direct observation on the formation of an image by certain kinds of eyes, especially mosaic eyes of very small size. Mr. Cole's "aim has been, rather, to treat the formation of images from the point of view of their relation to the animal as a living organism—to determine in what way the ability to form a more or less perfect image affects the responses of the animal to light, and what relation, if any, this result has to the normal habits of the creature, and to its behaviour under experimental conditions" (p. 337).

For phototropic observations, Mr. Cole devised an arrangement by which two sources of illumination were so placed as to cause one or other to illuminate the eyes. The animal was placed with its long axis at right angles to a line joining the two lights. One light was so much larger than the other that the ratio of the two areas illuminated was as 10,000 to 1. The intensity of the light from either source was about 1·25 candle metres. The qualities of the two lights were also compared and tested, and the differences in the spectral components were so slight as to be negligible. The experimenter wished to ascertain "to what extent complexity in the organisation of eyes is correlated with the reactions to luminous areas of different size but of equal total luminosity" (p. 347). The character and relative percentage of phototropic responses as movements to or from lights were used as measures of the reactions. Suppose an animal positive in its reactions to directive light is so placed as to be midway between two luminous areas of the same shape, size, and intensity, the one acting on the right eye and the other on the left. Assume that each luminous area is 1 cm. square, has an intensity of 100 candle-power, and is 2 metres from the animal. The measure of the light falling on each eye would be 25 candle metres. Thus simultaneously stimulated on each side, the animal might go straight ahead without turning, or it might turn at random towards one light more than the other, and as the animal is positively phototropic it would continue to crawl towards this light. But as the chance of random movements in one direction is as great as in the other, in a large number of trials, we should find the number of times that the animal would go towards each light would be practically equal. Enlarge one of the areas to 100 cm. square, but keep the total amount of light the same. The area being 10,000 times as great, the intensity from 1 sq. cm. is now only 0·01 candle-power. The whole amount of light on each side is still the same, 25 candle metres. If the animal had no light-perceiving organs, the reactions would be the same as when the lights were of equal size; the animal would be indifferent. But if it had cells sensory to light distributed in its skin, as there is no apparatus for concentrating the light, the amount of light received at any point of the skin on either side of the animal would be equal to that received by any other. "This is evident from

[1] "An Experimental Study of the Image-forming Powers of Various Types of Eyes." By Leon J. Cole, Zoological Laboratory of the Museum of Comparative Zoology at Harvard College. (Proc. of American Academy of Arts and Sciences, vol. xlii., No. 16, January, 1907.)

the fact that light from every one of the 10,000 areas (each 1 cm. sq.) which make up the large area falls upon each point of the surface of the animal; the intensity of the light from any single square centimetre of the area is only 0·0025 candle metre, but since there are 10,000 such radiating squares the total intensity is 25 candle metres" (pp. 347–8).

In an animal having eyes that form a good image the case is different. The small light, only 1 cm. square, would form on the retina an image having a very small area (x), but the light would have considerable intensity (y). On the retina of the other eye there would be an image covering a larger area (10,000 x), but each area (x) would receive a light intensity of only 1/10,000 y. In all probability the difference between a very weak light and no light at all falling on a visual element would be more stimulating than the same or even a greater difference in the amount of the light at higher intensities. If so, we should expect an animal to react more strongly "to that stimulus which fell upon the larger number of visual elements—that an animal normally positive, for example, would be more strongly positive to the large light than to the small, and similarly that a negative animal would tend more often to move away from the larger than from the luminous area" (p. 349).

A large number of experiments was made on several animals, and the results, when discussed by methods now in use in biometrical work, on the whole bear out the line of reasoning just given. With the earthworm (*Allolobophora foetida*) the results showed that the *intensity* of the light is the controlling factor in its movements to right or left. This animal was negatively phototropic. It has no eyes, but it has cells in the skin sensitive to light. No image could possibly be formed. The largest of the land planarians (*Bipalium kewense*) has small *direction* eyes. Numerous experiments showed that animal has, to a slight extent, the power of appreciating differences of area, as it responded by turning away from the larger luminous area more often than from the smaller. It was negatively phototropic. The larva of the mealworm (*Tenebrio molitor*) has two or three ocelli on each side of the head, but nothing of the nature of lenses. It is negatively phototropic. When two lights, of different areas, acted simultaneously on both eyes, the responses right and left were equal in number, showing that "the ability of the eyes to form distinctive images of objects differing considerably in size is wholly lacking" (p. 371). The sow bug (*Oniscus asellus*), an active isopod, has small eyes consisting of a group of about thirty ocelli on the side of the head at the base of the antero-lateral lobe. It is negatively phototropic. The responses to light were of a less definite character than was observed in the larvæ of the mealworm. It has only unilateral illumination, and yet its eyes have greater efficiency for the formation of images than the larvæ of the meal bug. The cockroach (*Periplaneta americana*) has well-developed compound eyes, and it is very active and keenly sensitive to differences of light and shade. It was difficult to handle, and having more of what may be called a restless intelligence than the other animals already mentioned, the results do not seem quite so trustworthy. It reacts negatively to direct light in an excess of about 50 per cent. of its responses, but although it has relatively large eyes, Mr. Cole does not think the evidence bears out what one would have expected, namely, that the eyes were capable of forming better images than those of the animals already mentioned. The mourning-cloak butterfly (*Vanessa antiopa*) creeps and flies towards a source of light. It is positively phototropic for lights varying in intensity from 2 candle-power at 2 metres distance (0·5 candle metre) to 250 candle-power at 2 metres distance (62·5 candle metres). It can discriminate between lights of different area falling with equal intensity on the animal. Other animals, such as the water-scorpion (*Ranatra fusca*), the Pomace fly (*Drosophila ampelophila*), the European garden snail (*Helix pomatia*), the European garden slug (*Limax maximus*), were also examined. In the case of the garden snail, the inference from the experiments was "that the eyes of the snail do not aid greatly, if at all, in the discrimination of two lights differing in area as the two used" (p. 391).

The results with the cricket frog (*Acris gryllus*) are very instructive. It is, on the whole, positively phototropic. With luminous areas of different sizes but equal intensity, it turns in by far the greater number of trials towards the larger of the two areas. The result was the same when the skin was protected and the eyes alone were left uncovered. After section of the optic nerves, but having the skin exposed to the light, the animal is indifferent to the size of the luminous field. Still, even with the optic nerves severed, the frog is positively phototropic. Here light must be perceived by the skin, a result in keeping with the well-known experiments of Lord Lister made many years ago on the pigment cells in the skin of *Rana temporaria*. Similar results were found with the green frog (*Rana clamata*).

Mr. Cole concludes his paper with an interesting general discussion, showing that there is a correlation between the habits of the animals and the conditions under which they live. For example: "those are creeping forms whose movements towards the light take them in the direction of their food or else that other conditions prevent their phototropism from taking them into unfavourable surroundings" (p. 407). The following is very interesting:—"A query which Romanes found among Darwin's manuscript notes shows careful observation and puts the question very clearly. It is as follows: 'Query. Why do moths and certain gnats fly into candles, and why are they not all on their way to the moon—at least when the moon is on the horizon? I formerly observed that they fly very much less at candles on a moon-light night. Let a cloud pass over and they are again attracted to the candle.' Romanes thinks the answer is that 'the moon is a familiar object, the insects regard it as a matter of course, and so have no desire to examine it.'" Parker and Cole give a more reasonable explanation. The moths and gnats react to larger areas of light than to a point of more intense light. They therefore remain near the ground, on account of the bright patches of moonlight, instead of flying towards the moon; but if they come near a candle, the great intensity of the light at a short distance "overcomes the reactions of the moonlit areas," and the insects fly into the flame. Obscure the moonlight by a cloud so as to take away the patches of moonlit earth, and the insects fly more readily into the flame.

Mr. Cole gives at the close of his admirable and suggestive paper the following classification:—

Type A. Response of eyeless forms.—Usually negative; sometimes positive, and then usually to very weak light. Response to *intensity* only (earthworm).

Type B. Response of forms with "direction" eyes.—Usually negative (Bipalium, Periplaneta, Tenebrio larvæ); sometimes positive (larva of wood-borer). Response wholly to *intensity*.

Type C. Response to size of luminous field.—

Animals usually positive; may be temporarily negative, as in the frog.

Type D. Response to definite objects in the visual field.—Not simple reactions; responses involve psychical phenomena. Respond (1) to moving objects; (2) to stationary objects. This form of response usually inhibits ordinary phototropic reactions.

JOHN G. MCKENDRICK.

SIR W. H. PERKIN, F.R.S.

WITH deep regret the whole scientific world will hear of the death of Sir William Henry Perkin, F.R.S., the founder of the coal-tar colour industry, and one of the most distinguished of British chemists. Sir William Perkin passed away at his residence, Sudbury, on Sunday, July 14, after four days' illness, the cause of death being double pneumonia and appendicitis. Especially affecting will be the news to his London friends, among whom his bodily vigour and mental energy had, even up to the last, been the envy of many a younger man.

Born on March 12, 1838, William Henry Perkin was educated at the City of London School, and at fifteen commenced his studies under A. W. Hofmann at the Royal College of Chemistry. During the Easter vacation in 1856 he discovered mauve, and, supported by his father and brother, immediately began its manufacture under the name of "Tyrian Purple." The importance of this discovery, which has given birth to the extensive industry of coal-tar colours, was fully recognised at the Jubilee celebrations last year, when Dr. Perkin was presented with congratulatory addresses from all the important chemical societies of the world, and also received the honour of knighthood. Messrs. Perkin and Sons not only introduced the first aniline dye into commerce, but soon began to manufacture alizarin, in itself the first member of an important series of dyestuffs which are still to-day classed among the most valuable colouring matters used by dyers and printers. In 1873 the Greenford Green aniline-dye factory was sold, and the business finally transferred to Silvertown, where the manufacture of alizarin is still being carried on with success.

Perkin now devoted himself to laboratory work, and soon discovered the valuable method of synthesis of unsaturated aromatic acids, such as cinnamic acid, which bears his name. He also effected the synthesis of coumarin, the odorous principle of the Tonka bean. Later, he turned his attention to the magneto-optical properties of organic compounds, and enriched chemistry with a series of researches on this subject, of which the last account appeared in the Journal of the Chemical Society for May of the present year. In all he contributed about ninety original papers, published chiefly in the Journal of the Chemical Society.

The value of Perkin's work was not left unrecognised; the Royal Society made him a Fellow in 1866, he was awarded the Royal medal in 1879, the Davy medal in 1889, the Longstaff medal of the Chemical Society in 1888, the Albert medal of the Society of Arts in 1890, and the Birmingham medal of the Gas Institution in 1892. These were followed by the Hofmann medal of the German Chemical Society and the Lavoisier medal of the French Chemical Society in 1906. He held honorary degrees from Würzburg and Heidelberg (Ph.D.), St. Andrews (LL.D.), Manchester and Leeds (D.Sc.), and Munich (Dr.Ing.).

Sir W. Perkin married, in 1859, a daughter of the late Mr. John Lissett, and, some years after this lady's death, the daughter of Mr. Hermann Mollwo. Few fathers can have had the same happiness as he in seeing his three sons distinguish themselves in his favourite science.

Loved by his neighbours at Sudbury for his philanthropic work, respected and admired by his scientific friends the world through, all were instinctively attracted by Sir William Perkin's equable and amiable temperament, and unite in deploring the loss which they and the nation have sustained.

J. C. CAIN.

NOTES.

WE regret to see the announcement of the death of Dr. A. Dupré, F.R.S., on Monday, July 15, at seventy-one years of age.

WE learn with regret of the death, on July 13, of Prof. Heinrich Kreutz, who for many years acted as editor of the *Astronomische Nachrichten*.

THE eleventh International Navigation Congress is to be held at St. Petersburg in May, 1908.

THE American Academy of Arts and Sciences has awarded the Rumford premium to Mr. E. G. Acheson "for the application of heat in the electric furnace to the industrial production of carborundum, graphite and other new and useful substances."

DR. ARTHUR J. EVANS, F.R.S., describes in the *Times* of July 15 some further discoveries made by Dr. Mackenzie and himself, during the past two months, in the great prehistoric Palace of Knossos. The net result of these investigations is to show that an additional area of some three thousand square yards must be added to the palace. At a short distance from the actual "House of Minos," two beehive tombs have been found belonging to a period about 800 B.C., and their contents are of deep interest. If the accurate astronomical orientations have been measured of the structures now revealed, the results will be of great value.

A SMALL exhibition of science apparatus, mostly for chemistry and physics, is being arranged by Mr. R. E. Thwaites, of Wyggeston Grammar School, in connection with the forthcoming meeting of the British Association at Leicester.

THE Recorder of Section I (Physiology) of the British Association informs us that an important change has been made in the provisional programme for the Leicester meeting announced in last week's NATURE. On August 6 there will be no discussion on antitoxins, but instead one on the value of perfusion experiments. This will be opened by Prof. E. A. Schäfer, F.R.S., and will probably be of considerable interest to expert physiologists. To the list of those who will take part in the discussion on the physiological and therapeutical uses of alcohol has now been added the names of Prof. Cushny, and Drs. Dixon, Rivers, and Waller; Prof. Zuntz, Prof. Schäfer, Dr. Reid Hunt, and Prof. Sims Woodhead.

IN connection with the retirement of Prof. G. Lunge from the chair of technical chemistry at Zurich, of which mention was made in last week's issue of NATURE, an interesting farewell meeting was held on July 10 at Zurich Polytechnic. The occasion was the distinguished chemist's last lecture hour, and, in addition to the students, most of his fellow professors and some from the neighbouring university had assembled. On Prof. Lunge's entry into his lecture theatre all rose in silence. After an interval Prof. Treadwell, professor of analytical chemistry, made a short speech in which he eulogised Prof. Lunge's work, and afterwards read an address from the whole of the teaching staff. An address from the students was also read. Prof. Lunge made a suitable reply, and the whole audience showed by its enthusiasm the high regard in which he is held and the regret felt at his retirement.

THE Paris correspondent of the *Times* states that the French Government has just asked Parliament to grant a fresh credit of 12,000*l.* in order to prepare a new French expedition to the Antarctic. Some four or five months ago the Academy of Sciences declared that a new expedition would be of great scientific utility as well as an act of patriotism which would benefit the whole world; and it appointed a commission to draw up a scientific programme of work. The expense is estimated at 30,000*l.*, of which the State is to provide 24,000*l.* The 12,000*l.* now asked for by the Government will be immediately used for the construction of the special ship necessary for the expedition.

A LONG excursion, extending from August 15 to August 24, has been arranged by the Geologists' Association. The district selected is Appleby and its surroundings, and the party will be under the direction of Dr. J. E. Marr, F.R.S. Interesting observational work has been allocated for each day, and the arrangements which have been made for visitors will ensure comfort at a moderate expense. The party will leave Euston at 11.30 a.m. on August 14, and geologists who wish to avail themselves of the opportunity offered should communicate with Mr. A. C. Young, 17 Vicar's Hill, Lewisham, S.E. The association has arranged an excursion also in connection with the centenary celebrations of the Geological Society in September next. The excursion will be to Reading on September 28, and will be conducted by Messrs. H. W. Monckton, O. A. Shrubsole, and H. J. Osborne White.

THE Mackinnon studentship of the Royal Society in physical science has been awarded for a second year to Mr. W. Geoffrey Duffield, for a research on the influence of pressure on spectra, being conducted at the University of Manchester; and the studentship in biology to Dr. H. M. Woodcock, to aid him in working out the life-history of certain hæmatozoa of birds, an investigation which will be carried on at the Lister Institute of Preventive Medicine. The income of the Gunning fund accrued during the past three years has been placed at the disposal of Dr. F. H. Scott for the continuation of his investigations into the metabolic processes in nerve cells. The election to the Joule studentship of the Royal Society will be made at the end of July.

THE Commission appointed by the Presidents of the Board of Agriculture and Fisheries to inquire into the nature of distemper in dogs in Great Britain and the methods of its infection, and to report whether any, and if so what, preventive or remedial measures, exclusive of ordinary medical treatment, can with advantage be taken with respect to it, has now been fully constituted as follows:—The Duke of Beaufort, Lord Middleton, Lord Leconfield, Sir John McFadyean, Mr. E. Barclay, Mr. S. Stockman (chief veterinary officer to the Board of Agriculture and Fisheries), Mr. W. M. Wroughton, and Mr. E. W. Jaquet (secretary of the Kennel Club). The chairman of the commission will be Lord Middleton, and Mr. James Ralph Jackson (veterinary inspector, Board of Agriculture and Fisheries, 4 Whitehall Place, S.W.) will be secretary.

A DISTINGUISHED experimental physicist has been lost by the recent death of M. André Prosper Paul Crova, formerly professor of physics at Montpellier, and since 1886 a correspondant of the Paris Academy of Sciences. M. Crova was born in 1833 at Perpignan, and after receiving his education there became, at the age of twenty, professor of physics in the local Collège. Six years later he filled the same position in the Lycée at Metz. In 1864, M. Crova went to Montpellier, where, first at the Lycée and after 1870 in the Faculty of Science, he occupied a chair of physics. His most important work was devoted to the study of radiant energy, and included a classical determination of the constant of solar radiation. In addition to his well-known researches in this field he occupied himself very largely with optical and electrical problems of a general character, and published a large number of memoirs. As an experimentalist he possessed great skill and practical ingenuity in carrying out researches of very great difficulty, and to his inventive power are due several valuable instruments, including, besides his actinometer, an optical pyrometer and a spectrophotometer.

THE death of Sir William Broadbent, which occurred on July 10 after a long illness, removes a figure well known in the medical world. Those who saw the active interest he took in the meeting of the British Medical Association at Toronto last August little thought that he would soon be laid low, never to rise again. Born in the early part of 1835, he had completed his seventy-second year. He was educated at Huddersfield College, at Owens College, Manchester, and at the Royal School of Medicine at Manchester, graduated as M.B. in the University of London in 1858, taking the M.D. degree two years later. Early in his medical career he became associated with St. Mary's Hospital, of which he was successively assistant physician, physician, and consulting physician. As a clinician he had few rivals, and his teaching was thorough and painstaking. In 1870 he enunciated the hypothesis, since known as "Broadbent's law," on the association of nerve nuclei, by which he sought to explain the immunity of bilaterally associated muscles from paralysis in hemiplegia. He was also much interested in diseases of the heart, on which and on the pulse he wrote standard text-books and published a number of papers on clinical subjects. During the latter years of his life he took an active part in movements associated with the public health and the good of the profession, notably in the crusade against tuberculosis and in cancer research. He was a Fellow of the Royal Society, had bestowed on him many honorary degrees, and was physician-in-ordinary to His Majesty. He received his Baronetcy on the occasion of the marriage of the present Prince of Wales, and was a Knight Commander of the Victorian Order.

THE report of the Birmingham Natural History Society for 1906 records the incorporation with that body of the Midland Malacological Society, which now forms a malacological section. Another important event in the society's career during the period under review was the transference of the offices and library to Avebury House, Newhall Street, where it has been found possible to arrange all the books in one room.

WE have received from the author, Mr. L. M. Lambe, of the Canadian Geological Survey, copies of two papers published in the *Ottawa Naturalist*. One deals with a tooth of a musk-ox from a Canadian Pleistocene deposit, while the other records the occurrence of a supernumerary upper premolar in a dog. As dogs normally possess the full series of four upper molars, the occurrence of an additional one is more noteworthy than would be the case were three the normal number of these teeth.

The wide circulation of "Pokorny's Naturgeschichte der Thierreichs" is indicated by the appearance of the twenty-seventh edition not very long subsequent to the issue of its predecessor. This edition, published by G. Freytag, of Leipzig, is edited by Mr. Max Fischer, and illustrated by twenty-four coloured plates, in addition to the woodcuts. A new feature is an appendix, in which the proper care of the human body and its various parts is briefly described. The proper standard of weight, the amount of sleep and food necessary to be taken, and the care of the eyes are some of the subjects discussed in this appendix, which can scarcely fail to be useful.

Considerable importance attaches to an account of the skull of the Cretaceous pliosaurian genus Brachauchenius given by Mr. S. W. Williston in No. 1540 (vol. xxxii., pp. 477–489) of the Proceedings of the U.S. National Museum. Brachauchenius, which is known from West Kansas, is regarded by its describer as closely related to Pliosaurus, from which it differs in having single-headed cervical ribs. From other plesiosaurians in which the skull is fully known it differs in that the palatines meet each other in the middle, but this is a feature which the author thinks will be met with in Pliosaurus. The assumed relationship of the plesiosaurs to chelonians is disputed. The latter lack, for instance, epiphyses to the humerus, while such resemblance as exists between the shoulder-girdle in the two groups is due to adaptation. Chelonians are without the parietal foramen of plesiosaurs, and retain the hypocentral mode of articulation of the ribs, whereas in plesiosaurs the ribs are attached to the transverse processes. Sauropterygia are, indeed, probably descended from theriodont ancestors, while Chelonia appear derived from a cotylosaurian type, both being widely sundered from ichthyosaurs and rhynchocephalians.

Among fifteen recent issues of the Proceedings of the U.S. National Museum, special reference may be made to three (Nos. 1543, 1547, and 1551) by Mr. A. H. Clark, on new and other crinoids. The most important novelty is *Phrynocrinus nudus*, a new genus and species from Japanese waters, described in No. 1543. In general shape the calyx is acorn-like, and it is further remarkable for the presence of broad spaces between the radial, covered with a leathery skin, showing no external signs of radial plates. In the author's opinion, this crinoid probably indicates a family by itself. The same paper contains the description of a new species of Bathycrinus, also from Japan. *Ptilocrinus pinnatus*, described in No. 1547, is a new genus and species, from the neighbourhood of the Queen Charlotte group, allied to Bathycrinus, but characterised by a peculiar feather-like arrangement of the radials. Japanese crinoids of the genus Eudiocrinus, one of which is regarded as new, form the subject of the third paper (No. 1551). In No. 1548 Mr. P. Bartsch describes a gastropod of the genus Eulima parasitic in the calyx of Ptilocrinus. In three specimens the proboscis was found to be deeply embedded in the calyx of the crinoid; no other Eulima is believed to be parasitic.

Mr. M. J. Nowak communicates to the *Bulletin international de l'Academie des Sciences de Cracovie* (January) a description of fossil plant-leaves found in the Upper Senonian beds at Potylicz, in north Galicia. The leaves are typical of evergreen xerophilous plants, among the genera represented being Gleichenia, Cunninghamia, Quercus, Myrica, Eucalyptus, and Aralia. Mr. W. M. Kudelka presents a paper on the comparative anatomy of the vegetative organs of species of Ribes.

There are many difficulties militating against the successful exploitation of new woods from the colonies and foreign States, but with a little care it should be possible to provide fair, representative specimens for show or report. Mr. H. Stone, who has handled numerous collections in recent years, offers some hints on the subject in the Journal of Economic Biology, vol. iii., part i. He attaches special value to cylindrical samples with a dome-shaped top as showing every variation of grain from the radial to the quarter.

The report of the Midland Reafforesting Association for 1906 announces the formation of three small plantations at Walsall, Bloxwich, and Wolverhampton, the two former on pit waste, the latter on a sand-pit. The three local committees at Old Hill, Walsall, and Wednesbury have been augmented by two new committees for Wolverhampton and Ocker Hill. An arbor-day festival was held in some of the districts to interest the children in the preservation of the trees. The association still lacks the services of a paid secretary owing to insufficiency of funds.

Royal assent was given on July 4 to "The Destructive Insects and Pests Act, 1907," and the Board of Agriculture and Fisheries will now be able, under this new law, to issue an order against the American gooseberry mildew. Mr. E. S. Salmon, mycologist to the South-Eastern Agricultural College, Wye, sends us a letter in which he emphasises the necessity for growers to cooperate with the Board to stamp out this new pest. The disease has been allowed seven years' start in Ireland and two or three years' start in England. Now that the Board of Agriculture has acquired the necessary legislative powers to deal with the disease, it behoves all growers and gardeners generally to cooperate heartily with the Board if they wish to see the American gooseberry mildew stamped out and their gooseberry plantations kept healthy. Up to the present, the outbreaks that have occurred in England are as follows:—Kent, on standard gooseberries only in one nursery (disease believed to be now stamped out); Worcestershire, thirty-one outbreaks in gooseberry plantations; Gloucestershire, one outbreak; Wisbech and district, two outbreaks; Warwickshire, one outbreak.

Brilliant weather has at length set in over the whole of the British Isles, and the failure of summer, which threatened for so long, has fortunately not been realised. The past records of temperature for London fail to show any previous first fortnight of July as cold as that of the present year. The sheltered thermometer did not touch 70° from July 1 to 14, and the observations since 1841 show no corresponding period without that temperature being reached, and in most years a reading of 80° is shown, whilst in some years the thermometer registers 90°. On July 15 the thermometer in London registered 77°, which is the highest temperature since May 11 and 12. The whole type of weather has changed, and the persistent cyclonic disturbances have at last given place to an anticyclone, which during the present week has embraced practically the whole of England.

The volume of rainfall observations (*Nedbøriagttagelser*, vol. xii.) published by the Meteorological Institute of Norway for 1906 is a most important contribution to that branch of meteorological science. The institute, under the able superintendence of Prof. H. Mohn, deals with about 430 rainfall stations for the year in question, and includes means from seventy-seven additional stations at which observations have now been discontinued. Daily observations are given for 200 places, and daily statistics relating to snowfall for some fifty places. The monthly and yearly summaries for the whole 507 stations include means for past years, in some cases going back to 1867. The maps which accompany the volume are very clear, and exhibit the rainfall for the year 1906 by lines showing equal amounts (isohyets); the amounts on the *west coast* between lat. 59° and 62°, the usual track of the Atlantic storms, range from 1200 mm. to 3000 mm. at some few points, while inland the amounts vary from 400 mm. to 800 mm. yearly.

The Director-General of Indian Observatories has issued a memorandum, dated June 8, on the abnormal features of the weather of the past half-year, with a forecast of the probable character of the south-west monsoon rains of 1907. From the various conditions affecting the question, all of which are clearly stated, the outlook for the total rainfall of India during the period June to September does not appear on the whole to be unfavourable; it seems, however, likely that the effect of the heavy and late snowfall will show itself in north-west India in the delay of the establishment of the monsoon, or in diminished rainfall. An interesting fact in connection with the investigation is mentioned by Dr. Walker, viz., that statistical analysis shows that when estimating the amount of monsoon rainfall corresponding to a given pressure distribution and a given frequency of sun-spots, the influence of solar activity upon Indian rainfall is almost exactly that which corresponds to the disturbance in the pressure distribution caused by the solar activity.

In the Journal of the Meteorological Society of Japan for April, Dr. T. Okada gives several interesting instances of the occurrence of Föhn winds at Wonsan, one of the seven observatories of the first order established by the Japanese Government in Corea in 1904. The station lies on the eastern coast, in lat. 39° 9′ N., and is surrounded by high mountain ranges, except on the east side. The phenomenon is almost always associated with westerly winds, and causes abnormally high temperature and excessive dryness of the air as compared with that obtaining at other stations. In another article Dr. Okada discusses the effect of snow upon the diurnal variation of temperature in the lower parts of the atmosphere, based on hourly observations at various depths at Hokkaido in February last. The total daily heat exchange in the snow on the ground was found to be approximately 19 gram-calories per square centimetre; the amount of the exchange on clear days was nearly double that on cloudy days. Other articles (in Japanese) deal with periodicity of earthquakes, and density of snow and evaporation from its surface.

Prof. H. Potonié has issued a fourth edition of his pamphlet on the origin of coal (Berlin: Borntraeger Brothers, 1907). In its present form it covers forty-seven pages, and contains twenty-eight admirably reproduced illustrations. The author's views are well known, and we are pleased to note that he intends shortly to publish an exhaustive work on the subject.

The British standard specification for material used in the construction of railway rolling-stock (Report No. 24 of the Engineering Standards Committee) has been re-published in revised form. Several important alterations have been made. In the specification for steel castings, the number of tensile and bend tests required for waggon-wheel centres has been reduced, as it was considered that the quantity asked for under the existing specification was somewhat in excess of that usually obtaining in general practice. For locomotive-wheel centres cast with heavy balance weights it has been made permissible to reduce the height of the fall in the drop test. In connection with the specification for copper and brass tubes for locomotive boilers, an alternative drifting test has been added to the clause dealing with the bulging test. The principal alterations in the specifications dealing with steel plates for locomotive boilers, locomotive frames, and carriage and waggon frames, are in connection with the new standard iv. diameter test-piece for bars of more than 1 inch diameter. This shorter test-piece has been introduced to reduce the amount of material required for testing and the amount of turning down when such is necessary.

In the Journal of the Franklin Institute (vol. clxiii., No. 6) there is a lengthy paper by Dr. William Campbell on the changes in structure in iron and steel, in which the changes that take place in the iron-carbon series are considered in the light of recent work. He considers that the cementite-martensite series is the unstable one. Absence of silicon and rapid cooling tend to cause white cast iron to be formed. Grey cast irons are the martensite-graphite series, which occur with much silicon and slow cooling. The formation of graphite is due to the decomposition of cementite by re-heating to temperatures of about 1000° C. Most cast irons are a mixture of white and grey, or cementite, martensite, and graphite. The simultaneous occurrence of cementite and graphite in certain specimens of siliconless irons cannot be explained satisfactorily except by assuming that there are two systems, (*a*) ferrite and graphite, and (*b*) ferrite and cementite. This does away with the necessity of assuming a reaction between graphite and martensite to form cementite at about 1000° C. In this paper the term martensite is used in its old meaning, the solid solution of carbon in iron. Now, however, the solid solution is known as austenite, and martensite is regarded as a transition product.

Notwithstanding the much improved statistics recently issued by the Lunacy Commissioners, thoroughly satisfactory materials are still wanting for solving the question whether the prevalence of insanity is or is not increasing. The importance of the problem, especially in its bearing on the persistently urged theory of progressive physical deterioration, imparts special interest to a paper by Mr. Noel A. Humphreys on the alleged increase of insanity, published in the Journal of the Royal Statistical Society (vol. lxx., part ii.). This paper shows in a striking manner the value of scientific statistics in checking crude figures. The author expresses a decided opinion that there is no absolute proof of actual increase of occurring insanity in England and Wales, and that the continued increase in the number and proportion of the registered and certified insane is due to changes in the degree and nature of mental unsoundness for which asylum treatment is considered necessary, and to the marked decline in the rate of discharge (including deaths) from asylums.

In an article entitled "The Measurement of Nerve Force," contributed to the May number of the *Contemporary Review*, Dr. A. T. Schofield describes experiments with an instrument called the "sthenometer," which, it is suggested, provides a means of measuring an unknown "nerve force" emanating from the human organism. The instrument consists essentially of a straw balanced on a needle point and placed under a glass case. When a hand is brought close to the glass, at right angles to the straw and with the tips of the fingers opposite the end of the straw, a motion of the straw toward the hand is obtained. Dr. Schofield concludes from evidence of this kind that the "movement is produced in the sthenometer by some unknown force emanating from the right and left hands that can move a straw over a very considerable arc." It was shown, however, by Messrs. F. J. M. Stratton and P. Phillips in the Journal of the Society for Psychical Research for December, 1906, that heat radiated from the hand is the cause of the motion of the balanced straw of the sthenometer. Hot objects were observed to produce the same effects, and the extent of the motion was found to increase with the heat radiated from the hand as indicated by a thermopile. With the results of these experiments before us, and also a note by Mr. Stratton in the March number of the Journal of the society, it is difficult to understand why the effect described should be supposed to be produced by an unknown force. Much more substantial evidence will be required than that adduced in the article in the *Contemporary Review* before any firm foundation can be secured for the position taken up by Dr. Schofield.

THE three official articles, on the work done at the Physikalisch-Technische Reichsanstalt during the year 1906, which appeared in the April, May, and June numbers of the *Zeitschrift fur Instrumentenkunde*, have now been issued as a separate pamphlet. In addition to statistics showing how the work of the institution is growing, short summaries of the principal conclusions arrived at during the course of the year's work are given, and greatly enhance the interest and value of the publication. As typical examples may be mentioned the paragraphs on the expansion of bodies at very high and at very low temperatures, on the comparison of the various temperature scales at high temperatures, on the self-inductance of lead-covered and other cables, and those on the comparison of the methods of testing magnetic materials. Apart, however, from its scientific value, there is one feature of the report which teaches us an important lesson, that is, the close contact which exists between the institution and the manufacturers of Germany. Almost every official, from the president downwards, has spent some time during the year in visiting the works of clients of the institution, "um persönlich Fühlung mit der Industrie zu nehmen," to quote the words of the report. How long will it take us to learn this lesson?

AN important series of determinations of fundamental atomic weights is described by Prof. T. W. Richards, in conjunction with several of his students, in No. 69 of the Publications of the Carnegie Institution. The atomic weight of potassium was re-determined by ascertaining the ratio of the weight of potassium chloride to that of the silver chloride it produces when precipitated by means of almost exactly the theoretical quantity of silver nitrate. By using a Gooch crucible with a matting of platinum sponge the weight of the silver haloid formed could be determined with a high degree of accuracy, a correction being introduced for the minute quantities of silver chloride retained in the mother liquors. A similar series of determinations was also made with potassium bromide by converting the latter into silver bromide. In both series exactly the same value, 39·114, for the atomic weight of potassium was obtained (Cl=35·473, Br=79·953). Determinations were also made, introducing many new refinements, of the weight of silver nitrate formed from a known weight of silver; the results are of especial interest, inasmuch as they are incompatible with the low value recently advocated for the atomic weight of nitrogen if the atomic weight of silver be taken as 107·93; assuming this value, the atomic weight of nitrogen becomes 14·037. The atomic weight of sulphur was also determined by a new method based on the conversion of silver sulphate in a quartz tube into silver chloride by means of gaseous hydrogen chloride. The change takes place in a manner very favourable to accurate results, and gives a value 32·113 for the atomic weight of sulphur (Ag=107·93), which is considerably higher than that accepted hitherto. An interesting account of the general principles underlying recent determinations of atomic weights was given by Prof. Richards in a lecture delivered before the German Chemical Society, and printed in the current number of the *Berichte*.

THE Board of Agriculture has published colour-printed geological maps of Worms Head (Sheet 246). The map is issued in two editions (price 1s. 6d. each), on one of which (the solid edition) glacial deposits are omitted, while on the other (the drift edition) such deposits are indicated by colour. The scale is 1 inch to the mile.

THE latest list issued by Messrs. Voigtländer and Son, of 12 Charterhouse Street, E.C., is a handsome production. It contains numerous examples of photographs taken with various types of lenses made by this firm, and is in addition provided with an excellent introduction by Dr. H. Harting on the selection of photographic lenses and cameras.

THE Livingstone College Year-book for 1907 contains the annual report, extracts from letters from old students, hints on diet and hygiene in the tropics, &c. The college gives a training in elementary medicine and surgery to missionaries, and is doing much good work.

DR. M. MOSZKOWSKI has translated into German Prof. T. H. Morgan's work on "Regeneration," and the volume is published by Mr. W. Engelmann, Leipzig, at the price of twelve marks. Prof. Morgan has provided his translator with new material relating to facts and theories of scientific importance published since the first or English edition appeared in 1901, and this has been incorporated in the German edition. At the end of the chapter on the theories of regeneration, Prof. Morgan states the views he now holds concerning some questions of fundamental interest.

OUR ASTRONOMICAL COLUMN.

COMET 1907*d* (DANIEL).—Several observations of this comet are recorded in No. 4188 of the *Astronomische Nachrichten* (p. 207, July 4). Observing at Kremsmünster on June 24, Prof. Fr. Schwab saw a nebulous body of about 2′ diameter with a bright nucleus; the comet disappeared in the dawn simultaneously with stars of the ninth magnitude. Herrn van Biesbroeck, with the 15-inch refractor at Uccle, found the magnitude to be 8·5 for the whole comet, on June 19, this being decidedly brighter than on the previous day. On June 27 Prof. Hartwig saw a bright centrally-placed condensation. On July 4, Dr. Lappa, observing at Rome, found the magnitude of the nucleus to be between 6.0 and 7·0.

This object now rises about midnight, about four hours before the sun, and may be seen with a good field-glass.

COMET 1907*c* (GIACOBINI).—Dr. Strömgren continues his daily ephemeris for comet 1907*c* in No. 4189 (p. 223, July 6) of the *Astronomische Nachrichten*, and carries it forward to July 31. This object is now travelling in a south-easterly direction through the constellation Virgo, and its brightness is only about half that at the time of discovery, its magnitude then being 13·0.

THE ORBIT OF α CENTAURI.—Finding that his second set of elements does not represent the angles measured at periastron passage, and having many more observational results on which to base his calculations, Prof. Doberck has re-investigated the orbit of α Centauri, and publishes the result in No. 4189 (p. 209, July 6) of the *Astronomische Nachrichten*. In the new set of elements (iv) the eccentricity is given as 0·5057 and the period as 78·81 years. There are still differences between the observed and calculated positions which must be accounted for either by unusually large constant errors in the measures or by the presence of an invisible third body, the effect of which, in this case, would be enhanced on account of the large eccentricity of the orbit; an ephemeris for 1907·5–1936·5 accompanies the paper.

COMPARISON OF THE SPECTRA OF THE LIMB AND CENTRE OF THE SUN.—In No. 5, vol. xxv. (p. 300, June), of the *Astrophysical Journal*, Prof. Hale publishes an important paper showing the results of a comparison of the spectrum of the central parts of the sun's disc with that of the sun's limb. In 1879–80, Prof. Hastings showed that the modifications of the Fraunhofer spectrum at the limb were similar to those which obtain when a spot spectrum is examined, but were much less in degree. Recent work at Mount Wilson confirms this, and shows that the effect is greater than was previously expected.

The differences between centre and limb are plainly shown in three sets of spectra which Prof. Hale reproduces. All winged lines such as H, K, $H\gamma$ and the lines of the *b* group lose, to a great extent, their hazy borders, the latter, for example, appearing as comparatively hard, well-defined lines. Other lines, *e.g.* $\lambda\lambda$ 5156·823, 5219·875, 5426·474, which are intensified in passing from the Fraunhofer to the spot spectrum, are intensified at the limb, whilst still others, generally "spark" lines, are weakened at the limb as they are in spots.

There are, however, as shown by the preliminary examination, important differences in the changes undergone. Perhaps the most striking is in the winged lines the borders of which, at the limb, are universally contracted, whereas in spots the wings on the strong lines in the more refrangible portion of the spectrum are intensified rather than diminished. Another anomaly is that at the limb the lines of V and Ti, certainly the most affected in spots, are not so strongly affected as those of Mg, Fe, Ca, &c. Again, in spots, $H\alpha$, like all the other H lines, is thinned, whereas at the limb this line is actually widened and perhaps strengthened.

The thinning of the spark lines is strikingly shown in a table in which the behaviour at the limb of twenty-seven of the more prominent enhanced lines of Fe, Ti, and V, as given by Sir Norman Lockyer, is exhibited. All these lines are considerably weakened in passing from centre to limb, and the majority of them have been observed similarly affected in spots.

A discussion of these results in their bearing on the solar theory is promised in a later paper.

THE ORBIT OF ι ORIONIS.—A note by Mr. Plaskett in No. 3, vol. i. (p. 206, May–June), of the Journal of the R.A.S. (Canada) mentions the preliminary results obtained from the radial-velocity measurements of the spectrum of ι Orionis. These show that the eccentricity of the orbit is 0·75, greater than that of any other yet known spectroscopic binary, and that the period is about 29·12 days.

METEOR AND FIREBALL OBSERVATIONS.—*Astronomische Nachrichten*, No. 4187 (p. 183, June 29), contains an account by Mr. Denning of a first-magnitude Leonid observed on November 17 last. This meteor travelled along a visible path more than ninety-one miles in length at a velocity of thirty miles per second, a considerably lower velocity than that usually attained by Leonids. The height at the beginning of the flight was seventy-seven miles, at the end sixty-six miles, so that the path was very long and nearly horizontal, facts which may account for the low velocity, as the body would thus encounter considerable atmospheric resistance.

A fireball, observed over Yorkshire on November 23, 8h. 5m., was brighter than Venus, and appears to have proceeded from a radiant at $46°+5°$, a position near α Ceti. From previous observations there appears to be a shower of long duration, or a succession of showers, from this radiant, Cetids having been observed in September, October, and November, those in November furnishing the most brilliant examples. The mean position of the radiant is $43°+5°$.

THE ROYAL SOCIETY OF CANADA.

THE annual sessions of this society, the premier scientific society in Canada, were held, as usual, in the capital city of Ottawa on May 13–16. The society, which was founded twenty-five years ago by the Duke and Duchess of Argyll (the Princess Louise and the then Marquis of Lorne), combines the features of the Royal Society of London and the French Academy. The number of fellows is very limited, and there are four sections, viz. French literature and history, English literature, &c., physics and chemistry, and biology and geology. There was an unusually large attendance from all parts of the vast Canadian dominion, and in Sections iii. and iv. the meetings were regarded as the best ever held.

Dr. Wm. Saunders, C.M.G., president of the society for 1906–7, and head of the Government Experimental Farms, gave his presidential address on the evening of May 14 in the presence of a distinguished audience, including Sir Sandford Fleming, Sir James Grant, Profs. Ramsay Wright, Penhallow, Prince, and Clark Murray, and representatives from most of the universities of Canada. The subject was "The Development of Agricultural Science," and it consisted of a masterly review of the history of farming from classical times to our own day.

The ancient Hebrews and Egyptians were the most proficient tillers of the soil in those distant ages, and the latter race was the first to raise domestic cattle. Amongst the Romans, agriculture was highly esteemed, and when luxury brought demoralisation, the noblest minds reverted to farming. "The earth," said one of these old Romans, "gives back what it receives with usury, and nothing can be more profitable or beautiful than a well-kept farm."

During the Middle Ages, only the wealthy ate wheaten food; the poorer classes used rye, barley, and oats. But in the sixteenth century Raleigh introduced the potato into Ireland. However, when the Queen of England wanted a salad for luncheon, she had still to despatch a messenger to Holland.

Up to the eighteenth century land was sown until exhausted. By that time farmers had learned the alternate crop plan of conserving the strength of the soil, and at the opening of the nineteenth century they understood the value of manure as a fertiliser.

"It is highly probable," declared Dr. Saunders, "that the plant-life will always supply enough food for mankind, and the supposition sometimes advanced, that the rapidly increasing population will not find sufficient nourishment, seems far remote from probability."

Twenty-three years ago farming was in a very depressed condition in Canada. In 1884 a select committee of the Canadian House of Commons investigated the causes of this depression, and found it was due, not to poor soil or idleness, but to a lack of knowledge and skill in the farmers, and the committee recommended the establishment of experimental farms to promote agriculture and instruct the farmers. Accordingly, in 1886 a central farm was started near Ottawa, with four other branch farms in other parts of Canada. In agriculture, Canada is now preeminent among the nations, and even Egypt, the ancient farming land, is asking for samples of Canadian products that she may emulate this country in the pursuit of the farming industry.

Prof. Rutherford, F.R.S., was president of Section iii. (Physics), and gave an address on the life-history of radium, and other fellows of the society presented twenty-five original communications, while Prof. Edward E. Prince, Chief Commissioner of Fisheries, delivered an address, as president of Section iv. (Biology and Geology), on marine biology in Canada. Prof. Prince is the head of the three biological stations carried on by the Government on the Atlantic, the Pacific, and the Great Lakes shores, and his account of the progress of zoological research and of the investigations at the stations proved exceptionally interesting. Twenty-seven papers were read and discussed, including one, the first ever presented to the society by a lady, the subject being "The Islets of Langerhans in the Pancreas of Certain Fishes," by Prof. Swale and Mrs. Thompson, of Winnipeg. Prof. Adami, McGill University, gave a paper upon certain curious cases of vertebrate teratology recently studied by him, and Prof. A. B. Macallum, F.R.S., described some new cells with protruding tail-like processes occurring in the mesoglœa of Aurelia and other Medusæ.

The popular evening lecture, which is always an important feature of the Canadian Royal Society's annual meeting, was delivered to a crowded assembly in the large hall of the Normal School by Prof. Ernest Rutherford. The subject was "Recent Results of Researches on Radium." In a graphic manner, the lecturer explained his famous "disintegration" theory, the transformation of chemical elements, the marvellous phenomena of radiant matter, and illustrated his remarks by striking experiments. He aroused much interest by stating that in Canada there were probably more rocks containing radium than in any other territory on the globe, and he had found, by suspending a wire in the open air in Montreal during a shower of rain, that radium collected on the wire. Many brilliant social functions took place during the meetings, including a large garden party by Dr. and Mrs. Saunders at their official residence; dinners given by the president-elect, Dr. S. E. Dawson; luncheons by Sir James Grant, former president; and other entertainments.

THE ROYAL VISIT TO THE UNIVERSITY COLLEGE OF NORTH WALES.

IN last week's NATURE, a short account was given of the visit of the King and Queen to Bangor to lay the foundation stone of the new buildings of the University College of North Wales. A few particulars relating to the origin and work of the college, and some thoughts suggested by speeches made at last week's ceremony, may be of interest as a supplement to the report that has already appeared.

The University College of North Wales was founded in 1884, and is at present located in the buildings of the former Penrhyn Arms Hotel. It has been enlarged by the addition of laboratories and lecture rooms for the faculty of science, which includes departments of agriculture and electrical engineering. The former was the first institution of its kind in Great Britain, and has been adopted as the model of similar agricultural departments started elsewhere. Its operations have been extended by the foundation in 1904 of a school of forestry under the auspices of the Board of Agriculture, one of two in the United Kingdom. The electrical engineering department is maintained by an annual grant from the Drapers' Company. If its resources in the matter of equipment have not been on a lavish scale, the training it has afforded has been of a high character and has probably possessed advantages which an over-elaborate plant might not afford. Still, much apparatus is badly needed before the condition of maximum efficiency can be reached. Another feature is the fisheries department, which has performed useful work in developing the fishing industry of North Wales, an industry which is capable of being greatly developed by the diffusion of practical scientific knowledge in the fishing districts. Although the present notice necessarily deals primarily with the scientific aspect of the work of the college, allusion must be made to the day training department, the courses in secondary education, and the facilities for kindergarten training afforded by the establishment of a preparatory school under the auspices of the college.

The new college will consist, when finished, of two quadrangles. At present it is only intended to erect the arts and administrative buildings, and it is to be hoped that by the time this has been done the building fund will admit of the science buildings being commenced. The library is very inadequately housed, and when we point out that only about 10*l.* a year is available for the purchase of books in such a subject as pure and applied mathematics combined, physics or chemistry, it will be seen that the present college staff is doing good work under difficulties which would not exist in a similar institution in Germany or America.

At the public luncheon, the Right Hon. D. Lloyd George, M.P., gave some interesting statistics showing the liberality and enthusiasm of the people of North Wales in matters relating to education. The contributions for university and technical education are six times, and to secondary education nine times, as high as in England, and the contributions of the town and suburbs of Bangor to the college alone represent the proportional equivalent of a sum which for a town of the size of Liverpool and its suburbs works out to 1,750,000*l.* In regard to the question of Government assistance, Mr. Lloyd George thought that waiting for Governments was like waiting for sunshine, and that the college afforded a grand opportunity for a millionaire to earn gratitude and fame.

But where is Mr. Lloyd George going to find his millionaire? A country which raises a protective tariff against millionaires in the form of death duties is scarcely a promising field. When we take account of the heavy losses North Wales has sustained by the death of a number of its most influential and prominent landowners during the last decade, the progress of the new college buildings will be found to represent a widespread feeling of munificence and loyalty towards the cause of higher national education far in advance of anything that exists in America. But in the race between British and American universities, Great Britain is heavily handicapped, with the result that, in spite of all the efforts we are putting forward, we are rapidly falling further and further behind. The inevitable result is that the responsibilities which the acquisition of wealth entails will be pressed more and more heavily every year on our Governments, and unless they can supply the extra few rays of sunshine we shall be less and less able every year to raise up the intellectual produce necessary to enable us to compete with the foreign producer.

The problem was solved long ago for Germany by her system of State universities. That Germany owes her national prosperity in no small measure to the principle of *Lehrfreiheit*, which has been adopted as the fundamental law governing the relations of the university professors with the State, is a fact which every German citizen knows well. It is no trifling thing to say that there is probably not a single university college in the United Kingdom the council and senate of which are more thoroughly imbued with the spirit of the German ideal than the University College of North Wales. In the large industrial centres of South Wales there exists an unfortunate conflict of rival factions, and it is sad to notice that many people only associate themselves with university education in order to acquire a cheap reputation by belittling the academic element, making unjustified and vexatious attacks on its representatives, and hampering the progress of the nation whose interests they falsely profess to have at heart. We refer in particular to the state of affairs which culminated some years ago in the premature death of the late Principal Viriamu Jones, and has continued to exist ever since. In North Wales the ardent Welsh nationalist, and the scientific worker who believes that "he is the greatest patriot who has the world for his nation," all realise that they are working together for a common cause.

G. H. BRYAN.

THE ALDROVANDI CELEBRATIONS AT BOLOGNA.

IT is not improbable that some of the delegates appointed to represent foreign universities and learned societies at the tercentenary of the death of Ulisse Aldrovandi (1522–1607) were insufficiently acquainted with the works of this great naturalist to appreciate thoroughly the importance of the occasion. The international gathering at Bologna (June 11–13) has been the means of rescuing from partial obscurity the memory of one of the many pioneers in the study of nature which Italy has produced. Bologna, the birthplace of universities and the *alma mater* of not a few students whose names occupy a prominent place in the history of the natural sciences, is an ideal meeting place of the nations to do homage to one of the fathers of scientific investigation. The numerous coats of arms which decorate the walls of the old university buildings bear witness to the hospitality of Bologna to students from all parts of the world, and the celebration which has now been brought to a successful conclusion testifies to the continuance of a spirit of hospitality after the lapse of centuries.

Aldrovandi's works, including several volumes published after his death, are in themselves a striking monument to his prodigious industry and encyclopædic knowledge; his wealth and long life were given up to an attempt to realise his ideal—"nothing is sweeter than to know all things."

The committee appointed under the patronage of the King to carry out the arrangements for the Aldrovandi celebrations had as honorary presidents the Marchese Tanari (Prosindaco del Commune) and the Rector of the University, Prof. Puntoni. Prof. Capellini, whose geniality is well known to many English friends, filled the office of acting president, and it is mainly to his labours and to those of the general secretary, Sig. Sorbelli, that the success of the meeting is due. On arriving at Bologna delegates were met at the station by members of the reception committee, from whom they received useful literature and information as to the lodgings provided for them. A general meeting was held in the Archiginnasio in the afternoon of June 11, at which Prof. Capellini welcomed the guests and gave an account of the order of procedure; in the evening a conversazione was given by the Marchese Tanari in the municipal buildings. The morning of June 12 was devoted to the most important business of the meeting; the delivery of discourses by Prof. Capellini, the Minister of Public Instruction and Agriculture, Prof. Costa and others, was followed by the presentation of addresses, accompanied by a few remarks by selected delegates. A feature of special interest was a speech by Count Luigi Aldrovandi—connected through fourteen generations with his illustrious ancestor. Prof. Ferguson, of Glasgow, was chosen by the British delegates as their spokesman. Oxford University was represented by Mr. Ashburner; Cambridge University, the Royal Society, the Linnean and Geological Societies of London, by Prof. Seward; St. Andrews, by Dr. Steele; and Glasgow University by Prof. Ferguson, who had previously taken part in the celebration of the octocentenary of the Bologna University. Among other delegates who spoke were Prof. Pélissier, of Montpellier; Prof. Schück, of Upsala; Dr. Wieland, of Newhaven; Prof. Entz, of Budapest; Prof. Richter, of Kolozsvar; and Prof. Brusini, of Zagabria (Agram, Croatia). The unveiling of a memorial tablet to Aldrovandi in the courtyard of the Archiginnasio terminated a somewhat lengthy programme.

In the evening delegates were afforded an opportunity of seeing the new Italian Opera—"John the Baptist"—in the Municipal Theatre. A cordial reception was given to the composer, a young priest from Turin, as he appeared before the curtain with those who took the parts of Christ, John the Baptist, Herod, and Salome. On June 13 the delegates were present at the inauguration of the Aldrovandi Museum. This was the most striking event during the meeting. A large collection of well-executed wood-blocks, together with the original specimens, shelves filled with volumes of unpublished manuscripts, a collection of coloured drawings of natural objects, and a series of herbaria formed a most impressive demonstration of the industry and whole-hearted devotion with which Aldrovandi applied himself and his means to the pursuit and organisation of knowledge. The fact that a catalogue of the unpublished manuscripts, specially printed for the celebrations, consists of 300 pages affords some measure of what Aldrovandi accomplished. Each delegate received a bronze medal bearing a bust of Aldrovandi and the following inscription on the reverse:—

Cui natura parens
Quaerenti tota refulsit

Virum post tria saecula meritas et gloria florentem
civitas et universitas
Bononiensis doctorum totius orbis adsensu rite
concelebrant. Prid. id. iun. MDCCCCVII.

In the afternoon a visit was paid to the Istituto Rizzoli at San Michele, in Bosco. Within the building devoted to orthopædic treatment were seen strange machines in motion to which were attached patients in various attitudes. The view from the grounds of the institute of Bologna and the plain beyond could not easily be surpassed.

An enjoyable banquet at the Hotel Brun in the evening brought the celebrations to a conclusion.

The presentation of several specially compiled volumes to those attending the meeting afforded another proof of the pains taken to render the meeting a success, and supplied a permanent interest to a thoroughly enjoyable reunion of nations. The volumes included "Intorno alla vita e alle opere di Ulisse Aldrovandi—Studi di A. Baldacci, E. de Toni, M. Gortani, F. Morini, A. C. Ridolfi, A. Sorbelli"; "Chartulorum Studii Bononiensis"; "Catalogo dei Manoscritti di U. Aldrovandi a Cura di Ludovici Frati con la collaborazione di A. G. e Albano Sorbelli.'"

NATIONAL POULTRY CONFERENCE AT READING.

THE second national poultry conference was held at University College, Reading, last week, July 8–12, under the presidency of Sir Walter Palmer, Bart.

In addition to papers and discussions, there was an exhibition of pairs of about 150 breeds of poultry, both English and foreign. Several breeds of the latter had not been seen in this country previously.

Mr. C. C. Hurst read a paper on Mendel's law of heredity and its application to poultry breeding. After briefly alluding to Mendel's work on peas, he went on to describe the Mendelian pairs of characters in fowls, such as rose and single comb, white and coloured plumage, colours of legs, and others. The "law of segregation" was then explained and illustrated by reference to crosses between rose-combed Hamburgh and single-combed Leghorn, and between white Leghorn and black Minorca and other coloured varieties.

The rose-combed are dominant over the single-combed varieties, and the first cross are all rose-combed birds. Bred among themselves they produce on the average three rose-combed chicks to one single-combed bird. The latter mated with a similar one breeds true. The nature of the blue Andalusian fowl was then discussed, and the want of fixity of colour, in spite of more than fifty years of breeding and separation of "rogues," was pointed out. Pedigree "blue" birds produce only one-half blue like the parents, the remainder being black and splashed white birds in equal proportions. The black and white breed true, but when crossed produce all "blue" birds. The necessity of the determination of what characters are Mendelian was emphasised, and the practical value of Mendel's law in enabling breeders to calculate what the results of particular crosses will be was referred to in conclusion.

The next paper in the section dealing with breeding problems was by Dr. J. Llewelyn Thomas, on "Hybridisation Experiments with the Ceylon Jungle-fowl." These experiments were undertaken in 1903–4 with the view of solving the following questions:—(1) Will the Ceylon jungle fowl (*Gallus stanleyii*) breed with the domestic fowl? (2) Will the hybrids breed with the jungle fowl and with the domestic fowl? and (3) will the hybrids breed among themselves? The view that the black-breasted jungle fowl of India (*Gallus bankiva*) is the parent stock of the domestic game fowl is generally accepted, and Darwin, in his "Animals and Plants under Domestication," says that the Ceylon jungle fowl "may in all probability be rejected as one of the primitive stocks of the domestic fowl," a statement which he based on information supplied by a Mr. Mitford that two hybrids raised by the latter proved sterile. It was felt that the evidence just mentioned was not sufficient to establish a conclusion one way or the other, and experiments were undertaken to obtain further information on the matter. Wild Ceylon jungle fowls were obtained after much trouble and placed in specially built runs with domestic fowls in various parts of the island.

The mating of jungle hens with the domestic cock was a complete failure. The jungle cock, however, mated readily with domestic hens! The eggs laid proved fertile, and about thirty chicks were raised from them. The hybrid cock crossed with the domestic hen gave fertile eggs, and the offspring was fertile not only with the domestic parent, but also with the hybrid parent and with one another. No chickens were obtained from the crosses

(1) hybrid cock × jungle hen, (2) hybrid hen × domestic cock, (3) hybrid hen × jungle cock.

From the cross-bred cock × hybrid hen several addled eggs were obtained, four more had chicks dead in the shell, and from two of the eggs live chickens were hatched out. The latter were apparently sturdy and robust enough for a short time, but died on the twelfth and eighteenth day respectively after hatching. The sterility of the hybrids cannot, therefore, be adduced as evidence that the Ceylon jungle fowl is not a parent stock of the domestic fowl. It was pointed out that the Ceylon jungle fowl has a reddish-brown breast, and when reversion occurs among domestic fowls, even those of pure bred black-breasted types, the males usually have red or brown breasts and not black like *Gallus bankiva*.

Mr. F. V. Theobald gave an account of a parasitic liver disease in fowls, specimens of which had been sent to him during the last three or four years. Although previously unrecorded, it is probably quite common, and due to a protozoon *Amoeba maleagridis*, Sm. Diagnosis is somewhat difficult, but the *post-mortem* appearances of the liver with yellow spots along with swollen cæca are characteristic. The life-cycle of the parasite is not yet fully worked out.

Mr. Theobald incidentally referred also to an infectious disease among poultry in South America, produced by a Spirochæte, which passes part of its life-cycle in a fowl tick (*Argas miniatus*). J. P.

HYDROLOGY IN THE UNITED STATES. PURIFICATION OF SEWAGE.

WE have on several previous occasions noticed the papers issued by the United States Geological Department on Water Supply and Irrigation.[1] Recently we have been favoured by the receipt of nineteen further papers bearing on this subject.[2]

The greater part of these, although containing a great deal of information bearing on water supply, are yet chiefly of local interest.

Paper No. 180 of the series now sent deals with the efficiency of turbine water-wheels, and consists of a compilation of data derived from tests and from manufacturers' power tables of American stock sizes, and is intended principally for the use of the hydrological surveyors in cases where the turbine is used for gauging streams.

Paper No. 179 gives an account of investigations carried on for the purpose of discovering means for preventing the pollution of streams by distillery refuse. Paper No. 189 further deals with the disposal of the waste liquors resulting from the manufacture of strawboard, an important problem connected with the prevention of stream pollution in the districts where this industry prevails.

Paper No. 187 deals with the measurement of streams when they are frozen over, and with the modifications of the ordinary methods of gauging these streams when they are covered with ice.

Paper No. 182 describes the various wells in use for municipal or domestic supply in Michigan, and the means adopted for raising the water from these wells.

Paper No. 185, on investigations into the purification of Boston Sewage, with a history of the sewage disposal problem, is of much more general interest, and contains a great deal of information of value to sanitary engineers and chemists engaged in sewage disposal. It therefore deserves a more extended notice in this Journal.

The origin of the paper was as follows:—An anonymous friend of the Massachusetts Institute of Technology, moved by the magnitude and gravity of the sewage disposal problem as it concerns householders and communities, in 1902 presented to the institute a sum equal to 1000*l.* a year for three years, afterwards extended to five years, for the purpose of making experiments on sewage purification and giving the widest possible publicity to means or methods by which the present too often crude and imperfect systems may be improved.

The report now under review, which contains 162 octavo pages, has been drawn up by Messrs. Winslow and Phelps in consonance with the wishes of the donor, and consists of a popular statement of the history of the several methods that have been tried for the purification of sewage, and a record of the results obtained at the laboratory of the Massachusetts Institute. It is claimed by the authors that the paper is written in a popular style and in language so simple that citizens, boards of health, and sewerage commissions may readily avail themselves of the information contained in it.

The sewage experimental station at the institute is situated adjacent to the City of Boston, U.S.A. Within the last few years the whole of the sewage of this city has been collected into two large main outfall sewers, and is discharged into the harbour on the ebb tide. The station is connected with one of these outfall sewers. The sewage is pumped directly from the sewer through $2\frac{1}{2}$-inch galvanised pipes into a series of twenty-five tanks having an area of 24 feet each, the depths varying from 3 feet to 6 feet. In these tanks the sewage is treated by intermittent sand filtration; the septic process; contact filtration through coke, stone, and brick of various diameters; and by trickling filters. The result of the effluent from the different tanks, as obtained by analysis, is given.

Under the conditions of these experiments crude sewage has been successfully filtered through a 2-feet bed of sand with an effective size of 0·14 millimetre at a rate of 0·4 million gallons per acre per day, divided into four doses in the twenty-four hours. The effluents were clear, bright, and well purified.

With single contact beds of stone $1\frac{1}{2}$ inches in diameter, passed at the rate of 1·2 million gallons per acre per day, the effluent of the crude sewage was only partially purified. The beds clogged rapidly, and the surface required much attention.

The double contact system in primary beds of 2-inch material, and secondary beds of $\frac{1}{2}$ inch, yielded a fairly well-purified and stable effluent at the rate, on the combined double system, of about 0·7 million gallons per acre per day with beds 6 feet deep.

The most practical of the methods that have been studied appears to be the treatment of the sewage either sedimented or subjected to a very short period of septic action in double contact beds.

The process of trickling filtration remains to be considered in a further report, but, so far as the present experiments indicate, this method will probably prove superior to any so far tested.

In the report is also given a summary of the history of sewage purification in England, Germany, the United States, and other countries, and the gradual development of the processes at present in operation. Starting from the discharge of the crude sewage into the sea or rivers, broad irrigation or sewage farming is described, and also chemical precipitation, intermittent filtration through sand, septic tanks, contact process in beds of coarse material, and continuous trickling over coarse material.

With regard to the first, it is shown that, although where the conditions are favourable sewage may be discharged into the sea without creating a nuisance, there yet remains to be considered its effect on shell-fish. With regard to the discharge into rivers, the conclusion arrived at by the River Pollution Commission of 1874 is given, that sewage mixed with twenty times its volume of pure

[1] Water Supply and Irrigation in the United States, January 7, 1904; July 28, 1904; November 3, 1904; December 22, 1904; January 26, 1905; December 21, 1905; March 2, 1906; May 24, 1906.

[2] Reports issued by the Department of the United States Geological Survey. Water Supply and Irrigation Papers. (Washington: Government Printing Office, 1906.) No. 185, Purification of Boston Sewage; No. 179, Prevention of Stream Pollution by Distillery Refuse; No. 180, Turbine Water Wheel Tests and Power Tables; No. 159, Summary of Underground Water Resources of Mississippi; No. 161, Quality of Water in the Upper Ohio River Basin; No. 162, Destructive Floods in the United States in 1905; No. 164, Underground Waters of Tennessee and Kentucky; No. 172, Progress of Stream Measurements, Missouri River; No. 174, Progress of Stream Measurements, Western Gulf of Mexico; No. 175, Progress of Stream Measurements, Colorado River; No. 177, Progress of Stream Measurements, California; No. 179, Means of Preventing Pollution of Streams by Distillery Waste; No. 181, Geology and Water Resources of Owens Valley; Nos. 182 and 183, Flowing Wells and Municipal Water Supplies in the Southern Peninsula of Michigan; No. 184, Underflow of South Platte Valley: No. 187, Determination of Stream-flow during the Frozen Season; No. 188, Water Resources of the Rio Grande Valley in New Mexico; No. 189, The Prevention of Stream Pollution by Strawboard Waste.

water would be two-thirds purified in flowing 168 miles at the rate of one mile an hour. With regard to broad irrigation, the conclusion generally arrived at is that sewage farms can never be expected to show a profit if interest on capital is included in the expenditure, and the experience is that there need be no serious danger of the spread of disease from irrigated crops, but that fruits and vegetables so grown should never be eaten without being cooked. With chemical precipitation the great difficulty is the disposal of the sludge, which amounts to twenty to twenty-six tons per million gallons of sewage. The disposal of this sludge generally involves considerable expense, it being found by practice to be of no value as manure. In fact, in some places, after being compressed into cakes, it is burnt or buried in the ground.

The result of the other processes has already been dealt with in the experiments conducted by the Massachusetts Institute.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Liverpool.—The annual exhibition of antiquities arranged by the Institute of Archæology, illustrating excavations in Upper Egypt 1906–7, was inaugurated at Burlington House, London, W., on Tuesday, July 16, and will remain open until July 30. The exhibits include scarabs, ornaments, and inscriptions of 2000 B.C. to 1200 B.C., and stelæ of Ptolemaic and later dates, recently discovered by Prof. Garstang, Mr. E. Harold Jones, and the Hon. R. H. Trefusis.

Manchester.—By the will of the late Mr. Mark Stirrup the university has received the following bequests:—Specimens of volcanic rocks and fossils; 1000*l.* for the maintenance of a geological and palæontological collection; 1500*l.* for the foundation of a palæontological scholarship, tenable for two years by anyone who has studied geology in the university.

Mr. J. W. Bews has been appointed to the newly instituted post of lecturer in economic botany.

Oxford.—In a convocation to be held on September 30, the degree of D.Sc. *honoris causa* will be conferred upon Prof. Charles Barrois, Lille; Prof. A. Heim, Zürich; Prof. A. Lacroix, Paris; Prof. A. Penck, Berlin; Dr. Hans H. Reusch, Norway; Prof. F. Zirkel, Leipzig.

Dr. George Dreyer, lecturer in general and experimental pathology in the University of Copenhagen, has been elected to the newly established professorship of pathology.

Sheffield.—The University has just issued its list of results of examinations, and we observe that three students have obtained the new degree of Bachelor of Metallurgy (B.Met.), viz. R. Mather, Z. T. K. Woo, and G. S. Ludlam. It seems only appropriate that the University's first three graduates should have taken their degree in metallurgy, as this department has for many years upheld a high standard of training in the metallurgy of iron and steel compatible with the ancient fame of the city as the home of the manufacture of high-class and special steels. It may not be inappropriate to note, in connection with the present trend of affairs in the East, that one of the honour graduates is a native of China.

Private enterprise has succeeded in founding, with the sanction of the Ministry of Education, confirmed by the Czar, an Institute of Archæology and Archæography in Moscow. The institute, which has just obtained its charter, ranks with a university, and is open to all graduates of Russian or foreign universities. Its aim is to prepare qualified archæologists and "archæographists." The latter term is applied to persons skilled in the preservation and use of historical archives, libraries, museums, and other collections, public and private, demanding special knowledge. The Moscow Institute of Archæology is the first institution in Russia founded on autonomous principles; it has the right to elect its own staff of professors, and generally to conduct its own internal affairs, subject only to a possible veto of the Minister of Education in certain cases. The course is a three years' one, the final year of which must be spent in practical work either in archæological expeditions and research among the monuments of antiquity as yet so little studied in Russia, or in similar special work at home or abroad. The institute grants the degree of doctor of archæology or archæography. Among those connected with the new institute whose names are favourably known outside Russia may be mentioned Dr. Uspensky, director of the institute, the author of fifty capital monographs in Russian; Dr. Fleischer, who was associated with English and American archæologists in recent excavations in Persia; Prof. Grot, and other Moscow professors. Privat-docent Visotsky has been appointed secretary to the institute.

The first meeting of the governing body of the Imperial College of Science and Technology was held on July 12 at the Victoria and Albert Museum, South Kensington. Mr. R. McKenna, M.P., President of the Board of Education, who was accompanied by Sir Robert Morant, opened the meeting. The following members of the governing body were present:—The Earl of Crewe, Sir F. Mowatt, Sir Julius C. Wernher, Sir W. H. White, Principal MacAlister, Mr. A. H. D. Acland, Mr. F. G. Ogilvie, Mr. J. C. G. Sykes, Dr. Glazebrook, Sir E. H. Busk, Prof. Capper, Prof. Farmer, Sir A. W. Rücker, Mr. A. Acland Allen, M.P., Mr. H. Percy Harris, Sir C. Kinloch-Cooke, Mr. R. A. Robinson, Mr. J. T. Taylor, Sir J. Wolfe-Barry, Sir Owen Roberts, Sir W. S. Prideaux, Viscount Esher, Sir A. Geikie, Prof. Tilden, Prof. Gowland, Prof. Dalby, Sir Alexander Kennedy, Mr. T. Hurry Riches, Mr. R. K. Gray, Sir Hugh Bell, Dr. Elgar, Prof. Divers, Mr. A. Sopwith, and Mr. W. McDermott, with Mr. F. E. Douglas as secretary (*pro tem.*). Mr. McKenna, in opening the meeting, took the opportunity to explain the arrangements which would have to be made for the transfer of the Royal College of Science and Royal School of Mines to the control of the governing body, and referred to the importance of the work which lay before the governing body in connection with the provision and organisation of advanced technical education within the Empire. On the motion of Viscount Esher, seconded by Sir Alexander Kennedy, Lord Crewe was unanimously elected chairman. On Lord Crewe taking the chair, Mr. McKenna handed to him the Letters Patent containing the Grant of the Charter of the Imperial College. Provisional committees (including a finance committee, of which Sir F. Mowatt was appointed chairman) were appointed to deal with preliminary matters and to report to the next meeting of the governing body, which was fixed for July 19.

A recent issue of the Journal of the Department of Agriculture and Technical Instruction for Ireland contained an exhaustive article on technical instruction in Belfast, by Mr. F. C. Forth, the principal of the municipal technical institute in the city. This account has now been published in a separate form. In the inauguration of the scheme of technical instruction the Corporation had as the chief object the provision of instruction in the principles of those arts and sciences bearing upon the trades and industries of Belfast. The success of the trade classes has been due in great measure to the enlightened view which officers of trade societies in Belfast have taken of the operations of the technical institute and to the encouragement which has been given by employers. In 1900 it was decided to build the excellent technical institute which has now been practically completed at a cost of 100,000*l.* The Belfast Corporation was, it is satisfactory to note, well advised, and as the work of each department developed sufficiently to warrant such a step, a principal teacher for it was appointed, and his first duty was to superintend the equipment of the department allotted to him in the new building and to be responsible for the expenditure of his share of the 40,000*l.* set aside for the equipment of the new institute. Before the building was out of the contractor's hands a number of classes were transferred to it, and useful experience was gained which led to some modifications in arrangements before the building was completed finally. The great bulk of the equipment is now installed, and it is hoped that when the date for the formal opening arrives, the building and its contents will be complete. Belfast is to be congratulated upon the provision the Corporation has made for providing young men and women with a modern and thorough type of technical education.

SOCIETIES AND ACADEMIES.

London.

Zoological Society, June 18.—Mr. G. A. Boulenger, F.R.S., vice-president, in the chair.—The growth-forms and supposed species in corals: Dr. F. W. **Jones**. The author showed that the growth-form of the colony was the outcome of the conditions of the environment, and was not a specific character. The growth-form was largely the result of the method of division of the zooids of the colony, and different external conditions produced different methods of division, so that almost any coral could show almost any method of division.—The lizard of the Ionian Islands which had been named *Lacerta ionica* by Herr Philip Lehrs: G. A. **Boulenger**. The author stated his opinion that this lizard was not entitled to specific rank, and that it was merely a variety of *Lacerta taurica*, Pallas.—Neotropical Lycænidæ: H. H. **Druce**. A large number of new forms were described, and the synonymy of many others discussed.—Descriptions of *Velifer hypselopterus* and of a new fish of the genus Velifer: C. T. **Regan**.—The anatomy, classification, and systematic position of the teleostean fishes of the suborder Halotriognathi: C. T. **Regan**. The paper showed that the Lamprididæ, Veliferidæ, Trachypteridæ, and Lophotidæ formed a natural group closely related to the Beryciformes, from which they differed especially in the structure of the mouth.—Monkeys of the genus Cercopithecus: R. I. **Pocock**. All the known forms of this genus may be arranged into groups typified by the following species:—*patas*, *aethiops*, *petaurista*, *cephus*, *nictitans*, *leucampyx*, *albigularis*, *mona*, *neglectus*, *l'hoesti*, and *diana*.—Some African species of Felis, based upon specimens exhibited in the society's gardens: R. I. **Pocock**. Special attention was directed to some interesting points connected with *F. nigripes*, *F. serval* and *servalia*, and *F. aurata* (=*chrysothrix*). A specimen of the last-named species from Sierra Leone changed from red to dusky grey while living in the gardens, thus proving that the differences in colour between individuals of this species were not of specific or subspecific value.—The jelly-fish of the genus Limnocnida collected during the third Tanganyika expedition: R. T. **Günther**. The material was obtained on four distinct dates in September, November, and February, by Dr. W. A. Cunnington, and therefore during the season of the great rains. The greater number of specimens in all the collections showed a vigorous growth of young medusa-buds on the manubrium, and that therefore the theory that asexual reproduction occurred during the dry season only, which was propounded by Mr. Moore, must be abandoned. Dr. Cunnington's material threw new light upon the order and succession in which the tentacles developed, and had enabled the author to record all the stages of tentacle development as exhibited by individuals ranging from 2 mm. to 22 mm. Certain variations in the arrangement of radial canals and of sense-organs were discussed. So large a percentage as 24 per cent. were found to possess five or more radial canals, the greatest number being seven instead of the normal four. The Victoria Nyanza form of Limnocnida collected by Sir C. Eliot, which was also dealt with in the paper, was believed to be a variety, which differed from the Tanganyika form in that the tentacles were more deeply embedded in ridges of jelly of the exumbrella than in the Tanganyika form. All the individuals in a collection from the Victoria Nyanza were females. The result of a re-investigation of both Limnocnida and Limnocodium led the author to the conclusion that both genera were to be referred to the Trachomedusæ, in spite of the fact that no other known trachomedusan had gonads on the manubrium. Reasons for this view were given, as also for the association of both fresh-water medusæ with the Olindiadæ. It was considered exceedingly doubtful whether either Limnocodium or Limnocnida ever passed through a hydroid stage at all.

Geological Society, June 19.—Dr. Aubrey Strahan, F.R.S., vice-president, in the chair.—The Inferior Oolite and contiguous deposits of the Bath-Doulting district: L. **Richardson**. In this paper a detailed description is given of the Inferior Oolite of the country between Doulting and Bath. It is shown that there is within the area no Inferior Oolite deposit of earlier date than the Upper Trigonia Grit—a deposit of Garantianæ hemera. In one appendix Mr. S. S. Buckman indicates the deposits in Dorset equivalent to those studied; in another the late Mr. J. F. Walker and Mr. Richardson deal with the Brachiopoda of the Fullers' Earth, naming seven new species; and in a third Mr. Richardson describes a new Amberleya and Spirorbis. The micro-fauna of the upper coral bed is dealt with by Mr. C. Upton, who obtained from material furnished him from Midford and Timsbury Sleight most of the micro-brachiopoda such as were found by Charles Moore at Dundry Hill.—The Inferior Oolite and contiguous deposits of the district between the Rissingtons and Burford: L. **Richardson**. This paper is presented with the preceding, because there are several points of similarity between the two districts described. Both are near lines of country along which movements of upheaval were frequent during the time of formation of the Inferior Oolite rocks.—The flora of the Inferior Oolite of Brora (Sutherland): Miss M. C. **Stopes**. This paper is to place on record the discovery of a bed containing impressions of plants, which represent a flora bearing a strong likeness to that of the Inferior Oolite of the Yorkshire coast. Previously, but one species and a second doubtful one were known from these coal-bearing beds. The bed in which the plants were found was a thin shale-band cropping out below high-tide level on the coast, about $1\frac{1}{4}$ miles south of Brora.—The constitution of the interior of the earth as revealed by earthquakes (second communication): some new light on the origin of the oceans: R. D. **Oldham**. The attempts which have been made to account for the oceans and continents are all subject to an uncertainty, in that we have had no means of knowing whether it is a mere irregularity of form that has to be accounted for or whether this irregularity is but the expression of a deep-seated difference in the constitution of the earth. The paper is an attempt to clear up this uncertainty by a comparison of the European records of the San Francisco and Colombian earthquakes of April 18 and January 31, 1906. The general conclusion is drawn that oceans and continents are not mere surface irregularities of the earth's form, but are accompanied by, and probably related to, differences in the constitution of the earth beneath them, which extend to a depth of about one-quarter of the radius. It is not possible to state exactly in what this difference consists, beyond that it causes the rate of propagation of the second-phase waves to be less, in comparison with that of the first-phase waves, under the oceans than under the continents.—The Swansea earthquake of June 27, 1906: Dr. C. **Davison**. With the exception of the Hereford earthquake of 1896, the Swansea earthquake was the strongest which has been felt in this country for more than twenty years. It disturbed an area of 66,700 square miles, reaching from Rochdale on the north to Penzance on the south, and from beyond Maidenhead on the east to Waterford on the west. The centre of the isoseismal 8 lies about three miles west of Swansea, the longer axis of the curve being directed E. 5° N. and W. 5° S. At Swansea, Neath, &c., the total number of chimneys thrown down or damaged must have amounted to several hundred. The shock consisted of two distinct parts, the first part being much weaker than the second, except at places within an oval area lying some miles to the east of the Swansea epicentre. The existence of a secondary focus beneath this area is also indicated by the relative positions of the isoseismal lines, the isoseismal 8 being much nearer the isoseismal 7 at the western than at the eastern end. Observations, fifty-three in number, were obtained from thirty-nine pits, distributed over an area forty-nine miles in length, from near Kidwelly to near Pontypool. The shock was, as usual, less strongly felt in pits than on the surface, and, the sound was more uniform and monotonous underground. Both shock and sound were observed in pits over about the same area. The originating fault in the neighbourhood of Swansea must run from E. 5° N. to W. 5° S., heading to the south, and passing not far from the line joining Llanelly to Neath, which is five or six miles to the north of the great east-and-west fault under Swansea Bay.—The Ochil earthquakes of September, 1900, to April, 1907: Dr. C. **Davison**. During this interval a series of slight shocks was felt chiefly in the villages of Blairlogie, Menstrie, Alva, and Tillicoultry, lying between the Ochil Hills and the river Forth. There were four shocks in 1900, one in 1903, ten in 1905, nineteen in 1906, and eight up to the end of April, 1907. The strongest shock of the series occurred on September 21, 1905; its intensity was 6, and it disturbed an area of about 1000 square miles. The originating fault must be directed from about E. 27° N. and W. 27° S., hading to the north, and passing not far from the villages mentioned above. It cannot therefore be identified with the great Ochil fault, which in the district referred to runs from about E. 13° N. to W. 13° S., and near Dollar hades to the south, although it is possible that some or many of the slighter shocks may have been due to slips along this fault.

Linnean Society, June 20.—Prof. W. A. Herdman, F.R.S., president, in the chair.—The distribution of conifers in China and neighbouring countries: the late Dr. M. T. **Masters.**—A group of papers on the collections of H.M.S. *Sealark*: J. Stanley **Gardiner.** A group of papers on collections obtained during the cruise of the yacht *Silver Belle*.—The pre-Glacial flora of Britain: Mr. and Mrs. Clement **Reid.**—Species and ovicells of Tubucellaria: A. W. **Waters.** The collections dealt with were from the Red Sea, Zanzibar, and the Atlantic.—Cephalopoda of the Sudan: Dr. W. E. **Hoyle.**—Triassic species of Zamites and Pterophyllum: E. A. N. **Arber.**—Plants collected on Mt. Ruwenzori by Dr. A. F. R. Wollaston (1906): E. G. **Baker,** S. L. **Moore,** and A. B. **Rendle.** The plants from the Ruwenzori range were collected from two camps, one at about 3500 feet above sea-level on the south-east slopes of the range between the mountains proper and Lake Ruisamba, the other at 6500 feet in the Mubuku Valley on the east side of the range. Expeditions were made to intermediate and higher altitudes, the highest camp being at about 12,500 feet, whence plants were collected up to the snow-level at about 14,500 feet on the east side. The time of year was January to July. Dr. Wollaston gives notes on the vegetation at different altitudes from 3000 feet to 15,000 feet, and has brought back some photographs showing the nature of the country and different aspects of the vegetation. The plants at the lower elevations include some common tropical weeds, with a fair percentage of more localised species and some novelties. Cultivation ceases above 7000 feet, and at from 7000 feet to 8000 feet is found the largest forest of the range; a large Dombeya is noticeable, and one of the finest trees is a Podocarpus. Above 8000 feet the forest thins out, and is gradually replaced by a belt of small tree-heaths and Podocarpus. The bamboo zone begins on the east side at about 8500 feet, and continues up to 10,000 feet. The big tree-heaths begin about 9500 feet, at which level a number of terrestrial orchids were found, with numerous ferns. From 10,000 feet to 11,000 feet moss is plentiful on the ground and trees, forming cushions 2 feet deep; here were found two tree Lobelias. In the next thousand feet Helichrysums, Lobelias, tree-heaths, and tree Senecios are the most conspicuous plants. The heaths cease about 12,500 feet, but the Senecios continue almost to 14,000 feet. Another Lobelia appears at about 12,500 feet, and is found on the steepest slopes almost to the snow-line. Helichrysums, sometimes forming bushes 4 feet or 5 feet high, grow luxuriantly. A small Arabis was found at 14,000 feet, and a rush, a grass (a new species of Poa), and mosses were found growing up to the level of permanent snow.—The anatomy of the Julianiaceæ: Dr. F. E. **Fritsch.**—Certain critical fresh-water algæ: G. S. **West.**

Faraday Society, June 25.—Prof. S. P. U. Pickering, F.R.S., in the chair.—The thermochemistry of electrolytes in relation to the hydrate theory of ionisation: W. R. **Bousfield** and Dr. T. M. **Lowry.** The process of ionisation of a neutral salt in aqueous solution "*is usually attended with a development of heat*" (Nernst, "Theoretical Chemistry," 1904, 659), *e.g.* $KCl \rightarrow \overset{+}{K} + \overset{-}{Cl} + 250$ cal. (Arrhenius, *Zeit. phys. Chem.*, 1889, iv., 106). It is pointed out that the decomposition of potassium chloride into molecular potassium and molecular chlorine involves an absorption of 105,600 cal., and that a further absorption must accompany the decomposition of the molecules into atoms. The electrification of the atoms is also probably an endothermic action, and the change represented by the above equation, so far from involving the liberation of 250 cal., must actually involve the absorption of more than 100,000 cals. The process of ionisation must therefore involve some powerful exothermic action not shown in the ordinary scheme, and it is suggested that this is supplied by the combination of the charged atoms or "ionic nuclei" with the solvent to form hydrated ions.—Influence of non-electrolytes and electrolytes on the solubility of gases in water. The question of hydrates in solution: Dr. J. C. **Philip.** The author supported the view according to which the diminished power of a solution to dissolve hydrogen and oxygen as compared with pure water is due mainly to the hydration of the solute and the consequent diminution of the "free" solvent.—Hydrates in solution: discussion of methods suggested for determining degree of hydration: Dr. G. **Senter.** It is pointed out that recent attempts to account for the properties of aqueous solution on the basis of association alone have not only proved inadequate to afford a quantitative representation of the facts, but in some respects do not appear to be even in qualitative agreement with experiment. The different methods of investigation indicate that the degree of hydration varies with the atomic weight; for example, in the case of the chlorides of the alkalis, the hydration decreases with increasing atomic weight of the alkali metals. From a quantitative point of view our knowledge of hydration is much less satisfactory, and the results so far obtained must be regarded as of a preliminary character.—The stability of hydrates as indicated by equilibrium curves: Dr. A. **Findlay.**

Chemical Society, July 4.—Sir Alexander Pedler, F.R.S., vice-president, in the chair.—*iso*Nitroso- and nitro-dimethyldihydroresorcin: P. **Haas.** The first of these substances is obtained by treating the potassium salt of dimethyldihydroresorcin with potassium nitrite in acid solution, and it is converted into the nitro-compound by treatment with nitrous gases in ether solution.—The structure of carbonium salts: F. **Baker.** *p*-Rosaniline and its monohydrochloride give absorption spectra conforming to the two types characteristic of carbonium salts such as the triphenyl- and trianisyl-carbinol sulphates, whence it is concluded that the magentas are carbonium salts.—Studies of dynamic isomerism, part vi., the influence of impurities on the muta-rotation of nitrocamphor: T. M. **Lowry** and E. H. **Magson.** The view previously arrived at that the mutarotation of nitrocamphor in solvents is conditioned by the presence of alkaline impurities is confirmed.—The relation between absorption spectra and chemical constitution, part viii., the phenylhydrazones and osazones of α-diketones: E. C. C. **Baly,** W. B. **Tuck,** Miss G. **Marsden,** and Miss M. **Gazdar.** Examination of the absorption spectra shows that these substances, in neutral solution, possess the ketonic structure, whilst phenylhydrazones in alkaline solution tend to assume the enolic configuration.—Permanganic acid: M. M. P. **Muir.** A solution containing 17 per cent. of this acid can be obtained by adding the calculated quantity of dilute sulphuric acid to a solution of barium permanganate and concentrating the filtrate in a vacuum.—Methyl dicarboxyaconitate: S. **Ruhemann.** Descriptions are given of additive and condensation products obtained by the interaction of this ester with (*a*) phenylhydrazine and (*b*) aniline. The action of heat on αα′-hydroxycarboxylic acids, part iii., αα′-dihydroxysebacic acid and its diacetyl derivative: H. R. **Le Sueur.** Both these compounds are decomposed at 250°–270° with the formation of carbon monoxide and the dialdehyde corresponding to suberic acid.—Dihydroxyadipic acids: H. R. **Le Sueur.** Two dihydroxyadipic acids are formed when the bromine atoms in αα′-dibromoadipic acid are replaced by hydroxy-groups. These are probably stereoisomerides.—The relation between absorption spectra and optical rotatory power: A. W. **Stewart.** The absorption spectra of racemic acid in concentrated solution differ from those of the optically active tartaric acids, but on dilution approximate to them in character, indicating that the acid breaks down into its two optical antipodes.—Experiments on the synthesis of the terpenes, part xi., synthesis of 4:*iso*propylidene*cyclo*-

hexanone and its derivatives: W. H. **Perkin**, jun., and J. L. **Simonsen**.—Purification of acetic ester: J. K. H. **Inglis** and Miss L. E. **Knight**.—Solubility of lead sulphate in concentrated solutions of ammonium acetate: J. J. **Fox**.—Researches on morphine, part iii.: F. H. **Lees**. By the hydrolysis of chloromorphide a second isomeride of morphine, neo*iso*morphine, has been obtained which on methylation furnishes the substance already known as *pseudo*codeine.

Association of Economic Biologists, July 4.—Mr. A. E. Shipley, F.R.S., president, in the chair.—Some notes on ticks: Cecil **Warburton**. The author dealt with the classification and means of identification, and discussed the leading generic characters.—Results of experiments with the spruce-gall and larch-blight disease: E. R. **Burdon**. The results showed that a paraffin emulsion applied early in the year, before the buds open and whilst the insects are still hibernating, is most effective.—The Cecidomyidæ or gall midges: W. E. **Collinge**. The author gave an account of his work, and appealed to entomologists and others for assistance in working out the life-histories, &c., of this very difficult family of Diptera.—A disease of bees in the Isle of Wight: Prof. A. D. **Imms**.—The American gooseberry mildew and the proposed legislative measures: E. S. **Salmon**.—The bionomics of the calypterate Muscidæ and their economic significance: C. G. **Hewitt**.—The next meeting will be held at Edinburgh about Easter, 1908.

Göttingen.

Royal Society of Sciences.—The *Nachrichten* (physicomathematical section), part i. for 1907, contains the following memoirs communicated to the society:—

July 28, 1906.—Measurements of the vertical electric current in the atmosphere, I.: H. **Gerdien**.

January 12.—A characteristic property of the *Klassenkörper*: Ph. **Furtwängler**.—A convergence theorem: E. **Landau**.—The most general conception of the plane continuous curve: A. **Schoenflies**.—The occurrence of genera and groups of Ammonites in the several zones of the Lower Chalk of Germany: A. **von Koenen**.

February 9.—The composition of quadratic forms: H. **Weber**.

February 23.—Researches from the Göttingen University chemical laboratory: O. **Wallach**. (1) Carbon acids of cyclic carbohydrates; (2) the behaviour of the nitrites of primary bases, and on the enlargement of the "ring" of carbocyclic systems.—(1) The Jacobian transformation of the quadratic forms of an infinite number of variables: (2) the transformation of assemblages of bilinear forms of an infinite number of variables: O. **Toeplitz**.

March 9.—Orthogonal systems of functions: F. **Riesz**.

Paris.

Academy of Sciences, July 8.—M. A. Chauveau in the chair.—Endosmosis between two liquids of the same chemical composition at different temperatures: G. **Lippmann**. If two volumes of pure water, one hot, the other cold, be separated by a porous membrane, there is endosmosis from the latter to the former. This phenomenon is adapted to very delicate thermometry.—Thermoendosmosis of gases: G. **Lippmann**. Between air at different temperatures there is endosmosis from cold to hot, more rapid than in the previous case of water.—The spontaneous combustion of balloons at ordinary atmospheric pressure: W. **de Fonvielle**. In the case of a recent explosion, the cause lay in a discharge of electricity between the earth and clouds. In previous instances the explosion was caused by an accumulation of positive electricity of the atmosphere in the metal of the valve.—The use of radiometry for the observation of low pressures in gases: application to researches on gaseous products emitted by radio-active bodies: Sir J. **Dewar**. Experiments show that by the use of a torsion balance or bifilar suspension radiometry can be used for quantitative researches at low pressures.—Polarisation by refraction, and the propagation of light in a non-homogeneous medium: Ch. **Fabry**. Light, passing through a medium the refractive index of which varies continuously, gives rise neither to any appreciable reflection nor in consequence to any polarisation.—The optical analysis of pyroxyles: M. **de Chardonnet**.—The electrolytic oxidation of platinum: C. **Marie**.—The sulphides, selenides, and tellurides of thallium: H. **Pélabon**.—On the preparation and properties of the borides of iron, Fe_2Bo and $FeBo_2$: Binet **du Jassonneix**.—The direct oxidation of toluene by catalysis: Paul **Woog**. Oxides of iron, nickel, copper, and manganese can be used as catalytic agents.—A new method of preparation of amino-primary alcohols: H. **Gault**. The action of halogen derivatives of ketones on some aromatic amines: A. **Richard**.—Complete analysis of the fruit of *Lycopersicum esculentum*: J. M. **Albahary**.—A proximate analysis of egg-yolk: N. A. **Barbieri**.—Photographic pelliplanimetry, a new method of rapidly measuring the surface of the living human body: B. **Roussy**.—The ferments in diseases of wine, especially *Coccus anamalus*: P. **Mazé** and P. **Pacottet**.—The extension of the Trias into the south of Tunis: A. **Joly**.—The Empidæ of Baltic amber: Fernand **Meunier**. These may be considered as belonging to a fauna indigenous to Europe and North America during Eocene times.—The principal characteristics of the leaf of *Stauropteris oldhamia*: Prof. **Bertrand**.—The distribution of temperature in the atmosphere under the North Polar circle and at Trappes: Léon Teisserenc **de Bort**.

CONTENTS.

THURSDAY, JULY 25, 1907.

DILLENIAN MEMORIALS AT OXFORD.

The Dillenian Herbaria: an Account of the Dillenian Collections in the Herbarium of the University of Oxford, together with a Biographical Sketch of Dillenius, Selections from his Correspondence, Notes, &c. By G. Claridge Druce. Edited, with an introduction, by Prof. S. H. Vines, F.R.S. Pp. cxii+258. (Oxford: The Clarendon Press, 1907.) Price 12*s*. 6*d*. net.

THIS volume is a valuable contribution to the history of the botanic preeminence of Oxford in the first half of the eighteenth century. It is significant that the three men Carl Linnæus visited in 1736 were Sir Hans Sloane, Philip Miller, and Dillenius. His credentials to the first were a commendatory letter from Boerhaave; but Sloane was then seventy-six, he had seen the rise and fall of many botanic arrangements, was a follower of our own John Ray, whose system he had adopted when indexing his large collections of plants, and was averse to further change. To him the young Swede of twenty-nine, with a brand new scheme of his own, was a visionary to be dismissed with speed, and therefore, with a few cold compliments, Linnæus departed. With Philip Miller, the gardener to the Company of Apothecaries at Chelsea, he became acquainted, bringing with him letters from his patron Clifford, and a mutual appreciation was the result. The residence of Dillenius at Oxford was the chief attraction which drew Linnæus to that place; there he stayed a month, and might have shared the liberal offer of Dillenius to divide the emoluments of the professorship between them had he so wished.

At this time Dillenius had been only two years installed as Sherardian professor, though he had received the stipend from the death of William Sherard. His tenure of the chair from 1734 to his death in 1747 was a bright interlude between two uneventful periods.

Mr. Druce has drawn up this account of the collections left by Dillenius, and has critically examined the specimens preserved as vouchers, illuminating many doubtful passages in the third edition of Ray's "Synopsis," and practically disposing of the dubious entries which have troubled many subsequent botanists. For studies of this character the facilities offered at the Botanic Garden, Oxford, are extremely good, and only to be excelled by the Sloane volumes in the department of botany, Cromwell Road. Mr. Druce has performed a labour of love in bestowing the work of years on these collections, and should be encouraged to persevere until all the more important of the pre-Linnean herbaria at Oxford are enumerated in similar detail. It should not be forgotten that the types of Sibthorp's splendid "Flora Græca" are also preserved at Oxford.

The introduction by Prof. Vines is an appreciative essay on the position of Dillenius as regards his contemporaries; then, with a single page of preface, Mr. Druce gives a life of Dillenius and bibliography, a full selection from his extant correspondence (the letters from Linnæus have, unhappily, disappeared), and thus, after an ample preamble, the principal portion of this volume begins.

Part v. opens with the collation of the Dillenian edition of Ray's "Synopsis" issued in 1724, with the plants preserved in that special herbarium. This edition was practically the chief guide of British botanists for something like forty years, in fact until Hudson's "Flora Anglica" superseded the Raian method by the Linnean system and nomenclature. We have for the first time an authoritative statement of what is in the herbarium, and what stands there for any given name.

Next and in similar fashion we find an account of the specimens representing the plates and descriptions in the "Hortus Elthamensis," that account of the garden of James Sherard the plates of which were etched by Dillenius. Following this we come to the great work of the author, the "Historia Muscorum," with a prefixed statement of the authorities whose determinations are the basis of the modern reductions; errata and index close this interesting volume.

The temptation to dwell longer on this theme is strong, but must be resisted; the book vividly recalls days spent long ago amongst these very plants and manuscripts, and this notice must end with the hope that another instalment from this treasure house may in due time be forthcoming.

B. D. J.

THE FOURTH INTERNATIONAL ORNITHOLOGICAL CONGRESS.

Proceedings of the Fourth International Ornithological Congress, London, June, 1905, forming Vol. xiv. of the "Ornis." Edited, under the direction of the President, Dr. R. Bowdler Sharpe, by the Secretaries, Dr. Ernst J. O. Hartert and J. Lewis Bonhote. Pp. 696; with 18 plates. (London: Dulau and Co., 1907.) Price 21*s*. net.

AS in many other branches of science, the ornithologists have established an international congress, and the official account of their fourth meeting, held in London in June, 1905, is now before us. It forms a handsome and well-illustrated volume of 696 pages, and constitutes also the fourteenth volume of *Ornis*, the official journal of the association, which accompanies the presidency of the congress when it is moved from one country to another.

The first meeting of the International Congress of Ornithologists was held at Vienna in April, 1884, under the presidency of Dr. Gustav Radde, of Tiflis, and owes its inception, more or less, to the ill-starred Crown-Prince Rudolph of Austria, who had a certain amount of interest in natural history, inspired chiefly, we believe, by one of the Brehms, his personal friend and companion. The meeting at Vienna was a success to a certain extent, and was followed seven years later by the second meeting, which took place at Budapest in 1891. This congress was very well attended, and was carried out with great *éclat* by the enthusiastic naturalists of the Hungarian capital. English ornithology was represented by the late Mr. Danford and by Dr. Bowdler Sharpe, who read there an important paper on the classification of birds. The presidents on this occasion were Prof. Victor Fatio, of Geneva, and Dr. Otto Herman, of Budapest. The next meeting of the congress was deferred for several years from various causes. But the difficulties were at length surmounted, and the ornithologists of every part of the world were invited to assemble at Paris in June, 1900, under the presidency of the late Dr. Oustalet, the head of the magnificent collection of birds in the Jardin des Plantes. Although ornithologists are not numerous in France, the meeting in Paris was very well attended, and included visitors from all parts of the world. Many excellent communications were made to it. At the close of the *séances* it was resolved that the next (fourth) meeting of the congress should take place in England in 1905, and Dr. R. Bowdler Sharpe, the well-known head of the Bird Department at the Natural History Museum, South Kensington, was selected as its president. The present volume gives us a full account of the proceedings of this meeting, which was held in London in June, 1905, and was attended not only by the English devotees of ornithology, but by representatives of that science from France, Germany, Austria, Hungary, Italy, Holland, Belgium, Russia, Sweden, Switzerland, the United States, Canada, and Australia.

The fourth congress was opened at the Imperial Institute, South Kensington, on June 12 by a few words from the outgoing president, Dr. Oustalet, who then vacated the chair in favour of Dr. Sharpe, the new president. Dr. Sharpe gave a most interesting and instructive address on the origin and progress, from 1753 to the present time, of the national bird-collection in the British Museum, which is now by far the finest and most nearly complete of its kind in the world. This address, which is printed in full in the present volume, gives particulars of the additions made to the great collection year by year since its foundation, together with details on its mode of arrangement and government. By bequest, purchase, and presentation, Dr. Sharpe tells us, nearly every large private collection of birds made in England has ultimately passed into the British Museum, including those of the late Marquess of Tweeddale, Mr. Seebohm, Mr. Crowley, Mr. Allan Hume, Dr. Sclater, Mr. Osbert Salvin, Dr. Godman, and other well-known naturalists.

After the president's address the present volume is mainly occupied with the papers read at the meetings of the congress and at its various sections. These sections were five in number—systematic ornithology and distribution; migration; biology and nidification; economic ornithology; and aviculture. Excellent communications, altogether forty in number, were made on all these subjects. They are mostly of a somewhat technical character, but we may direct attention to Mr. Walter Rothschild's paper on extinct and vanishing birds, which was splendidly illustrated by the large series of specimens and drawings shown to the ornithologists when they made their excursion to Tring. We may also invite notice to Mr. Pycraft, who writes on the origin of the differences between the various kinds of nestlings, and seeks to justify his ingenious theory that all birds "were originally arboreal."

Those who require information on the eleven Acts for the Protection of Wild Birds passed by our Parliament may refer to Sir Digby Pigott's paper on this difficult subject read before the economic section, while those who keep birds in aviaries should not fail to study Mr. D. Seth-Smith's address on the importance of aviculture as an aid to the study of ornithology. The numerous and interesting facts ascertained by the votaries of this new branch of science are well set out in Mr. Seth Smith's contribution to the present volume.

THERMODYNAMICS.

Thermodynamics: an Introductory Treatise dealing mainly with First Principles and their Direct Applications. By Prof. G. H. Bryan, F.R.S. Pp. xiv+204. (Leipzig: B. G. Teubner; London: D. Nutt; Williams and Norgate, 1907.)

PROF. BRYAN has not been content in this work to follow closely the beaten track, but has given us the results of much original research. The fundamental conceptions of energy, available or unavailable, of entropy, and of temperature are given in their simplest form (see the general summary at end of the book).

As the conception of temperature is for the most part new, and throws much light on the subject, it is well to set out the author's definition. The absolute temperature of a body M is to be understood, and can be defined, only with reference to another standard body N. It is the ratio between the quantities of heat respectively taken from M and imparted to N, when M is used as reservoir, N as refrigerator in a reversible Carnot cycle. This, of course, is, and is intended to be, a theoretical definition only; and a theoretical definition is needed. Similarly, the entropy of a body cannot be defined as an absolute quantity. We can only say that in certain circumstances it increases or diminishes. In all irreversible transformations it increases by an amount equal to the available energy transformed into unavailable energy. Two definitions of entropy are given at p. 58.

Prof. Bryan encounters the usual difficulty in defining temperature, density, &c., *at a point* in a molecular medium. Given a continuous medium, we say that (for instance) the density at P is the limiting ratio of quantity to the containing volume when that volume (which contains P) becomes infinitely small. That definition is irreproachable, but, as applied to a medium consisting of discreet molecules, wholly devoid of meaning. It is possible to give a logical definition by proceeding to the limit in the other direction. But in practice—and Bryan follows the practice—it is usual to define density as the number of molecules in an element of volume at P—large compared with molecular dimensions, it being assumed for the purpose of the definition that the density may be taken without sensible error as constant throughout small distances near P. The same method applies *mutatis mutandis* to temperature.

The chapter on the diffusion of gases from the point of view of thermodynamics requires more explanation than the author has directly given. He says (p. 125):—

"When two gases at equal temperature and pressure mix by diffusion, the gain of entropy is the same as would occur if each were to expand by escaping into vacuum till it occupied the volume of the mixture."

To this Advocatus Diaboli would say, If instead of two gases you have two quantities of the same gas, oxygen, *caeteris paribus*, the whole system remains throughout in the same physical state, and, therefore (art. 86 [2]), there is no gain of entropy. What difference can it make that one volume of oxygen is replaced by nitrogen?

I think Prof. Bryan would justify his statements thus:—He asserts, art. 124 (*a*), "as two gases at equal pressure and temperature in general tend to mix by diffusion and not to separate, the process of diffusion is irreversible." And he implies (*b*) that every irreversible process necessarily involves increase of entropy. If these principles (*a*) and (*b*) be granted, 125 is probably justified. But they are both very questionable.

It is not possible within the limits of this notice adequately to discuss either (*a*) or (*b*). I would, however, point out that in diffusion, as in all motions of gases, if at any instant the velocities of all the molecules were reversed the system, if isolated, would retrace its course. Does not this fact make a broad distinction between diffusion of gases and irreversible processes usually admitted as such?

S. H. BURBURY.

VOLCANOES.

I Vulcani Attivi della Terra. Morfologia—Dinamismo—Prodotti Distribuzione Geografica-Cause. By G. Mercalli. Pp. viii+421; illustrated. (Milano: Ulrico Hoepli, 1907.) Price 10 Lire.

THIS history of the study of volcanoes may be divided into three periods; the earliest is covered by the fragmentary remains of the writings of classical philosophers and the sporadic records of great eruptions of Vesuvius and Etna during the Middle Ages; the second commenced with the eruption of Vesuvius in 1631, which gave rise to over 200 publications, and from this date on we have a fairly complete record of the activity of Vesuvius and Etna; in the third period, observation became systematised, and vulcanology, as a science, may be said to date from Spallanzani's study of Stromboli in 1788. In the nineteenth century the science expanded its boundaries, volcanoes in other parts of the world besides Italy began to be studied, experimental methods were applied to elucidating the mechanism of eruptions and the formation of volcanic rocks, and the microscope to the investigation of their composition and structure.

As a consequence of this expansion of the science it has come to pass that we have had to look, not to Italy, but to other countries, and especially to England, for a general handbook; Prof. Mercalli has rectified this, and the country where the study of volcanoes, and the science of vulcanology, took their birth has produced the best and most complete guide to their pursuit. In the compass of a moderate sized book, we have a remarkably complete, well-balanced review of the subject, which commences with the final result of volcanic activity, in an account of the rocks produced, and works back through the forms of volcanoes, their dynamics, and distribution, to the cause of volcanic activity.

The longest and most generally interesting chapter in the book is doubtless that dealing with the dynamics of volcanoes. Fissure eruptions and the outflow of lava without the formation of a volcanic cone are recognised, and in the classification of volcanic explosions we come across a third type—in addition to the familiar vulcanian and strombolian types—in what are termed plinian eruptions. This name is applied to the violent explosive eruptions, like that of Vesuvius in 79 A.D., of Bandaisan and of Krakatoa, which follow prolonged periods of repose, are of extraordinary violence, are accompanied by comparatively little or no outpouring of lava, while causing the ejection of large volumes of previously solidified material, and are succeeded by another period of repose. The eruptions of Pelée and St. Vincent in 1902 are regarded as differing in degree only, not in kind, from other known eruptions; the celebrated spine of Pelée, which was thrust up to 1000 feet above the crater, was an extreme case of extrusion of solidified lava, and the "black cloud" an extreme case of the avalanches of incandescent ashes which are a not uncommon accompaniment of great eruptions.

In dealing with the cause of volcanic activity, Prof. Mercalli favours the view, first propounded by Seneca, that it is produced by the access of sea water to highly-heated material in the interior of the earth, resulting in the production of high-pressure steam; but here, as elsewhere throughout the book, the theory is not pressed, and alternative explanations are fairly stated. A word, too, may be said for the illustrations, which are numerous and excellent.

OUR BOOK SHELF.

Shaft Sinking in Difficult Cases. By J. Riemer; translated from the German by J. W. Brough. Pp. xii+122; with 18 illustrations and 19 folding plates. (London: Charles Griffin and Co., Ltd., 1907.) Price 10s. 6*d*. net.

MR. RIEMER is one of the leading German authorities on sinking, and a translation of his valuable treatise forms an addition to English technical literature that is specially welcome in view of the fact that shaft sinking, the most complicated of all mining problems, is necessarily dealt with in a brief manner in the standard works on coal-mining. The volume is confined to a description of means that have to be resorted to when ordinary methods of sinking cannot be applied on account of excessive influx of water, the means described being shaft sinking by hand, boring shafts, the freezing method of sinking, and the sinking-drum method.

The particulars given relate exclusively to recent practice in Germany, where, unfortunately for the colliery owners, the subject of shaft sinking in circumstances of special difficulty has necessarily received special attention. Some of the difficulties recorded are appalling. For example, the sinking of a shaft at the Rheinpreussen colliery occupied twenty years, and at the Friedrichshall shaft sinking thirty-four yards cost no less than 437*l.* a yard with the shaft-boring process, whilst the unsuccessful attempt to sink ten yards by pumping cost 1563*l.* per yard. The author favours the Kind Chaudron method of sinking by the process of boring, a method that has never been known to fail. The freezing process, which was devised in 1883, has been applied in sixty-four cases, the deepest being at the Schieferkaute mine, where the ground had to be frozen to a depth of 240 yards. The depths that can be dealt with by this process are limited by the plasticity of ice.

The value of the author's detailed descriptions is greatly enhanced by the large-scale dimensioned drawings of the various shafts. On the whole, the volume furnishes those in charge of mining undertakings with a review of the various methods that may be used in difficult cases of sinking, so that the selection of the best method for any particular case is facilitated. It is not a book for elementary students, but one that deserves the careful study of advanced students and of experienced engineers. The translation has been carefully made, and a bibliography and index, that are wanting in the German edition, are undoubtedly valuable additions.

Die philosophischen Grundlagen der Wissenschaften. by Prof. B. Weinstein. Pp. xiv+543. (Leipzig and Berlin: B. G. Teubner, 1906.) Price 9 marks.

This volume contains a series of thirty-five lectures originally delivered in the University of Berlin. A wide range of subjects is treated—from sense-perception to time, space, causality, substance, hypothesis, explanation. As the lecture form is preserved, the discussion never becomes crabbed or too compressed—a great virtue in a book—and the author moves naturally and easily whithersoever the topic leads him. He touches no subject without elucidating it, and the hope expressed in the preface that the work will be of some value alike to specialists and ordinary readers will, we are sure, be amply fulfilled. In particular the work may be heartily recommended to young philosophical students with some knowledge of German who are trying to crack some of the nuts of psychology and metaphysics. Had Prof. Weinstein but added at the end of each chapter a short list of other discussions of his subject that might profitably be consulted, our gratitude would have been even greater than it is.

A few indications of the author's standpoint and mode of treatment must be given. The attempt to "explain" phenomena of consciousness by physical terms like attraction, pressure, vibration of molecules, and the like is well characterised on p. 54, where it is pointed out what utter folly it would be thought to "explain" in the same way the inertia of lifeless substances as caused by vibrations of the substance. How competing perceptions are unified is a topic that occupies several excellent pages. We see things upright, although the retinal image really shows the object in an inverted form. Prof. Weinstein is at pains to contest the view that this takes place because the judgment of the sense of touch is so powerful as to overwhelm that of the sense of sight. He points out, for example, that all orientation in space takes place with reference to our bodies, and we judge according to the movements which we perform with parts of our bodies. "Below" means what we have to bend our bodies to touch; "above" what we must stand on tip-toe to touch. If we saw everything inverted, according to the information supplied by the retinal image, we should see our bodies as well in an inverted position. Hence the sense of touch, and the sense would always give harmonious judgments. The treatment of the *a priori* nature of Zeitlichkeit and of the whole subject of causality leaves little to be desired, and atomism and æther have a few illuminating paragraphs. It is an excellent volume in every way.

The Toxins and Venoms and their Antibodies. By Em. Pozzi-Escot. Authorised translation by Dr. Alfred T. Cohn. Pp. vii+101. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1906.) Price 4*s.* 6*d.* net.

We regret that we are unable to speak favourably of this little book. In 100 short pages an attempt is made to survey the whole domain of toxins, bacterial, vegetable, and animal, of the venoms and of antitoxins, with the result that it is superficial and sketchy. It teems with errors in spelling, and with curious sentences, probably due to faulty translation, *e.g.* Micocher for Miescher, Rauson for Ransom, tumors for humors, Chauvée for Chauveau, Zalnosky for Zalensky, methylotoxin for mytilotoxin, &c.; mussels are spoken of as crustacea, and scorpions as insects; it is stated that "toxins act as toxic agents only when in a condition to be introduced into the circulation sub-cutaneously," "the action of bee poison is very often benign," "*in vitro* it (antivenine) acts quite as well preventively as therapeutically," and so on. R. T. Hewlett.

Everyman's Book of the Greenhouse (Unheated). By W. Irving. Pp. 247. (London: Hodder and Stoughton, n.d.) Price 5*s.* net.

The designation "unheated" is a convenient term to denote a greenhouse in which there is no set heating apparatus. A small stove that will keep out the frost adds materially to the utility of a greenhouse, as it is thus possible to provide a winter domicile for half-hardy plants, besides enabling the possessor to force plants into growth and prepare plants for window boxes or house decoration.

The author has extended the limits of his selection to include alpine plants and others that are especially suitable to pot culture. The directions as to choice and management are based on Mr. Irving's long experience at Kew, and are simply and clearly expressed. The longer paragraphs, such as that on the genus Primula, are the most instructive, and since it is easier to grow a few kinds well, these might have been amplified to the exclusion of certain of the less important genera. The numerous photographs are very effective and fascinating, but the coloured plates are not attractive.

"Mephistopheles." The Autobiography and Adventures of a Tabby Cat. By Keiro (Charles Yates Stephenson); with illustrations by Louis Wain. Pp. 158. (London: Jarrold and Sons, n.d.) Price 2*s.* 6*d.*

An interesting account is given of the episodes in the life of a cat possessed by Mr. Stephenson for more than eighteen years. The narrative and the excellent illustrations will both appeal to young people.

Healthy Boyhood. By Arthur Trewby; with an introduction by Sir Dyce Duckworth, and a Foreword by Earl Roberts. Pp. viii+63. (From the author.) Price 1*s.* 6*d.*

This booklet contains useful advice to boys, expressed is a temperate manner; it may be commended to the attention of parents and schoolmasters.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Origin of Radium.

IN replying to Mr. Soddy's communication published in NATURE of June 13 (p. 150) I cannot refrain from expressing my regret on learning that he has apparently taken my paper in the *American Journal of Science* for December, 1906, as such a serious "criticism" and "imputation" on my part in dealing with his paper on "The Production of Radium from Uranium." It was my intention merely to point out certain conditions of experiment which appeared to me to be quite essential to the solving of the problem of the growth of radium in uranium compounds, conditions which had apparently been neglected in his own experiments, and to show that where these conditions had been fulfilled the results were not in agreement with those which had been obtained by him. I was then, and am still, of the opinion that the experimental procedure which Mr. Soddy adopted was not suited to give conclusive results of either a positive or negative character, and this opinion is certainly strengthened by the fact that, under very similar conditions of experiment, Prof. Rutherford was unable (Bakerian Lecture, Phil. Trans., 204, 218) to observe the growth of radium in a solution of Giesel's "emanating substance," although he has since concluded that radium was actually being produced in quite notable quantities.

My suggestion of the "accidental and unconscious introduction" of radium salts during Mr. Soddy's tests was only one of a number of possible sources of error to which I have already directed attention. That the other suggestions have not met with his disapproval, and that he is at least convinced of the necessity of starting with purified uranium salts, would seem probable from his statement that he is now continuing the investigation with purified uranium compounds. I am very glad to learn that the results which he has now obtained entirely confirm and extend the results which I have already published. It may be of interest to add that my original solution of one hundred grams of *purified* uranium nitrate has recently been tested and found, after a period of more than two and one-half years, to contain less than 10^{-11} gram of radium.

"The experiments described in this paper are considered to indicate that the results obtained by Mr. Soddy are without significance and that one or more products of a slow rate of change intervene between uranium and radium." This is the particular paragraph to which Mr. Soddy now raises an objection. I fully realise that this statement is open to criticism; it was an unsuccessful effort at brevity. A longer but more satisfactory summary would perhaps have been:—The results of the experiments described in this paper are in support of the hypothesis that one or more products having a slow rate of change intervene between uranium and radium, and indicate that the results obtained by Mr. Soddy are without quantitative significance in so far as they relate to the production of radium by uranium.

"Commercial salts" of uranium may contain, and usually do contain, quite appreciable amounts of every constituent of the minerals from which they have been prepared. The presence in such salts of a small proportion of the immediate parent substance from which radium is derived is therefore in itself no indication of any genetic connection whatever between uranium and radium. My observation of the growth of radium in actinium preparations, even if it has served no other useful purpose, has certainly indicated where the immediate parent of radium is to be sought. To judge from the results which I have obtained in recent experiments along the same lines it would appear that, unless the rate of disintegration of radium now assumed is greatly in error, the chemical process outlined in my "Note on the Production of Radium from Actinium" is capable of effecting the essentially quantitative separation of the radium parent from most of the other substances present in a uranium mineral.

In conclusion, it may be desirable to direct attention to the fact that the only evidence we now have that radium is a disintegration product of uranium is the constancy of the ratio between the quantities of these two elements in the natural minerals, a relation which was first pointed out in these columns by the writer.

BERTRAM B. BOLTWOOD.

Yale University, New Haven, Conn., June 29.

The "Double Drift" Theory of Star Motions.

I HAVE been greatly interested in Mr. Eddington's account in NATURE of July 11 (p. 248) of Prof. J. C. Kapteyn's investigations of this subject. Although I do not quite follow his argument for the existence of two overlapping systems of stars (more dramatically termed "two Universes" by Prof. Turner), I yet venture to suggest an explanation of the apparently (perhaps really) opposite "drifts," which seems to me to agree sufficiently with the observed facts.

If we adopt Lord Kelvin's postulate of a single vast stellar universe very slowly condensing towards its common centre of gravity, we might expect that the component stars would move for the most part in ellipses or spirals of very varying degrees of eccentricity and of inclination to the mean orbit—perhaps indicated by the Milky Way. If we further postulate (what is very generally admitted) that our sun is situated towards the central rather than towards the outer portion of the whole system, then, just as the planets, through differential angular motions as regards the earth, appear sometimes to move in a retrograde direction or to be quite stationary, so a certain proportion of the stars might be expected, at any given period, to exhibit the same phenomena.

But further, considering the enormous distances that are known to separate the stars and star-groups from each other and the extreme slowness of their angular motions, there seems no reason why their respective orbits should not be almost as frequently in a right-hand as in a left-hand direction in regard to the central plane of general motion.

Our knowledge of the actual motions of the stars may not inaptly be compared to what astronomers would possess of the solar system supposing the whole of their observations had been limited to a period of about twenty-four hours, and that the sun was invisible. The motions of the planets and their satellites thus determined would seem as strange and incomprehensible as do those of the stars at the present time, our accurate observations of which have been limited to a few centuries.

It will probably be of interest to many of your readers (as it certainly will be to myself) if some of your mathematical correspondents will explain why, and in what way, some such system as is here suggested is incompatible with the facts set forth by Prof. Kapteyn and others.

ALFRED R. WALLACE.

IN the article to which Dr. A. R. Wallace refers, and elsewhere, I have confined myself to attempting to establish the result that the stars distribute themselves into two systems according to their motions, abstaining as far as possible from defining what physical connection is implied by the rather vague word "system." Whether the two systems are comparatively permanent and have come together from different parts of space, or whether they may have been evolved from a single system, is, in the present state of our knowledge, a somewhat speculative question, and it is with some reluctance that I enter upon it. Still, without asserting that the hypothesis of two *permanent* systems is the only possible one, I know at present of no other satisfactory explanation. In the system suggested by Dr. Wallace (in which the stars move about the centre of the universe in ellipses, some forward and some retrograde, with all sorts of eccentricities) the motions would be for our purposes haphazard. Thus the system would form a single and not a double drift; the extremely eccentric orbits form a perfect transition between the direct and retrograde orbits. To account for two drifts, it is not sufficient to show that some stars move forward and some backward; it must be shown that there is a concentration of the motions about two definite velocities (definite in magnitude and direction), and it does not appear to me that the suggested system provides for this. In fact, it is difficult to see how gravitation towards the centre of the universe could separate the motions of the stars into two systems, if they originally formed one system.

A. S. EDDINGTON.

Royal Observatory, Greenwich, July 18.

The Dental Formula of Orycteropus.

NORMALLY the adult Orycteropus has in each jaw but five teeth, though frequently, especially in young animals, a number of smaller teeth are found further forward. In 1890, Mr. Thomas discovered in both the upper and lower jaws of fairly large fœtal specimens a number of milk-teeth, seven in the upper and four in the lower jaw. So far as I am aware, nothing further has been discovered regarding the dental succession.

In the skull of a newly-born specimen which I have been enabled to study through the kindness of Dr. Perinquey, of the S. African Museum, I have been fortunate in finding a full set of milk-teeth in both upper and lower jaws. In the upper are three minute but calcified incisors, one canine and six premolars. Of these only the last five premolars probably cut the gum, and only the fourth and sixth are large enough to be functional to a slight extent. Succeeding teeth are found under the third, fourth, fifth and sixth premolars, and possibly under the second. Beyond the sixth premolar there is evidence of at least four true molars. In the lower jaw there are also three minute calcified incisors, one minute canine, and six milk-premolars. Of these the second, third, fourth, fifth, and sixth premolars probably cut the gum, and are slightly functional. The germs of replacing teeth are found in connection with all the premolars except the first. Behind the last premolar are evidences of five true molars. The dental formula of Orycteropus may thus be taken to be :—

Incisors	Canine	Premolars	Molars
		?2 3 4 5 6	1 2 3 4 5
1 2 3	*1*	*1 2 3 4 5 6*	
1 2 3	*1*	*1 2 3 4 5 6*	
		2 3 4 5 6	1 2 3 4 5

This dental formula is quite unlike that in any living mammal, but if we assume that the ancestor of Orycteropus had functional succeeding incisors, and canines, it would have had a formula not at all unlike that found in many of the Mesozoic mammals. Elliot Smith suggests that it may have branched off very early from the subungulate stem. Kitchen Parker was more impressed with the resemblances of the skull to that of the marsupials and lower insectivores.

Some further light may be obtained by a careful microscopic examination of the developing teeth, which I hope to undertake immediately.

R. BROOM.

Victoria College, Stellenbosch, June 25.

THE RADIO-TELEGRAPHIC CONVENTION.

THE report of the select committee appointed to consider the radio-telegraphic convention drawn up by the Powers in November last has just been published as a parliamentary paper. The committee recommends, by a majority of five to four, the ratification of the convention, a result which will hardly surprise those who have followed the evidence given before the committee, though the narrowness of the majority may be difficult to understand.

The provisions of the convention have already been summarised in NATURE (vol. lxxv., p. 59, November 15, 1906), so that it will not be necessary to repeat them here. It will be recollected that it was then pointed out that the provision of prime importance, and the only one likely to lead to opposition to the ratification of the convention, was the one requiring that "coast stations and ship stations are bound to exchange radio-telegrams reciprocally without regard to the particular system of radio-telegraphy adopted by these stations." The necessity for this provision and the highly beneficial results likely to accrue from its enforcement to civilisation and maritime interests were described, and the hope was expressed that the private interests of the Marconi Company would not stand in the way of its adoption.

A study of the evidence presented to the committee and clearly summarised in its report shows that the only opposition to ratification came from those representing the interests of the Marconi Company. They, having already secured what amounts to a practical monopoly so far as Great Britain, Italy, and Canada are concerned, are not unnaturally desirous of maintaining and increasing that monopoly. Whether the policy of not ratifying the convention which they support is likely to lead to such a result seems more than doubtful. The evidence shows that, so far as the world as a whole is concerned, the Marconi Company do not possess even a majority of existing stations, but only about one-third of the total number.

The ratification of the convention by all the signatory Powers except Great Britain would inevitably lead to a growth of other systems at the expense of Marconi stations: existing Marconi stations under their control would necessarily be discontinued unless they consented to acquiesce in the provision for intercommunication. The numerous stations existing along the south coast of England, if they refused to intercommunicate, would be useless for the shipping of foreign nations using other systems, and the necessity for the erection of other stations in their place on the north coast of the Continent would arise. If these, as is probable, interfered with the working of the English stations, protest would be useless from a country outside the convention. From almost all points of view it seems, as a matter of fact, that the Marconi Company stands to gain rather than to lose by the adoption of the convention by Great Britain.

Of the technical objections raised by the Marconi Company little need be said. Since the representatives of all the other systems were agreed that there exist no real difficulties in intercommunication from the technical standpoint, one is compelled to the conclusion that these objections are biassed by other considerations, unless, indeed, the Marconi system is so inferior to all others that it alone possesses this great disadvantage.

It will be recollected, probably, that great stress was laid by many writers in the daily Press at the time of the international Conference on the naval and military aspects of the convention, and Great Britain was represented by some as handing herself over bound to the Powers. That these contentions were entirely without foundation was pointed out in NATURE (*loc. cit.*), and would have been clear to anyone who took the pains to study the actual provisions of the convention. The section of the report of the select committee dealing with this aspect of the question should be sufficient to dispel any lingering doubts which may still remain.

Wireless telegraphy has been very much before the public for the past ten years. In sensational achievement much has been accomplished, and of recent years it has figured somewhat largely as an international bone of contention. But the practical commercial development has been disappointingly slow. It is to be hoped that with the ratification of the convention a period of peaceful progress may ensue, and that some of the well-deserved fruits of many years of patient experimenting may be gathered by the numerous inventors who have been working in this field.

MAURICE SOLOMON.

THE LIFE OF ST. PATRICK SCIENTIFICALLY TREATED.[1]

PATRICIUS MAGONUS SUCATUS, the Roman-Briton from South Wales who became the apostle and patron saint of Ireland, was a great man, who occupies a large place in history, and Prof. Bury has presented us with a great biography, worthy of the subject and of the brilliant equipment brought to bear on it.

Our "fabulous" lives of saints are full of facts, often strangely disguised and misplaced. The venerable records deserve the most thorough scientific treatment, of which this book is a noble illustration. Our remarks by way of review will be confined to some points of interest to astronomers and archæologists.

We were curious to learn when and how St. Patrick's Day, March 17, became a fixed festival. It is with Patrick, as with many another saint, that while the circumstances of his death are very obscure, the day stands forth with a positiveness which at once challenges inquiry. The saint died in 461 A.D. He was "buried quietly in an unmarked grave." "The pious excitement about his bones arose long after his death." In searching this book for information about the day, a very curious state of things discloses itself. The author says that the legendary date of the saint's death "had become vulgar in the seventh century," but the earliest reference we can find is the statement of a scribe who died in 846 A.D., a postscript to a copy of Patrick's "Confession." "Huc usque uolumen quod Patricius manu conscripsit sua: septem decima Martii die translatus est Patricius ad cælos" (p. 227). That was written 385 years after the saint's death. Though we should have liked to have the matter more clearly explained, we make it no point to doubt that March 17 was observed before the ninth century. What strikes us is the fact that in 846 A.D. that was the date of the vernal equinox. It is hard to believe that the Irish of the ninth century could have celebrated St. Patrick's Day without noticing the coincidence.

Turning to the legend of the saint's death, we find him converted into a solar hero. An angel predicted that his death would "set a boundary against night that no light might be wasted on him: Up to the end of the year there was light, that was a long day of peace" (p. 264). Another version has it that "after his death there was no night for twelve days, and the folk said that for a whole year the nights were less dark than usually." The one version seems to refer to the equinox, and the other to the summer solstice when for twelve days before and twelve days after the sun's declination is within its highest northward degree.

It is of interest to note that our two native British patron saints, Patrick and Dewi, seem to have been made solar heroes. In the legend of the death of Dewi, or David, we have a midsummer festival described in Christian terms, and there is ample evidence that Dewi's day was June 24 before it was fixed on March 1.

When Patrick became a solar hero, assuming that he did, he became entitled to the shamrock. About the only thing one finds it hard to forgive in our author is that he never mentions the shamrock. How can we think of Patrick and March 17 without the shamrock? We must have it brought in. The story of how Patrick utilised the popular triadic herb to teach the Irish the fundamental dogma of his faith bears the stamp of truth as clearly as anything known of him. He found the plant in great popularity among the "pagan" Irish, as well as among his Brythonic countrymen. The Welsh bards used to decorate their spring Gorsedd with the trefoil, and, as we shall see, Patrick had a great deal to do with the Gorsedd. To Celts, who thought in threes, the plant had possibly no rival as an emblem.

We have now associated an equinox and solstice date, a solar hero, and a Gorsedd emblem which our modern bards state was used at the equinox. But our modern bards have evidently changed the order of festivals, substituting the solstitial quarter days for those of the May-year. The shamrock must have belonged originally to the May-day festival, as February would be too early for it. Patrick found in Ireland the May-year in its glory, and he set about changing it into the Church-year, as part of his mission. Legend represents him lighting a fire on Easter Eve in open defiance of the fire lit on the selfsame night at Tara in connection with a high pagan festival. Our author rightly interprets the legend.

"The idea is that Easter is to replace Beltane, the Church to overcome the heathen fire, and it is a matter of no importance that the day of Beltane was the first day of summer, which could never fall on Easter Eve" (p. 107).

"We can detect here, in the very act as it were, the process by which pagan superstitions which insisted on surviving were sometimes adapted into the Christian calendar" (p. 108).

The legend of the saint's death has quite a Beltane setting. "A thorn-bush burst into flame on the wayside and was not consumed. And an angel spoke and turned him back" to Saul, to die there rather than at Armagh. A thorn-bush bursting into flame, *i.e.* flowers, before March 17 reminds us of the Glastonbury thorn-bush flowering at Christmas. There is also a legend of an Irish saint presenting a queen with a dish of blackberries at the Easter festival. Over and over again the early Church festivals are spoken of in Beltane and All Hallows terms. The chief reason seems to be that for a long time the early British and Irish Christians had no effective substitutes for the May-year festivals.

Descriptions of British pagan and early Christian festivals should be read with the aid of whatever light the bardic Gorsedd, which was once common to all parts of the British Isles, can lend us. Where Patrick lay dead, angels who kept watch over his body diffused "sweet odours of wine and honey," which is dangerously like representing the angels holding a typical Irish wake. The angels are the bards who, dressed in white, presided over the ceremonies of the Beltane feast, and wine and honey were their customary dues on such an occasion, liberal quantities of which consumed at the feast diffused sweet odours. The legend strives to harmonise the pagan feast, the Church festival, and the anniversary of Patrick's death.

This brings us to a very instructive episode in the saint's life, his attack on the "King Idol of Erin." In the plain of Slecht was a famous idol, "apparently of stone covered with silver and gold, standing in a sacred circuit, surrounded by twelve pillar stones." "It was told in later times that the firstlings, even of human offspring, used to be offered to this idol, in order to secure a plenteous yield of corn and milk, and that the high kings of Ireland themselves used to come at the beginning of winter to do worship in the plain of Slecht." Our author thinks that "the story is based on a genuine fact, but that the later accounts impute to it a significance which it did not possess." The story relates that Patrick struck down the idol with his staff, which, Prof. Bury observes, he could not have done without the consent of secular powers.

[1] "The Life of St. Patrick, and his Place in History." By Prof. J. B. Bury. Pp. x+404. (London: Macmillan and Co., Ltd., 1905.) Price 12s. net.

It is the clear truth of the setting of the story that strikes us most. What Patrick attacked was a pagan Gorsedd, and the incident is of great value as showing the use of the stone circle in the fifth century. We seem to see it in use in the earliest of Welsh tales, but we cannot assign definite periods to the incidents recorded. Here, however, we have a fairly historical episode, which should be read with Geoffrey of Monmouth's account of the May festival at Stonehenge, also in the fifth century. The Slecht Gorsedd was the same in plan as the present Welsh one—a large stone surrounded by twelve other stones. The disappearance of the former goes far to prove the truth of the history. In Wales the Gorsedd was not suppressed in the interests of Christianity. It actually received Christian baptism. The first Gorsedd after the introduction of Christianity among the Welsh is called in the bardic records "Cadair Fedydd," baptismal chair. It is an expression that explains how in

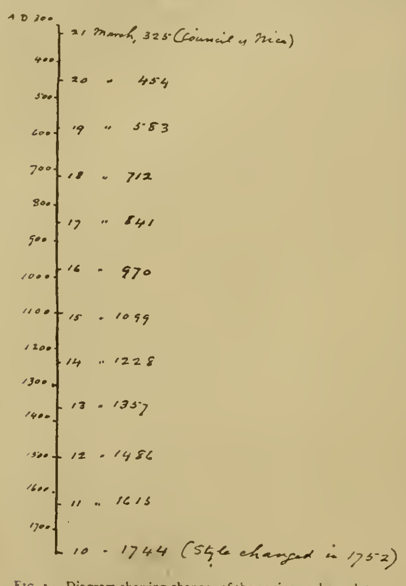


Fig. 1.—Diagram showing changes of the equinox-solstice date.

Wales it is unreasonable to look for any gap in the history of the Gorsedd there.

Our author has narrowed the inquiry into the birthplace of Patrick to the Severn estuary. Had he used some Welsh traditions about Patrick in Glamorgan he might have settled the question for good. There is a persistent tradition that Patrick was kidnapped by "pike-bearing" Irishmen from Llantwit-Major, in that county, and Mr. T. C. Evans (Cadrawd) has found three Banwens in that neighbourhood, either of which would suit for the Bannaventa mentioned as Patrick's home.

The accompanying diagram (Fig. 1) embodies the method by means of which Sir Norman Lockyer was able to note the equinoctial significance of St. Patrick's Day, before the facts mentioned by the present writer were available. Such a diagram may prove very useful to the historian. The changes in date have been calculated as from the Council of Nice, and each change represents an error of a day in 129 years. By a similar calculation as from B.C. 46, the beginning of the Julian Year, the 17th was an equinox date from A.D. 728 to 859, covering the whole period during which the particulars about Patrick were put together for an ecclesiastical purpose.

The present writer has found the following working hypothesis very useful in determining the significance of anomalous or irregular fair days. Any dates between the 10th and the 20th in March, June, September, and December may be suspected to be arrested solar days. When other evidence confirms such a supposition, the period of the institution of the fair or festival may be found by means of the above diagram. The process of arrest referred to is very evident in the case of fairs. In 1824 there were two three-days' fairs held at Bradford. One was on December 9, 10, and 11, being the dates of the fair before the change of style. The other fair was on June 17, 18, and 19. If the last figure is to be regarded as the solstice, we are taken back to 600 A.D. But it would be safer to regard the 17th as being the first of the three solstitial days, and that in the ninth century. The 17th is an important fair day, and it happens that St. Alban's Day is given in English calendars as June 17. The Welsh bards have somehow introduced the name Alban as that of a solstitial quarter day. That would naturally be suggested if Alban's Day at any time fell on the solstice, which may very well have happened in the ninth century. In an old Welsh calendar of about 1471 A.D., Alban's Day is June 22, when the date of the solstice was the 13th. That, however, does not dispose of our theory. By regarding the 22nd as the middle solstice day preceding the Council of Nice, we get the very period of the British proto-martyr. It was when the 21st was a solstice date that the earliest Christian calendar in the West was compiled, and it is possible that Alban's Day was fixed from the very first on the 22nd. The 21st is still called St. Alban's Eve. The question, therefore, is, Have we in the case of Alban's Day two arrested solar dates?

John Griffith.

NOTES.

Sir Henry Roscoe, F.R.S., and Sir William Ramsay, K.C.B., F.R.S., have been nominated foreign members of the Accademia dei Lincei, Rome.

The Vienna Academy of Sciences has awarded the Baumgarten prize to Prof. E. Ritter v. Schweidler, for his work on the phenomena of dielectrics; the Lieben prize to Prof. H. Benndorf, for his work on the transmission of earthquake waves in the interior of the earth; and the Haitinger prize to Dr. Robert Kremann, for his work on the esters.

We learn with regret of the death of Prof. Egon von Oppolzer at the early age of thirty-seven. Dr. von Oppolzer, who was a son of the celebrated Theodor von Oppolzer, was born at Vienna in 1869, and was educated at the universities of Vienna and Munich. In 1897 he became an assistant in the observatory at Prague, where he discovered in 1901 the variability in the brightness of the planet Eros. In the latter year he was appointed extraordinary professor of astronomy at Innsbruck, where he remained until his death. Among the subjects on which he wrote are astronomical refraction, solar physics, and the application of physical theory to stellar problems. He also made contributions to meteorology. A new form of zenith telescope was constructed by him, as well as a photometer of novel design. The variability of the minor planets, which has recently become a subject of very great interest, has naturally been investigated with the greatest success by the aid of photography, and it is worthy of note that Dr. von Oppolzer's important discovery in this branch of research was established by visual observations.

A MEETING of the Institution of Mechanical Engineers will be held on July 30–31, in the Mitchell Hall of the University, Aberdeen. The following papers will be read:—Aberdeen Harbour, by Mr. R. G. Nicol; cableways used on shipbuilding berths, by Mr. J. M. Henderson; portable pneumatic tools, by Mr. H. Bing; granite quarrying in Aberdeenshire, by Mr. W. Simpson; an electrically-controlled single-lever testing-machine, by Mr. C. E. Larard; observations on present-day practice in jute preparing and spinning, by Mr. D. J. MacDonald.

AFTER the current year the *Journal of Anatomy and Physiology* will be issued in two independent parts, one to be devoted to anatomical, histological, morphological, and embryological subjects, and the other to contain papers on subjects of physiological interest (including physiological histology and physiological chemistry). The acting editor of the anatomical part will be Prof. D. J. Cunningham, with whom will be associated Sir William Turner, K.C.B., Prof. A. Macalister, and Prof. G. S. Huntington. The acting editor of the physiological part will be Prof. E. A. Schäfer, with whom will be associated Profs. F. Gotch, W. D. Halliburton, C. S. Sherrington, and E. H. Starling.

THE Red-Hills Exploration Committee has issued an interim report for 1906. The committee is a joint committee of the Essex Archæological Society and the Essex Field Club appointed to make a systematic study of the red-hills, of which there are probably several hundreds on the coast of Essex alone. Work was commenced in the parish of Langenhoe, and three mounds have been examined thoroughly, particulars concerning which are given in the interim report. The red-hills vary in size from a few rods to several acres; they date from a remote period, and some at least are prehistoric. By some they have been regarded as salt works; by others as cattle shelters, human habitations, potteries, or glass factories. The object of the committee is to decide the question of their origin and significance, and an appeal is made for funds. Donations may be sent to Mr. H. Wilmer, St. Alban's Crescent, Woodford Green, Essex.

THE seventy-fifth annual meeting of the British Medical Association will be held at Exeter from July 27 to August 2. The president, Dr. R. A. Reeve, will deliver his address on July 30. The address in medicine, on "A Plea for Accuracy of Thought in Medicine," will be delivered on July 31 by Dr. W. H. White; that in surgery, on "The Contagion of Cancer in Human Beings, Auto-inoculation," on August 1 by Dr. H. T. Butlin; and the popular lecture, on "Weather, Climate and Health," on August 2 by Sir John W. Moore. There will be thirteen sections, and the names of these, with that of the president in each case, are as follows:—Pathology, Dr. R. Moore; medicine, Dr. W. Gordon; diseases of children, Mr. A. H. Tubby; psychological medicine, Dr. T. C. Shaw; electrical section, Dr. H. L. Jones; tropical diseases, Mr. J. Cantlie; surgery, Prof. G. A. Wright; ophthalmology, Mr. L. H. Tosswill; larynology, otology, and rhinology, Dr. R. McKenzie Johnston; dental surgery, Mr. J. McKno Ackland; obstetrics and gynæcology, Mr. E. H. Tweedy; State medicine, Dr. A. Newsholme; and naval and military, Dr. J. Porter.

ON Friday last, July 19, the new laboratory buildings erected by the Royal Horticultural Society in their gardens at Wisley, Surrey, were declared open by Lord Avebury in the presence of a large and distinguished assembly interested in the development of horticulture and in horticultural education in this country. The company was entertained to luncheon in the gardens by the council of the society, and the speakers after lunch included, in addition to Lord Avebury, Sir Trevor Lawrence, K.C.V.O. (president of the society), Lord Balfour of Burleigh, Sir William Chance, Sir Thomas Elliott, K.C.B., Prof. Michael Sadler, Sir William Vincent, and Sir John T. Dillwyn-Llewelyn. The laboratory buildings, which are the first in this country erected for the specific purpose of prosecuting research in horticultural science, include a research laboratory, a greenhouse for experimental work, a photographic dark-room, an office and store-room, and a students' laboratory accommodating twenty-four students at a time. The latter is equipped with all the necessary appliances for the study of plant life and its relationships to external conditions, and is excellently lighted and furnished with water and acetylene gas supply to the benches, &c. The subjects upon which the first researches are to be carried out are soil sterilisation and the etherisation of plants. The director of the laboratory is Mr. F. J. Chittenden, who was until recently a staff instructor in biology at the technical laboratories at Chelmsford.

THE following additional papers have been promised for reading before Section A of the British Association at the Leicester meeting: On the motions of ether produced by collision of atoms or molecules, containing or not containing electrons, Lord Kelvin; on variability in the products resulting from changes in radium emanation, Sir W. Ramsay, K.C.B.; on the production and origin of radium, Prof. E. Rutherford; the effect of high temperature on the activity of the products of radium, Prof. E. Rutherford and Dr. J. E. Petavel; Helium and radio-activity in common ores and minerals, Hon. R. J. Strutt; the transmission of the active deposit from radium emanation to anode, S. Russ; the absorption of gases by charcoal, Miss I. Homfray; on a theoretical method of attempting to detect relative motion between the ether and the earth, A. O. Rankine; the ultimate efficiency of illuminants, C. V. Drysdale; the variability in light of Mira Ceti and the temperature of sun-spots, Rev. A. L. Cortie; (1) on improving the plate constants of the astrographic catalogue, (2) on the determination of periodicity from a broken series of maxima, Prof. H. H. Turner; (1) some new results in the theory of functions of a real variable, (2) on the introduction of the mathematical idea of infinity, W. H. Young; the teaching of the elements of analysis, C. O. Tuckey.

IN the *Strand Magazine* for June, Mr. J. J. Ward, with the aid of numerous excellent photographs, tells the life-history of the goat-moth in a remarkably graphic manner.

IN the report of the Rugby School Natural History Society for the past year, attention is directed to the gift by Miss Loveday of a large collection of shells. Although these have been safely stored, the society lacks a conchologist capable of arranging the specimens in proper order.

THE second number of *British Birds* contains, as frontispiece, a striking portrait of the late Prof. Alfred Newton, reproduced from a photograph by Mayall. The publishers, Messrs. Witherby and Co., have also issued this photogravure in a large size suitable for framing. Mr. P. H

Bahr continues his account of the life of the osprey; while Messrs. Witherby and Ticehurst discuss additions made to the British bird-list since 1899.

Reports of papers and discussions on museum-fittings and the difficulties experienced by curators owing to reflection from the glass in exhibition galleries occupy a considerable space in No. 12 of the *Museums Journal* for the current year. Reflection is considered to present an insurmountable difficulty, which might, however, have been mitigated in many museums had more attention been paid to the needs of the exhibits when the buildings were designed. The same issue contains reprints of two addresses sent by the Trustees of the British Museum (natural history) to Upsala on the occasion of the recent celebrations in honour of Linnæus.

We are indebted to the author, Mr. Henri Piéron, of the physiological laboratories at Sorbonne, for copies of several papers from the *Comptes rendus de la Société de Biologie* dealing with experiments to determine the nature of the factors which induce sleep. In the first of these the nature of the experiments to be instituted on dogs for this purpose is discussed, while in the later ones such results as have at present been obtained are noticed. From the same author we have also received a paper from the Bulletins of the Institut général psychologique dealing with the "psychophysiology" of the sea-anemone *Actinia equina*.

Conchologists will be interested in two papers by Mr. Burnett Smith in the May issue of the Proceedings of the Philadelphia Academy. In the first the author discusses the genus Pyrula, which has existed since the late Eocene, and is now distributed in nearly all shallow tropical seas, a distribution suggesting that these seas had much freer intercommunication than is at present the case. Some of the Tertiary gastropods formerly included in Volutilithes, but now separated by the author as Athleta, form the subject of the second paper, in which the early stages of growth of these shells are discussed in detail.

A prosperous year in all branches is recorded in the report of the Yorkshire Naturalists' Union for 1906. An important piece of work undertaken by the geological section is the zoning of the Carboniferous rocks, which was inaugurated at the Ingleton meeting. The collection of photographs of important local rock-sections also continues to receive special attention. It is satisfactory to learn that the pair of peregrine falcons has continued to breed on Bempton Cliffs, although this is somewhat discounted by the driving away of a second pair which attempted to nest at Ingleboro'. Fortunately, in both instances public opinion is strongly in favour of protective legislation.

At the close of an article in the *American Naturalist* for June on the perception of colour by the eye, Mr. J. M. Dane summarises the three chief theories which have been proposed to explain the phenomenon. According to the first of these, all colours may be received by each cone of the retina; the second claims that not more than two colours can be impressed on any one cone; while the third admits the reaction of only one colour on a single cone, so that there are separate blue, red, yellow, and other cones, and corresponding transmission-fibres in the optic nerve. According to this third hypothesis the mixing of sensations, which gives rise to shades and tints, must take place in the brain. Evidence in favour of the same view is afforded by the fact that no nerve is known to respond to impulses of distinct kinds; but it should be borne in mind that no corroborative evidence is at present afforded by anatomy. Attention may also be directed to a paper in the same issue by Mr. A. B. Wright on a graphic method of correlating the environment and distribution of fishes.

Despite a falling-off in the number of papers read, the South London Entomological and Natural History Society, of which the report for 1906–7 is now before us, has to record a successful year's work. One of the features of the year was an exhibition of natural history objects held in the society's rooms in March last, which attracted a large number of visitors. The report is illustrated by several interesting photographs, from among which we are enabled, by the courtesy of the editor, to reproduce one illustrating a marvellous protective resemblance of a moth to its surroundings. So closely, indeed, do the colouring and contour accord with the bark upon which the insect is resting that it requires somewhat minute examination to detect the presence of the latter. A second, although

A specimen of the moth *Xylina ornithopos* reposing on oak-bark in the New Forest. From Report of S. London Entomological and Nat. Hist. Society, 1906–7.

somewhat less striking, case of the resemblance of a moth to its surroundings is shown in another photograph, where a specimen of *Aplecta nebulosa* is depicted on oak-bark at Leith Hill.

The second edition of the volume of the official guide to the museums of economic botany at Kew, devoted to dicotyledons and gymnosperms, has been out of print for some years, and is now replaced by a third edition, that has been carefully revised and considerably augmented, from which the gymnosperms have been excluded. Besides furnishing a guide to the collections at Kew, the book provides a valuable authority on the popular and scientific names of economic products and their sources.

The floras of the small islands known as sand keys, lying to the westward of Key West off the coast of Florida, also of the Marquesas and Tortugas groups, are graphically shown in a series of maps prepared by Mr. C. F. Millspaugh as publication No. 118 of the Field Columbian Museum. The mangrove vegetation in which *Rhizophora mangle* is the dominant species is an almost universal feature; an association of *Uniola paniculata* and *Euphorbia buxifolia* is commonly found, and a characteristic growth of *Suriana maritima* occurs on two of the Tortugas keys.

A systematic attempt is now being made to catalogue the flora of the county of Glamorgan. The work was done partly by the late Mr. John Storrie, but the new catalogue is being compiled by Prof. Trow, of the University College, Cardiff, assisted by a number of competent members of the Cardiff Naturalists' Society, and with the advice and help of Mr. A. Bennett, of Croydon. The catalogue will appear in the Transactions of the Cardiff Naturalists' Society, and is not expected to reach the complete form for another four years.

In the botanical section of the Philippine Journal of Science, vol. ii., No. 1, contains a collation of Philippine Cyperaceæ founded on the material in the Kew Herbarium by the late Mr. C. B. Clarke, and a short list of Philippine myxogastres named by Mr. G. Massee. In connection with an account of the pteridophytes collected by Mr. E. D. Merrill on Mt. Halcon, in Mindoro, Prof. E. B. Copeland, who is responsible for the identifications, notes the predominance of the Celebes element over the Bornean. The collection includes a large number of species of Polypodium, several of which are new, four new species of Diplazium, *Tmesipteris tannensis*, and a new species of Lycopodium.

The first number of vol. ii. of the botanical memoirs of the Department of Agriculture in India relates to diseases of cereals caused by *Sclerospora graminicola*, a member of the Peronosporeæ. While dealing with a matter of economic importance, the author, Dr. E. J. Butler, also gives consideration to the teratological aspect. The most interesting alteration occurs in the central prolification of the floral axis with the suppression of the pistil. The mycelium attains its maximum development in the leaves, and the reproductive organs are only produced there. The conidia arising on short, stout stalks germinate in water and give rise to zoospores; oogonia are formed in the leaf tissues at a later stage. Sclerospora disease has also been observed in India on *Sorghum vulgare* and Italian millet.

In a reference to the sixth report of the Woburn Experimental Fruit Farm (Nature, July 4, p. 231), Mr. F. V. Theobald stated that it had been found that "lead arsenate wash badly scorches the leaves under certain conditions and at certain strengths." Mr. Spencer Pickering informs us that the results obtained at the Woburn Fruit Farm do not lead to this conclusion; and upon referring the point to Mr. Theobald we find that the word "badly" written by him in his article should have been "slightly."

In the *Philippine Journal of Science* for May there are an address delivered by Dr. Paul Freer, on modern theories of immunity; a preliminary communication, by M. Mirjajima, on the cultivation of a bovine piroplasma, in which it is shown that the *Piroplasma parvum* of cattle in a blood-broth culture medium seems to develop into trypanosomes; and an exhaustive article, by Messrs. Ashburn and Craig, on dengue fever.

We have received a copy of the special bulletin of the State Board of Health containing a summary of the sanitary legislation in the United States enacted during 1906. Among others, we note that Massachusetts and Rhode Island have passed Acts to prohibit the misuse of vessels used in the sale of milk; Mississippi has passed an Act requiring the disinfection of public buildings, railway depôts, railway coaches, and sleeping cars; New Jersey an Act to provide for locating and abolishing mosquito-breeding places; and Virginia an Act prohibiting spitting in public places.

We have received from the Count Camillo Raineri-Biscia a copy of a reprint of the work entitled "Fior di Pensieri sulle Pietre Preziose di Armed Teifascite" (Bologna: L. Andreoli, 1906), translated from the Arabic and annotated by Antonio Raineri-Biscia. The translation was published originally in 1818, the translator being the eminent professor of Oriental languages at the University of Pisa, who died in 1839. A biography of the translator is given, and of his numerous works there recorded none is of greater interest than this translation of the Arabic manuscript on precious stones by Ahmed Teifascite, preserved in the Royal Library at Florence. The work is divided into twenty-five chapters, each dealing with the formation, occurrence, properties, and value of a different mineral. Some of the minerals are somewhat difficult to identify with certainty, but they appear to be as follows:—pearls, hyacinth, emerald, topaz, balas ruby, amethyst (*benfesc*), garnet, diamond, cat's eye, turquoise, carnelian, onyx, magnetite, corundum, fluorspar (*dahnag*), lapis lazuli, coral, agate, heliotrope (*giemest*), jet (*khamahan*), jasper, rock crystal, and talc. The translation is admirably reproduced, and forms a valuable contribution to mineralogical history.

As might have been expected, Sir H. Risley's theory that the Bengalis represent a blend of Dravidian and Mongoloid elements with a strain of Indo-Aryan blood in the higher groups has been contested by those members of that enterprising race who claim a higher ethnical origin. The latest critic of this school, Rama Prasad Chanda, deals with the subject in the April number of *East and West* (Bombay). Admitting, as he is compelled to do, that the Bengalis are brachycephalic, he urges that the inclusion in the anthropometrical statistics of partially assimilated races, like the Mals, Koch, and Maghs, unduly increases the ratio of brachycephaly. He proposes a new ethnical classification of the Indian races, including in what he calls the "Outlandic" group tribes of such varied character as Pathans, Baloches, Bengalis, and some races of the Brahmaputra valley, with the population of Coorg and Bellary in South India, all distinguished by round or medium heads, regular features, and moderate stature. In thus excluding a Mongoloid element from Bengal and associating the Bengali with the Turko-Iranian tribes of the North-western Frontier, his views are not likely to be received favourably by competent Indian ethnologists.

A select list of books, with references to periodicals, relating to iron and steel in commerce in the Library of Congress has been compiled by Mr. A. P. C. Griffin (Washington: Government Printing Office, 1907). The list, which covers twenty-four pages, is in no sense exhaustive. It forms, however, a handy guide to the most recent accessible literature of the subject.

In view of the recent discussion of matters connected with Belgium's exploitation of the Congo, a well-informed paper on the railways of the Upper Congo, by Mr. D. C. Boulger, in the *Engineering Magazine* (vol. xxxiii., No. 4), deserves careful attention. It is a friendly estimate of Belgian enterprise and achievement in pushing the railway across Africa from the western coast towards the great north and south artery of the Cape to Cairo line. The excellent reproductions of photographs illustrating the article show the difficulty encountered in cutting the track through the dense forest.

The following interesting details, referring more particularly to the telegraphic weather service of the United States, are taken from the annual summary, 1906, of the *Monthly Weather Review*. The Weather Bureau officials issue forecasts for thirty-six and forty-eight hours in advance daily for each State; the materials necessary for this service, including observations from about twenty stations in the Atlantic and Western Europe, are received by telegraph from about 200 stations in the morning, and from a lesser number in the evening. Storm-warning telegrams are sent to lightships and vessels from all wireless telegraph stations of the navy department along the coasts of the Atlantic, Pacific, and Gulf of Mexico; a similar service has also been inaugurated with the Marconi Company. The immense amount of information received from some 4500 stations of different classes is exhibited to the public in various ways. The daily issue of weather maps in Washington is about 1625 copies; there are also 105 other places, which issue an aggregate of 25,000 maps daily. The number of ships cooperating with the Bureau in the department of marine meteorology was 1771 during the year in question.

The Munich central meteorological station has for the first time published the preliminary results of the observations made in unmanned balloons in Bavaria in connection with the international ascents. The observations refer to the year 1906, and were made under various conditions, including periods of Föhn winds. The results will be classified for the different types of weather in a later discussion. Below 3000 metres the mean gradient (Δt/100 m.) was $-0^{\circ}.57$ C., which seems to point to a cooling effect of the mountains on the surrounding air. The largest gradients, $-0^{\circ}.71$, occurred at altitudes of 6000–8000 metres. The lowest point at which the upper inversion occurred was 8000 m., during a barometric depression; the highest point was 13,300 m., during an anticyclone. With one exception the temperature of the warm current in the upper inversion lay between -51° and -58° C. On December 5, in cyclonic conditions, a temperature of $-72^{\circ}.5$ was recorded at 13,270 m.; above this altitude an inversion occurred, and at the highest point, 14,170 m., a temperature of $-63^{\circ}.5$ was registered.

The extensive use of flexible cord in electric light fittings at the present time makes it of prime importance that definite tests of the rubber on which their insulation depends should be instituted. Prof. A. Schwartz has collected together a large amount of information on the subject, and has added the results of his own experiments in his paper on "Flexibles" in the July number of the Journal of the Institution of Electrical Engineers. He considers that the diagram connecting stress and strain for a complete cycle of stresses applied, which he calls a "hysteresis" diagram, furnishes a better criterion of the character of the rubber than any other test in common use. He is in favour of the use of pure as against vulcanised rubber in flexible cords.

The hope that the work of Dr. J. A. Harker at the National Physical Laboratory, and of Drs. L. Holborn and F. Henning at the Reichsanstalt, had definitely fixed 1710° C. as the melting point of platinum, has been rudely shaken by the appearance of additional work by Messrs. C. W. Waidner and G. K. Burgess in the May Bulletin of the United States Bureau of Standards, and by Drs. L. Holborn and S. Valentiner in the *Annalen der Physik* (vol. xxii., p. 1). The former, by the optical pyrometer method, find the point is 1753° C., while the latter, by a comparison of the optical scale with the nitrogen scale up to 1600° C., have assigned 1789° C. to the point. These discrepancies show the necessity for further work before the scale can be considered definitely fixed at these high temperatures.

The current number of the *Quarterly Review* contains two articles of interest to scientific readers. The first, under the title "The Case for the Goat," urges the value of the goat as a producer of milk. "It is not only that the goat produces a relatively large quantity of milk, and exceptionally rich milk, but . . . this milk may be drunk practically without any risk of tubercular infection." The second article, "Magic and Religion," by Mr. Edward Clodd, gives in the form of a review of a number of recent works on anthropology, an interesting summary of the growth of the science, explaining by the way how other branches of natural knowledge have assisted its growth, and enumerating the more recent contributions to the study.

The Carnegie Institution of Washington has published an "Index of Economic Material in Documents of the States of the United States: Maine, 1820–1904." The work was prepared for the department of economics and sociology of the institution by Mr. Adelaide R. Hasse, of the New York Public Library. The purpose of the volume is to furnish a guide to the economic material contained in the printed reports of administrative affairs, legislative committees, and special commissions of the State of Maine and in the messages of the governors to the legislature of that State. The present volume will be followed by others, each devoted to a single State.

Several new editions of important German scientific works have recently been received. Prof. Otto Lummer has a volume on optics in Müller-Pouillet's "Lehrbuch der Physik und Meteorologie," the tenth revised edition of which is in course of publication, under the editorship of Prof. L. Pfaundler. The new edition is to be completed in four volumes, and Prof. Lummer's work (price 15 marks), though it runs into nearly nine hundred pages, is only the third book of the first part of the second volume. The publishers are Messrs. F. Vieweg and Son, Brunswick. A second revised edition of "Die Kathodenstrahlen," by Prof. G. C. Schmidt, has also been published by Messrs. Vieweg and Son. The original work was briefly noticed in Nature of June 9, 1904 (vol. lxx., p. 124); its price is 3 marks. The fifth revised edition of Prof. A. Engler's "Syllabus der Pflanzenfamilien" has been published by Messrs. Borntraeger Bros., Berlin. Two volumes in the Philosophische Bibliothek have been received from the Dürr'schen Buchhandlung, Leipzig; No. 35 is the sixth edition of the German translation of Hume's "Enquiry concerning Human Understanding," edited by Raoul Richter, and No. 113 is a commentary on Kant's "Kritik der reinen Vernunft," by Prof. H. Cohen. Another philosophical work is "Das Weltproblem von positivistischen Standpunkte aus," by Joseph Petzoldt, published by B. G. Teubner, Leipzig. From the same publisher we have received a small volume by Prof. P. Maas, entitled "Lebensbedingungen und Verbreitung der Tiere." Two papers by A. S. Marggraf and F. C. Achard, founders of the beet sugar industry, form No. 159 of Ostwald's "Klassiker der exakten Wissenschaften," published by W. Engelmann, Leipzig.

OUR ASTRONOMICAL COLUMN.

Comet 1907*d* (Daniel).—The following set of elements and an ephemeris for comet 1907*d* have been computed by Herr H. H. Kritzinger, of Berlin, from places observed on June 15 and 24 and July 4, and are published in Circular No. 99 from the Kiel Centralstelle:—

Elements.

T = 1907 Sept. 4·168 (M.T. Berlin)

$$\left.\begin{aligned} \omega &= 293^\circ\ 49'\cdot16 \\ \Omega &= 143\ \ \ 2\cdot45 \\ i &= \ \ 8\ \ 56\cdot37 \end{aligned}\right\} 1907\cdot0$$

$$\log q = 9\cdot71590$$

An extract from the ephemeris is given below:—

Ephemeris 12h. (M.T. Berlin).

1907	α (true) h. m.	δ (true) ° ′	Brightness
July 24	3 20·7	+13 37·1	
26	3 37·5	+14 21·5	9·84
28	3 54·8	+15 2·5	
30	4 12·8	+15 39·4	11·81
Aug. 1	4 31·4	+16 11·3	
3	4 50·1	+16 37·5	13·81

The brightness at the time of discovery is taken as unity, and it is very probable that the comet will become an easy naked-eye object during August. On July 18 it was easily seen by Dr. W. J. S. Lockyer, at South Kensington, with a small telescope of about $1\frac{1}{4}$ inches aperture and 11 inches focal length, the brightness on that date, according to the above ephemeris, being 6·38.

According to the ephemeris, the comet on August 1 will be 47s. east and 18′ 8″ north of Aldebaran, and will rise four hours before the sun.

Anomalous Refraction.—No. 18 of the Miscellaneous Scientific Papers of the Alleghany Observatory contains a note by Messrs. Schlesinger and Blair on the effects of anomalous refraction on meridian-observation results. They show, from a discussion of the results obtained at the international latitude stations, that, at a properly chosen station, the effect is far less than the errors of observation in the best work that can at present be done. Incidentally, their computations indicate very strongly that the Kimura term in the latitude variation is real, and is not due, as has been suggested, to anomalous refraction.

Italian Observations of the Total Solar Eclipse of August, 1905.—The various reports which have from time to time appeared in the *Memorie della Società degli Spettroscopisti Italiani*, dealing with the results of the Italian eclipse expedition to Alcalà de Chivert in August, 1905, are now collected into one volume as the complete "Rapporto della Commissione Italiana . . ." With photographs of the instruments in position, reproductions of the solar photographs obtained, and the full discussion of the astronomical and meteorological results, the volume is a valuable addition to eclipse records. Prof. Riccò discusses the colours of the prominences, the heights of the "reversing layer" and of the chromosphere, the white prominences, the corona, the spectra, &c., whilst the discussion of the meteorological results is due to Dr. Chistoni.

Micrometer Measures of Jovian Features.—In No. 4190 of the *Astronomische Nachrichten* (p. 225, July 11) Dr. H. E. Lau gives the results of the observations of Jupiter made at the Urania Observatory, Copenhagen, during the opposition of 1906–7. The measurements of the five bands are first given, and are followed by the dimensions and positions of various "spots" in each band, the longitude and the motion of each feature, at a definite epoch, being appended. For the middle of the Great Red Spot Dr. Lau found the value of μ to be $+0^\circ\cdot071$.

July and August Meteors.—Some valuable hints to meteor observers are given in the July number of *Knowledge and Scientific News* (vol. iv., No. 7, p. 150) by Mr. Denning. The article deals principally with the Aquarid and Perseid showers, both of which should now be active. The former apparently form a fixed radiant point, near to δ Aquarii, from about July 23 to August 23, but this needs substantiating by further careful observations. Mr. Denning suggests that observers should record, very carefully, the exact data for each individual object, and afterwards seek to determine the radiant points quite independently. For the Perseids, and for the Aquarids at their maximum during the last few days of July, the radiant should be obtained separately from each night's observations.

For the minor showers the radiants have never been adequately studied, and many more observations are desirable, whilst even in regard to the Perseids it is probable that a number of important features yet remain to be detected or confirmed. No moonlight will interfere during the maximum of the present apparition.

Orbits of Binary Stars.—No. 5, vol. xxv. (June), of the *Astrophysical Journal* contains discussions of the orbits of κ Cancri and β Arietis by Mr. N. Ichinohe and Herr Ludendorff respectively.

From the discussion of twenty-five plates taken at the Yerkes Observatory, the former observer found the period of κ Cancri to be 3·393 days, whilst the eccentricity of the orbit is 0·149, and the length of its semi-major axis 5,890,000 km.

Seventy-six plates of β Arietis were examined by Herr Ludendorff, but only two lines on each, Mg λ 4481 and Hγ, could be employed in the discussion. The duplicity of the Mg line could not be detected on seventy-four plates, although, as mentioned in a previous paper by Dr. Vogel, it certainly does appear double on the other two. The writer of the present paper suggests that this doubling may be due to special disturbances in the atmosphere of the star. The results of the investigation show that the period of this binary is 107·0 days, the length of the semi-major axis of the orbit is 22,880,000 km., the total mass of the system, assuming that the masses of the components are equal, is 0·34 that of the sun, and that the eccentricity of the orbit has the extraordinarily large value 0·88. No other known spectroscopic binary orbit has an eccentricity greater than 0·55, although the values for several visual binaries exceed 0·80, but in these cases the periods are very much greater.

SCIENTIFIC WORK IN THE SEA-FISHERIES.[1]

In the first lecture the earlier history of the pre-scientific period was alluded to, from the third century onward, and even in those early times fears as to the permanence of the sea-fisheries were prevalent, as shown by regulations as to meshes of nets, small or immature fishes, and other features. Indeed, ever-recurring fears as to the decline of these fisheries have been conspicuous. Inquiries and commissions were numerous, and in the seventeenth century many protective Acts were passed, and companies floated to encourage the struggling sea-fisheries, whilst in the eighteenth century the bounty system was instituted and was only abolished in 1830.[2] The Commission of 1833 reported that the fishes of the British Channel had declined since the peace of 1815, and that the fishermen and their families were dependent on the poor-rates for support. It is clear that at that time the finny wealth of the Channel was unknown. The Commission of 1866, on the other hand, came to the conclusion that the supply of sea-fishes was increasing, and admitted of progressive increase. Then the United States Fish-Commission came into existence, from the complaints as to the diminution of the fishes on the American fishing-grounds, and artificial hatching of sea-fishes commenced in 1878. In Britain, again, a commission of two reported in 1878 much as that of 1866 had done.

Lord Dalhousie's Commission of 1883–5 was due to the complaints of the liners against trawling, and it introduced scientific investigation into the subject for the first time. This investigation was made by the same eye and the same hand on sea and on land; a method of dealing with the fishes was adopted, and subsequently followed

[1] Abstract of two lectures delivered at the Royal Institution on May 4 and 11, by Prof. W. C. McIntosh, F.R.S.

[2] An interesting historical account of the sea-fisheries, by T. Fulton, from which part of the foregoing is taken, was given in the *Fish Trades' Gazette* for 1893.

in the case of the *Garland's* work under the Scotch Fishery Board. This scientific report gave an account of beam-trawl fishing; the kinds and proportions of saleable and unsaleable fishes; the proportions of the living and the dead and of the immature fishes; the development and growth of the food-fishes; and the universal presence of floating eggs in all the ordinary food-fishes, except the herring and the wolf-fish. It showed that no noteworthy destruction of the spawn of food-fishes occurred, and that the small or immature fishes from the deeper waters consisted chiefly of dabs and long-rough dabs. It gave the distribution of the food-fishes on the various grounds, and the relative condition of the districts; a list of unsaleable fishes (chiefly frog-fishes); the fauna of the trawling grounds—surface and bottom; the food of fishes; temperature of the air; temperature of the surface and bottom water, and other points, including the satisfactory condition of the fishes themselves, and the effects of frequent hauls of the trawl on the same ground. It demonstrated that the inshore was dependent on the offshore for the supply of eggs and young of various fishes; that a gradual passage of the eggs and young shorewards, and of the growing fishes at a later stage seawards, took place. Further, that in a bay like St. Andrews Bay, constant and long-continued trawling did not exhaust the fishes, and that the men invariably kept the same line (by fixed land-marks) in their operations, a feature which at once disposed of the fears as to "trawling out." No interference with well-conducted modes of fishing was suggested.

The scientific report further recommended the establishment of experimental sea-fish hatcheries, the closure of certain areas for experiments, and the keeping of records by all fishermen of the ground, weather, depth, and nature of the fishes. Statistics were put on an improved footing in Scotland. The Fishery Board for Scotland received increased powers and funds, and carried out the trawling experiments in the closed areas, but it did not follow the advice given as to ship, staff, apparatus, and regularity of work. The Board proceeded further to close other areas, such as the Moray Firth, but upon data which science rejects. The Parliamentary Committee of 1893 followed, but the scientific evidence as to diminution was founded on data supplied by the Scotch Fishery Board, and, unfortunately, the faulty method of handling the statistics misled all as to the supposed decrease of flat-fishes. Carefully checked subsequently, the work of the Board's ship *Garland* showed that no increase of fishes had occurred in the closed areas, that the fish-fauna at the end of the ten years' experiments stood very much as at the beginning, and that, on the whole, the marine food-fishes were able to withstand man's interference. Other committees, such as that on the "Immature Fishes Bill" and the "Ichthyological Committee," were also dealt with. Sea-fish hatching was shown to be inconclusive up to date, whilst the enormous numbers of young fishes in the sea rendered the procedure of doubtful advantage.

The whole history of the subject, including the most recent work and statistics in America, Canada, Japan, Newfoundland, Norway, St. Andrews Bay, and elsewhere, showed that it was neither scientific nor practical to doubt the permanence of the British marine food-fishes or the marvellous resources of nature in the sea. Even the lobster (a form supposed to be diminishing) had been shown by Prof. Prince, of Canada, to be able to hold its own in the most rigorously fished district of western Nova Scotia. If such a species can do so, how much more the food-fishes, which survive notwithstanding the distrust of the public and the fishermen, and the fears of the learned as to man's upsetting the balance of nature.

LECTURE II.

In taking a broad survey of the reasons which prompted our country to join in the International Investigation of the Sea, it would appear that the main object was the prospective benefit to the British fisheries, though the testing of the antagonistic views, viz. of the "Resources of the Sea" and the "Impoverishment of the Sea," may have influenced the decision. The lines upon which such work should be carried out had been laid before the Ichthyological Committee, and subsequently published.[1] It is difficult to ascertain what the British investigators expected to discover, but, briefly, one of their tasks was to find out "whether the quantity and consumption of fish taken from the North Sea and neighbourhood are in proper proportion to the production." To this the observers added the exploration of the small fish grounds. The ambiguity on the subject is apparent from the mention of the "publication of annual results," of "discoveries of practical importance to the fisheries," and of "recommendations for international action."

One department, viz. hydrography, made itself prominent from the beginning, but a study of its work in the German ship *Pommerania* in 1872, of the efforts to connect temperatures with the captures of fishes in 1884, of the observations of the Scotch Board in the eastern and western waters of North Britain, of the International Survey of the North Sea (in which the same Board joined) in 1893–4, gave reasons for reserve. The present results of hydrography in connection with the fisheries in the international investigations emphasise this reserve.

We now turn to the work of the senior naturalists whose efforts were to be directed to the elucidation of fisheries' problems, such as the present condition of the food-fishes of the North Sea, and to prove the "impoverishment of the sea." Briefly, the Marine Biological Association, in the southern area of the North Sea, announces that "facts have been obtained upon which a proper understanding of the yield of the sea must in future be based," and that this pregnant statement rests on the results of experiments with marked plaice. From the numbers subsequently captured three important conclusions are drawn, viz.:—"(1) the migrations of the species, (2) the rate of growth, and (3) the intensity of fishing." Marking of plaice has long been carried out by the Scotch Board, by the Americans with cod, and by the Germans and Dutch in the international work also on the plaice. A simple method of tattooing is suggested as more likely to place the fishes (plaice) on a normal footing than the present somewhat rough one of silver wire and buttons. The data are yet too few and the time too short for a trustworthy conclusion, and British and German observers disagree. The second head has long been studied, and the present observations relate rather to the proportional rate of growth in connection with locality. Thus plaice transplanted from the Horn reef to the Dogger shoal grew faster than would have been the case had they remained, but this increase was exceeded in the Scager Rack. Transplantation is thus suggested by Dr. Garstang, as the Danes have done for some years in the Lim Fjord. So far as experience goes, however, there is little fear of suitable areas off our open shores being left unoccupied by such fishes as the plaice. The third head is apparently considered important by the Marine Biological Association, the percentage captured in the offshore waters being 20 and in the inshore 10, so that it is concluded that a limit has been reached in sea-fishing, and that it is no longer an uncertain pursuit (in the hands of the association). But this conclusion is not supported by long experience in St. Andrews Bay, nor by the history of the plaice-fishery of the Cattegat, nor by the work on the old trawling grounds on the east coast. The international observers, again, differ amongst themselves, the number experimented with being too few for a conclusion so important.

In the northern section hydrographical work is again too prominent, and surprise was felt that a new and original series of fisheries' investigations, based on a well-considered plan, was not forthcoming. The statistics of commercial trawling vessels and their treatment have little real bearing on the present inquiry, even though they are portioned out in Fulton's squares, yet it is asserted "that by these methods, if we only had statistics enough, we should mark down accurately for each fish the time of the coming at every position in the North Sea, and then weaving all the facts together show the route followed in the migration of any species." A tribute may be paid to this enthusiasm, but the importance of all these pages of tables and curves is doubted.

A contribution of a different type is that of the Scotch

[1] "A Second Decade of the Sea-Fisheries," 1903.

Board on "The Distribution and Seasonal Abundance of the Flat-fishes in the North Sea," by Dr. Fulton. This is also largely a statistical paper, and somewhat overlaps Henking's work in the North Sea and the Cattegat, and Dr. Heincke's, so far as flat-fishes are concerned. A main point is the "complementary and compensatory fluctuations" in the statistics, *e.g.* the "witch" or pole-dab in square xiv., near the Fair Isle, taking, during the winter, the place of dabs, lemon dabs, and plaice. Uncertainty, however, exists, as no other method of fishing than trawling was used on the same ground to make sure the other forms were not there. This condition is well known to fishermen. In regard to the maximum of the captures in each fish, it is found that it corresponds to the spawning season. While this paper likewise does not deal directly with the great question handed over to the Scotch Board to solve, it indirectly supports the "Resources of the Sea" in so far as the total average of lbs. per hour of fishing was greater (in flat-fishes) in 1903 than in 1901.

One of the most important papers is that of Dr. H. M. Kyle, who shows that the quantity of fish of all kinds landed in the North Sea ports, and especially of flat-fishes, was greater in 1903 than in 1902. This is clearly substantiated by Johansen's observations on Danish plaice. Hjort's work, again, removes any fear of diminution of round fishes for the supply of the North Sea.

While, therefore, the work of the British international observers up to date does not show an answer to the fundamental question submitted by the Government, yet it inadvertently supports the "Resources of the Sea," and is fairly compatible with the safety of the fishes in the North Sea. Finally, a separate English Fisheries Board, as Lord Dalhousie recommended, was suggested.

NEW ZEALAND PETROGRAPHY.[1]

THE first volume of this work was reviewed in NATURE of January 4, 1906, vol. lxxiii., pp. 234, 235. We noticed in that place the reasons which led to these Cape Colville rocks being selected for special study, and also the circumstances which made it necessary to call in extraneous aid for the descriptive part of the work. Of the volume now before us, the first two-thirds, to which alone the title of the book is properly applicable, completes the account of the volcanic rocks of the Cape Colville Peninsula. As before, the petrographical descriptions are by Prof. Sollas, and the notes relative to locality and occurrence by Mr. McKay, who also furnishes a clear geological map of the district. The details of mineralogical composition and micro-structure do not include much that is new, though we may mention the occurrence of a felspar of the anorthoclase type in some of the rhyolites, the frequent association of hornblende (or its pseudomorphs) with hypersthene in the andesitic rocks, and the presence of olivine in certain basic hypersthene-andesites or hypersthene-basalts. The interest of this collection of Tertiary andesites, dacites, and rhyolites lies, not so much in any novelty which they present, as in the close resemblance of the whole assemblage from this "petrographical province" to familiar types from better-known areas, such as Hungary and the Great Basin of North America.

The lack of arrangement and some minor blemishes, on which we will not insist, are drawbacks doubtless incidental to the conditions under which the work was carried out, by the cooperation of a petrologist in England with a field-geologist at the Antipodes. When this investigation was taken in hand, Mr. McKay, we believe, embodied in his own person the Geological Survey of New Zealand, and the work must be considered a notable production in these adverse circumstances. The re-organised Geological Survey, under the directorship of Dr. J. M. Bell, has begun operations with greater advantages, and two important memoirs of the new series have already appeared.

A special feature of the present work is the profusion of plates. This was not, we understand, a part of the original design, but it greatly enhances the value of the book. In the two volumes more than two hundred full-page plates are devoted to the illustration of the volcanic rocks of the Cape Colville Peninsula alone. The thin slices have been photographed with polarised light, usually with an amplification of sixty diameters, and most of the plates are very successful in rendering the micro-structure of the rocks selected. Such a collection of illustrations is welcome independently of the immediate object of the book, and the fact that most of the rocks belong to types of world-wide distribution is, from this point of view, an advantage.

The latter part of this volume is devoted to the description and illustration of various rocks from numerous places in New Zealand. Some of these, from the Kaimanawa Mountains and other localities in the North Island, are volcanic rocks generally comparable with those of Cape Colville. Other descriptions are included here, without regard to relationship, to fill out the volume, and the want of any orderly arrangement gives a somewhat confused appearance to this section. Some remarkable teschenites are described from the east coast of Wellington Province. They appear to occupy the neck of an old volcano, and it is noteworthy that, like the similar rocks from some European localities, they are referred to a Cretaceous age. Special interest attaches to a collection of crystalline schists from Westland Province, on the west side of the South Island. In addition to garnetiferous mica-schists, epidote-amphibole-schists, and other ordinary types, there occurs a series of schistose ultrabasic rocks composed of serpentine, talc, tremolite, calcite, &c. Through the same district there runs also a belt of massive ultrabasic rocks, viz. fresh and altered dunites. The geological relations of these two very interesting groups are only briefly touched in this work, but they are fully discussed in the first Bulletin (new series) of the Geological Survey, already mentioned.

Prof. Sollas's investigations, while devoted mainly to the exhaustive description of one group of rocks, afford also a glimpse of the rich variety of material which New Zealand offers to the petrographer. When we recall further the widely different "petrographical province" of Dunedin, characterised by highly alkaline rock-types, some of which have recently been described by Dr. Marshall, we may expect that a more comprehensive examination of the igneous and crystalline rocks of the colony will result in further important additions to petrological science.

A. H.

[1] "The Rocks of Cape Colville Peninsula, Auckland, New Zealand." By Prof. Sollas, F.R.S.; with an Introduction and Descriptive Notes by Alexander McKay. Vol. ii. Pp. 215; with geological map and 133 photographic plates of rock-sections. (Wellington, N.Z.: J. McKay, 1906.)

UNSOLVED PROBLEMS IN THE DESIGN AND PROPULSION OF SHIPS.[1]

THERE are but few problems in the design of ships, as in most other branches of engineering, that can be exactly or completely solved in the full scientific meaning of the word, and those are of a secondary character. The primary or fundamental problems of safety, strength, speed, and steadiness at sea are far too complicated to bring under anything like general mathematical treatment. The results obtained by the most advanced calculations cannot be applied directly to the real conditions of a ship at sea. After all is said and done, they merely relate to hypothetical cases which are simple in character and are amenable to mathematical treatment. Some of these calculations are very elaborate, and their elaboration may sometimes tend to magnify their importance. The real problem is often very imperfectly dealt with after they are made, and it can only be solved approximately for working purposes by accepting the results of calculation for what they may be really worth, judging of the allowances required for their incompleteness, and using them in a scientific way and a scientific spirit to arrive at safe conclusions. We are obliged to come to a conclusion somehow, because we have to build ships as well as we can, whether we can solve exactly all the problems that arise in their design or not; and we have to take the responsibility of guaranteeing results, however difficult to obtain, or of declining to do so, within the time allotted for the preparation of

[1] Abridged from the "James Forrest" Lecture, delivered before the Institution of Civil Engineers on June 18, by Dr. Francis Elgar, F.R.S.

designs and tenders, which is often very short. This is of the nature of engineering work of all kinds.

The nature of some of the principal problems that arise in the design of ships, and the extent to which their solutions are scientific, empirical, or merely tentative, will be indicated in some degree as I go on. I pass over what I venture to call the secondary problems of mensuration and hydrostatics—which relate to bodies floating in equilibrium in still water, and constitute the bulk of the ship-designer's purely scientific stock-in-trade—and will endeavour to direct attention to some of the fundamental problems of a ship's behaviour at sea. I do not underrate, however, the great importance of those passed over, for it is the results of mathematical and physical research into the still-water properties and conditions of floating bodies which enable us, with the aid of observation and experience, to judge the probable qualities and behaviour of ships at sea. They also furnish the best data for comparisons between ships of varying dimensions and forms.

The class of problems that demand attention first are those which bear the most directly upon safety at sea. These are very general and comprehensive in character, and are impossible of anything like complete solution from the purely scientific side; but they are of vital importance, and solutions of them, which will be upon the right side, have to be found somehow for every ship that is built.

The first in natural order of the problems that relate to safety is the maximum depth of safe loading, or the minimum sea-going freeboard for a ship of any given size or type.

The losses of cargo-steamers, and of lives at sea, became so serious twenty-five to thirty years ago that many attempts were made to get a law passed for limiting depth of loading. The great difficulty and complexity of the problem resisted for a long while all efforts to deal satisfactorily with it. It was considered by many authorities, upon all sides, to be impossible of solution; and yet individual shipowners, or shipping companies, were obliged to regulate the loading of their own ships in some way, and upon some system, or make it the duty of others to do so. It followed, therefore, that if the knowledge and experience of those separately responsible for the loading of the various types of vessels could be brought together and analysed, it ought to be possible to frame rules and tables of freeboard which would embody the results of safe loading, and prevent steamers being sent to sea in a dangerously overladen condition.

The present Board of Trade freeboard rules and tables, which limit, by an Act of Parliament passed in 1890, the depth of loading of British ships, were arrived at in this manner. The first official tables were prepared in 1885 by a committee appointed by Mr. Chamberlain when he was President of the Board of Trade.

The close attention paid during recent years to the protection of openings in the weather-deck, in association with the strict limitation of loading now enforced by the Board of Trade freeboard tables, has resulted in an extraordinary diminution of losses at sea. The effect upon safety of the present regulations, and of the improvement all round in the size, strength, and equipment of ships is shown by the yearly statistics of losses, and it is well that the figures relating to these should be known. In the three calendar years 1881–3 there were 1982 of the British ships registered in the United Kingdom, exclusive of fishing-vessels, lost at sea from all causes—foundering, stranding, collision, and missing—and 5599 lives of crew in them, besides 332 passengers. For the three years ending June 30, 1906, the corresponding figures were 654 ships, 1394 lives of crew, and 133 passengers—and more than 100 of these passengers were lost in the channel steamer *Hilda*, on her passage to St. Malo in November, 1905. The number of lives of crew lost at sea has thus been reduced to one-fourth of what it was twenty-five years ago, while not more than thirty passengers, besides the unfortunate victims of the *Hilda* disaster, lost their lives in all the vessels, large and small, that were lost at sea during the three years ending June 30, 1906.

An important element of safety at sea is the division of the hull into separate water-tight compartments. A collision with another ship may occur, and it is necessary to provide, in such case, against being sent quickly to the bottom. Much attention has been given to this point during recent years, especially in large passenger liners. The number and positions of the water-tight bulkheads in these are often regulated so as to carry out the recommendations of the Board of Trade Bulkheads Committee, presided over by the late Sir E. J. Harland in 1891.

Compliance with the Bulkhead Committee's rules is optional on the part of shipowners, but, although they may be sometimes used as a guide in fixing the position of bulkheads, full compliance with their requirements is by no means general, even in the highest class of steamers.

The next point of vital importance to safety at sea is stability. The stability of a ship when floating in equilibrium in still water is readily calculated, and is represented graphically by curves which show at any angle of inclination what the righting moment is which operates to move her back towards the upright position supposing her to have been forcibly inclined away from it. It is thus determined very completely for the assumed still-water conditions, but the designer, although he is obliged to trust to his judgment for making it satisfactory for sea-going purposes, often knows little of what it may become under working conditions upon a voyage. I made two voyages in a large ocean liner not long ago, the metacentric height of which is about 7 inches when light and 18 inches when filled up with passengers, stores, fresh water, coals, and a homogeneous cargo of such density as completely fills all the cargo spaces and immerses her to her load draught. The metacentric height was 2 feet 2 inches at sailing upon the first voyage; at the middle of the voyage it was 21 inches, and at the end 20 inches. Upon the second voyage the metacentric heights were 2 feet 10 inches at starting, 16 inches in the middle of the voyage, and 20 inches at the end. The irregularities in the metacentric height from day to day were largely due to the manner in which the water-ballast was used. This was the case of an ocean liner, in which the weights carried were about one-half the fixed weight of the hull and machinery. In a large cargo-steamer, where the weights carried may amount to twice the weight of the hull and machinery, it will be seen how much the stability on service depends upon those who regulate the loading, and how little upon the designer.

The ship-designer requires to decide, of course, what metacentric height to give a ship in the circumstances to which his calculations apply, but it is only by comparison with other ships of similar types that have been found satisfactory after passing into the hands of their owners that he can properly fix the exact figure.

The question of stability was raised before the Loadline Committee of 1885 in connection with the regulation of freeboards, and has often been revived since. It has been felt, however, that stability is so intimately related to stowage, and so much in the hands of those who regulate it, that it would be impossible to treat stability satisfactorily as a mere factor of depth of loading. Nothing can make a ship safe if her stability is not secured by proper stowage; but when vessels will obviously admit of being loaded with homogeneous cargoes, so as to have their stability dangerously reduced at sea, the official bodies who assign load-lines should look for proof that the danger is understood, and that proper measures will be taken in regulating the stowage to guard against it. I understand this is the course taken by the Board of Trade and the authorities who assign freeboards when cases of such a nature come before them.

One of the most important elements of safety at sea is structural strength, and there is no more intricate or difficult problem which we have to consider. Mercantile steamers have been made what they are, in respect of design and strength of structure, chiefly by observation and experience of the effects of straining action at sea. The usual calculations of strength of structures do not carry us very far by themselves in shipbuilding, and although much attention has been given to these by ship-designers they cannot be greatly relied upon in practice. As a matter of fact, the arrangement of material shown upon the transverse section of a ship, and the sizes of the various parts, are practically what they have been made from time to time by Lloyd's Register Society. Classification at Lloyd's is so important in the mercantile marine for purposes of insurance that the design of a ship's structure is usually little, if any, more than compliance with Lloyd's rules and tables. These rules have been modified as ships have increased in size and varied in type; and when exceptional ships not directly provided for by the rules have to be classed, the structural design is specially dealt with by Lloyd's; but the governing principle throughout is experience of the behaviour of ships at sea.

Lloyd's Register Society has also done, and is still doing, much in the way of scientific research. It has a highly trained technical staff which has conducted and published some of the most valuable investigations yet made of the structural strength of ships; but the general problem of how to obtain the requisite strength of structure with the minimum weight of material is extremely difficult of approach from the scientific side. The usual calculations of structural strength are based upon still-water conditions. The most important are those which relate to longitudinal strength, because the greatest stresses that can come upon a ship are in the longitudinal direction. In these calculations the structural portion of the hull is regarded as a steel girder supported over the whole of its length by the upward pressure of the water.

In order to approximate somewhat to the worst conditions at sea, the maximum stresses at the top and bottom are calculated for two hypothetical cases of support upon a wave surface. The surface usually taken is that of a trochoidal wave of the same length as the ship, the height of which is one-twentieth of its length. The vessel is first considered in equilibrium upon a wave-crest with her bow and stern in the adjacent hollows, and next to be supported at the ends upon two wave-crests with her midship part in the hollow between them. The whole system of wave-water is supposed, for the purposes of the calculations, to be fixed for the moment, and the ship to be floating upon it in statical equilibrium.

It is not known how nearly the results given by calculations, which rest upon assumptions that differ so widely from the real circumstances, correspond with the maximum stresses really brought to bear at sea, but it is certain that they are often much in excess of the truth. In the new big Cunarders, *Lusitania* and *Mauretania*, the limiting stress accepted by Lloyd's as determined by calculation was 10 tons per square inch for mild steel the ultimate tensile strength of which is 28 to 32 tons per square inch. This gives an apparent factor of safety of only 3.

Many vessels have been running for years in which the figures, obtained by similar calculations, for the maximum stresses would amount to 10 tons per square inch. This must be largely in excess of the truth, and it is impossible to say exactly by how much.

The quantitative values of the calculated stresses are thus extremely doubtful. Even in comparing them with figures obtained in a similar way for other ships, it is necessary to be careful not to press the comparison too far. Attempts have been made to measure the actual stresses at sea upon portions of a ship's structure by means of strain indicators. Extensive experiments were carried out in H.M.S. *Wolf* a few years ago by an Admiralty Committee with Stromeyer's indicators, which gave some interesting results; but very little real progress has yet been made towards a quantitative solution of the strength problem.

The *Great Eastern* proved, by her Atlantic voyages to New York and Quebec, and her subsequent experiences in the trying work of cable-laying in the Atlantic, that she was quite strong enough for anything required of such a ship; and if we compare her structure with that of the standard ship of her dimensions and type to-day, which embodies the results of fifty years' more experience than her designer had at command, it appears very remarkable. Sir W. White came to the conclusion, which I believe is right, that after making full allowance for features of modern designs, that involve additional weight, which the *Great Eastern* did not possess, her structure was lighter than that of the corresponding ship of to-day, although the ship of to-day is built of steel 50 per cent. stronger than the iron plates of the *Great Eastern*, and the riveting of the edges and butts of plating is much more extensive and efficient, and is performed by hydraulic power in those parts where strength is most important.

The difference in principle between the two designs is so great, and the comparison of the weights of material they require is so much in favour of the *Great Eastern*, that there certainly seems to be a case for careful investigation, and for seriously considering whether a radical change in the structural design of large ocean liners might not be made with advantage. Novel structural arrangements are constantly being introduced into the design of cargo-steamers in order to give large open holds and to facilitate stowage. Some of these are now being built of large size and depth, with only a single strongly plated deck at the top, and there seems no reason why this principle should not be applied to large passenger vessels. Any saving of weight thus effected would not only be a saving of cost, but would better enable the difficulties of draught of water in harbour and docks for the largest ships to be overcome.

The problem of speed has always been a very vexed and difficult one, and there is none which has caused more trouble, or given rise to more fallacies in theory and errors in solution. I cannot even direct attention to the numerous theories and the various approximate formulas that have been invented and employed from time to time for explaining and solving the speed problem. These formulas are generally so restricted in their range of application, and require so much knowledge of their limitations and the conditions under which they can alone be relied upon for results that will be approximately near the truth, as to prove dangerous traps to the unwary and ill-informed. The man who can use these intelligently and safely, and with full knowledge of their limitations and their tendencies to error, is able to deal with the speed problem much more completely and effectively—and I shall confine my remarks to the way of doing that.

The practical solution of the speed problem was effected by the late Mr. William Froude when he discovered the law of similitude or comparison which enables the resistance of a model, as ascertained by experiment, to be used for calculating the resistance of another model upon a different scale, or that of a full-sized ship of similar form. His analysis of the separate elements of resistance, showing that the two great ones, friction and wave-making, varied independently of each other, and the latter in a very irregular manner, explained why simple approximate formulas are so untrustworthy.

What is wanted for the practical purposes of a designer is the means of ascertaining the resistance of a ship of given dimensions at any desired speed; and also of readily determining the precise form or degree of fineness of under-water body that would enable the maximum of carrying power to be obtained at a moderate rate of fuel consumption. It is one thing to know exactly what power is required to give a ship of given dimensions and form the speed asked for or promised, and quite another to determine what are the dimensions, form, and degree of fulness that will give the maximum passenger and freight-carrying capacity with moderate engine power and expenditure of fuel.

In order to exhaust the problem of the best form of ship to meet the requirements of any particular trade or service, considerable investigation is required. This can only be made satisfactorily by testing the resistances of models in an experimental tank upon the late Mr. Froude's system.

That method is unfortunately impracticable, however, for ship-designers in this country, because there is no experimental tank here available for general use. The very few that exist belong either to the Admiralty or to private shipbuilders, and are confined exclusively to the work of their respective owners. I have had experiments made occasionally for my own purposes, but had to go abroad for them. The experiments required by Mr. Yarrow for his valuable investigations into the effect of shallow water upon speed were made in the North German Lloyd tank at Bremerhaven, where other experiments have also been made for him. A British shipbuilder can only get such experiments made by setting up an independent establishment for himself or going abroad. Now an experimental tank, with its equipment and a competent staff for working it, is very costly to create and to maintain; and over and above the cost of construction, and of running it, there is the all-important question of the quality of the results it will produce. It is not enough to procure a tank with all its apparatus and appliances and to attach to it a staff of scientific men to run models and take records of their speed and resistance. The work is of so delicate and intricate a nature that the personal qualities of the experimenters count for very much in it. The results obtained by the late Mr. W. Froude and the present Mr. R. E. Froude owe much of their value to the exceptional qualifications of those eminent men for scientific research, especially upon the experimental side. It is the men, and not the tools, who constitute the most important factor in work such as this, and the right men for it are very difficult to obtain and to keep.

An attempt has recently been made to provide an experimental tank at the National Physical Laboratory, to be worked by members of the staff there, at which ship models might be tested for resistance, but up to now this has been without result. There is another way of dealing with the matter, however, and a readier one for the ordinary purposes of the ship-designer, which has been initiated by Mr. R. E. Froude, that promises to overcome the difficulty in a satisfactory manner. Mr. Froude read a paper at the Institution of Naval Architects, three years ago, upon "Some Results of Model Experiments," in which he gave results of a series of general experiments on systematic variations in form of hull, the variations consisting of six different sets of typical lines, varied in proportion by independent variations of length, beam, and draught. The resistance data given by these experiments are published in the paper in such a form that the resistance of a ship of any dimensions, the lines of which are similar to the typical ones, which are also given, can be readily taken out. The types dealt with have block coefficients, or ratios of displaced volume to product of length, breadth, and draught, varying from 0·4865 in the finest to 0·541 in the fullest. Now this covers a very important class of mercantile steamers—that of fast Channel boats—and the designer of such a boat could have nothing better for his speed calculations than the data in this paper. He has only to refer to Mr. Froude's tables and diagrams in order to determine at once the proportions and form that will best suit the circumstances, and to construct the lines of his boat.

If similar data could be obtained for other forms of ships, say for the fast-liner type, with block coefficients varying from about 0·6 to 0·7, the designer of that class of vessels would indeed have cause to be grateful. The best practical solution of this long-vexed problem of the relation of power to speed appears to be an extension of Mr. Froude's system to vessels of the fast-liner type, and to others with which the ship-designer ordinarily has to deal, leaving those of abnormal proportions or form, and also the work of general research, to a public experimental tank—if ever we find enterprise enough among those interested to get one set up in this country.

The resistance of a ship may be estimated to a close degree of accuracy in the manner mentioned, but the determination of the engine power required to overcome that resistance involves the important consideration of screw-propeller efficiency. The problem of the most efficient design of propeller for any given size and form of ship and rate of turning of shaft is as yet far from practical solution. Model experiments have been carried out at Haslar with a large number of propellers of varying pitch, diameter, and developed area, but these model screws have been very small, as the size and speed at which they could be worked were limited by the stresses the experimental mechanism is capable of bearing.

Further advance might be effected by carrying out experiments on a larger scale than those already made, and with stronger appliances than those now used for the purpose in the Admiralty tank. A still more effective means, which I hear is under consideration by Mr. Froude, would be to build an experimental launch for the purpose, to be run in open water and propelled by machinery of considerable power. The propelling machinery could be so arranged that the thrust of the screws and the torque on the shaft would be automatically recorded, as in the case of tank experiments. With such an arrangement screws up to 3 feet in diameter could be experimented with—a great advance on anything that could be hoped for in the tank—and the important problem of propeller efficiency might thus be brought much nearer to a practical solution.

We now come to the greatest problem of all with regard to the propulsion of ships, and that is the form which propelling machinery is likely to take in the immediate future. Already an important change is in progress from the ordinary reciprocating marine engine to the steam turbine, and the question is not only how far that change will extend, but whether the whole of the cumbrous apparatus required for producing steam may not before very long be swept out of mercantile steamers, and the power be obtained from some form of internal-combustion engine. Very few ocean steamers have been fitted with turbine machinery or are being so fitted, and although this may not cause surprise in the case of cargo-boats and other vessels of low or even moderate speeds, it may appear strange that liners of high speeds are still being fitted with reciprocating engines, and that the bold lead given by the Cunard Company with their two fastest new boats and the *Carmania* should not be generally followed.

The chief reason for hesitation to put turbine machinery into ocean liners is the doubt which exists as to coal consumption. The amounts at stake are so large in these costly vessels when experiments with novel propelling machinery are tried that everybody prefers to see someone else make them. The Cunard Company is making the crucial experiment upon the largest scale that is now possible, and everyone interested in progress must wish those responsible for it all the success they hope for and deserve; but the result is to some extent uncertain, and the immediate future of the turbine in fast liners depends greatly upon it.

In warships the consumption of coal has been brought down to about 1·7 lb. per equivalent I.H.P. of reciprocating engines per hour, and the same in mercantile boats of cross-Channel type. That is as good as can be obtained with reciprocating engines in the same classes of vessels, as weight has to be kept down as much as possible in these by shortening the stroke, and using high mean pressures of steam in the cylinders, in order to get all the power that is practicable out of a moderate size and weight of machinery. It pays better, in these cases, to stop somewhat short of the maximum efficiency that is attainable than to carry the additional weight which the increase would involve. In ocean liners the conditions are different, and economy of consumption is there the chief point aimed at. Their consumption with quadruple-expansion engines and a boiler pressure of 210 lb. to 220 lb. per square inch has been brought down to 1·3 lb. of coal per I.H.P. per hour for all purposes. The substitution of turbines for reciprocating engines in ocean vessels depends chiefly upon whether the consumption with turbines can also be brought down to this low figure, and there is no satisfactory evidence that this is now practicable. It appears probable that the marine turbine may ultimately be so improved as to beat the best reciprocating engines in economy of consumption in ocean liners, but no proof is forthcoming that it can yet be relied upon to do it.

The correct measurement of the power given out by turbine machinery is a practical problem of great importance. Considerable success has been achieved with a telephonic recording apparatus for indicating the twist of a shaft over a given length, and thus giving a measure of the torque. The record is not always, however, so definite and accurate as could be desired. A satisfactory solution of this problem is much required by ship designers.

The question of some form of internal-combustion marine engine suitable for large ocean vessels is still about where it was when Mr. Milton's paper was read and discussed here last January, and I do not feel able to add anything with advantage now to that paper and discussion. I will therefore merely enumerate the conditions, most of which were mentioned by Mr. Milton, that must be satisfied by a successful marine engine of any type whatever:—

(1) The engine must be reversible.

(2) It must be capable of being stopped quickly, and of being started quickly either ahead or astern.

(3) It must be capable of being promptly speeded to any desired number of revolutions between dead slow and full speed, and of being kept steadily at the required speed for any length of time. "Dead slow" ought not to be faster than one-quarter of full speed, and should be less in very fast vessels.

(4) It must be capable of running continuously for long distances, with but short intervals between the runs, without risk of stoppage or breakdown.

(5) It must be capable of working well, not only in smooth water, but also in heavy weather in a seaway, where the varying immersion of the propeller causes rapidly changing conditions of resistance.

(6) All working parts must be readily accessible for overhauling, and all wearing surfaces must be capable of being promptly and easily adjusted.

(7) The engine must be economical in fuel, especially at its ordinary working speed.

(8) It must be compact, light in weight, and well balanced so as not to cause vibration.

(9) It must not involve any risk of accumulation of gas in the ship such as could form an explosive mixture.

(10) It is a *sine qua non* that it must be capable of using a fuel the supply of which at moderate price is practically unlimited, and that could be obtained readily in whatever part of the world a ship might happen to be.

Engineers and metallurgists may together succeed in overcoming some day the difficulties of producing large cylinders which will stand the high impulses and great and rapid variations of temperature that occur with internal combustion, but until that is accomplished no great step ahead can be taken. There are no two opinions, however, as to the advantages that would be gained by doing away with the present boilers and their appurtenances, and abolishing with them much of that very arduous and disagreeable class of labour known as marine stoking.

The subject of oil fuel for marine boilers is interesting, but I have no time to say more than that great practical advance has been made with it during the last decade, and a consumption as low as 0·9 lb. per I.H.P. per hour has been regularly realised in mercantile vessels which employ the system of spraying the liquid for combustion by means of hot air. American steamships have used oil fuel largely during the last three years, under a combined system of high and low pressure air respectively for desiccating or pulverising the oil before combustion and for assisting the combustion afterwards. This system has proved highly successful and economical. Vessels of 14,000 tons displacement belonging to the Shell Transport Company have made voyages regularly and successfully from Singapore to this country by the long route of the Cape of Good Hope, and still larger vessels have made equally successful voyages from New York to San Francisco *viâ* Cape Horn.

The securing of all the comfort that is possible for passengers on board ship is a modern idea. Formerly it was thought sufficient to take them safely, and without much regard even to time, to their destination, and very little attention was paid to comfort. Now it is the chief object of the best shipping companies to leave and arrive in port on fixed days, and even at fixed hours, and to make the life of passengers on board ship as comfortable and luxurious as on shore.

Much of the comfort and luxury now in such demand by passengers is provided by those who manage the ships, and not by their designer. There is one very important element of comfort, however, which the designer can do much to supply, and to which increasing attention is given. I refer to steadiness at sea, and freedom from heavy rolling and pitching. But whatever may be done by the designer to give a metacentric height favourable to steadiness, its proper regulation at sea by suitable stowage of cargo and stores in the first instance, and by the judicious use of water ballast afterwards, requires the careful and close attention of the ship's officers if unpleasant rolling is to be kept at a minimum. About 18 inches of metacentric height appears to give a satisfactory combination of resistance to inclination in large ships with a long rolling period.

After reducing the tendency to roll as much as possible by suitable regulation of the metacentric height, the next thing is to increase the resistance to whatever rolling there may be. This is done chiefly by means of bilge keels, which oppose the whole of their surface to the motion of rolling, and are very effective in reducing its extent when they are of sufficient depth. In ships I have known that have been fitted after they were built with bilge keels suitably formed and placed, the extreme angles of rolling have been reduced to one-half. Their steadying effect is now well known and admitted in the mercantile marine.

Other devices have been considered, and some have been tried for still further increasing the resistance to rolling. Sir Philip Watts described in the Transactions of the Institution of Naval Architects for 1883 and 1885 the trials in H.M. ships *Inflexible* and *Edinburgh* of free water in large chambers that extended right across the lower deck, the transverse motion of which, as the ship rolled, was regulated by the shape of the water-chamber and the depth of the water, so that it would operate as a drag or brake upon the rolling motion. The same device was tried in a small passenger ship, the *Ohio*, in 1887, and in the *City of New York* and *City of Paris* in 1889. In the two last-named ships the chamber was upon the orlop deck. These water-chambers appear to have given good results within certain limits of rolling and when the motion of the water in them was well timed, but the action upon the rolling depended very much upon the way in which the water was regulated. Whether it was on account of this or because of the space occupied, or other objections that exist to the free motion from side to side of large quantities of water in a ship, I do not exactly know, but whatever the reason may be the idea has been dropped.

A proposal has recently been made by M. Victor Cremieu, of Paris, to check rolling by means of a heavy pendulum of long period that would oscillate in a closed chamber filled with viscous fluid, and he has contributed a paper upon the subject to the Académie des Sciences. His idea is to make the length of pendulum and its weight such as would give it an angular moment up to possibly one-tenth that of the ship. The clearances between the pendulum and the sides of the chamber, and the degree of viscosity of the liquid—M. Cremieu suggests oil, or a mixture of water and glycerin—would be so arranged as to make the energy of the pendulum most effective in offering resistance to rolling. A simplification of the apparatus is suggested by substituting for the pendulum a weight that would move backwards and forwards upon a curved path in a transverse chamber or tube filled with the viscous liquid. In both cases the principle is that of opposing the rolling of the ship by the statical moment of the oscillating weight, and reducing the energy of motion by generating heat in the fluid through which the weight moves.

Sir John Thornycroft described an automatic steadying apparatus in 1892, which was fitted in his steam-yacht *Cecile* with some success. It consisted of a most ingenious controlling gear which regulated the motion from side to side of a heavy weight in opposition to the rolling motion. It was very cleverly worked out, and destroyed much of the rolling in a vessel of great metacentric height and very short period. This idea also has not been followed up.

A device which appears promising for increasing the resistance to rolling is one that has been ingeniously and effectively worked out by Dr. Otto Schlick, of Hamburg, a very eminent marine engineer. It depends upon gyroscopic action, and its principle was fully described by Dr. Schlick at the Institution of Naval Architects in 1904. This principle appears to deserve serious consideration, and is already ripe for application to the smaller classes of steamers. I am informed that an apparatus is being manufactured for placing in the Hamburg-American Company's passenger-boat *Silvana*, of about 1000 tons, which runs between the Elbe and Heligoland, and that Dr. Schlick is designing a standard gyroscope that will be suitable for boats of about 1200 tons to 2000 tons displacement. This standard gyroscope will be electrically driven, except in cases where there is not a sufficient margin of electric power available in a ship, when it would be driven by a steam turbine. An apparatus for vessels of the displacement named would be applicable to the class of Channel steamers, and we may perhaps see it tried before long in some of them.

What I have said with regard to making ships steady at sea has had reference only to rolling motion; but many persons consider it is not rolling that affects them so much as pitching, or as the skew motion near the ends of a ship that is neither rolling nor pitching, but an unpleasant combination of the two. There is also sometimes a vertical or heaving oscillation when large waves are passing a ship broadside on which may rise to an amplitude of several feet when the wave-period approximates to the period of her own dipping oscillations, but it is probably seldom that the motion from this cause is great. Pitching is often the chief cause of trouble and discomfort, and the motion due to it may be greater and more violent than any other, especially near the ends of the ship. The pitching period is sometimes as short as four seconds, so that there may be three or four pitches to one roll; and the vertical distance moved through near the ends in pitching is very much greater than at the ship's side during a roll.

After all has been done in the way of making the forward transverse sections of a ship such as will best resist plunging into the sea, and by good stowage, there still remains considerable tendency to pitch in certain conditions of sea which cannot be removed. The best way to avoid the ill effects of pitching is to get as near as possible to the axis of rotation, the position of which varies considerably according to the nature and direction of the seas which cause the pitching, but is, on the average, not far from the centre of length. The modern large steamers which have their first-class passenger accommodation upon three or four decks in the middle third of a ship's length are generally found to be the most easy and comfortable at sea. That is no doubt largely because the greatest vertical distance moved through in pitching in the passenger accommodation is only one-third of what it is at the ends of the ship. It is to this concentration of passenger accommodation near the middle of a ship's length that we have to look chiefly for neutralising the trying effects of pitching.

One of the chief causes of discomfort and distress to passengers on shipboard is vibration. This may be due to one or more of several causes, to which much attention has been given during recent years. The effect of reciprocating engines in causing vibration has been investigated by Dr. Schlick, Mr. Yarrow, Mr. Mallock, Prof. Dalby, and others, who have demonstrated the manner in which such engines operate to cause vibration, and how to reduce this effect to a minimum by suitable design, and by balancing the principal working parts. There is little to choose, in a strongly built ship, between modern well-balanced reciprocating engines and steam turbines as regards smoothness of running and absence of unpleasant vibration. Vibration is often due to the action of the propellers, and when these have to run at very high speeds, as with fast-running turbines, a certain amount of vibration is sometimes unavoidable. Apart from the essential conditions of trueness of propeller blades and exact balance of the propellers upon their shafts when turning, there is the action of the ends of the blades upon the water adjacent to the stern-plating where they pass nearest to it in revolving, which causes a hammering effect that is sometimes very great. The vibration and tremor of this plating may be quite local, and may be readily checked by strong bracket frames at the part where it is greatest; or it may be communicated throughout the hull, and set up sympathetic vibrations in large flat areas of plating, such as decks, straight side-plating, bridges, &c. These difficulties can generally be overcome by careful attention to the surfaces that vibrate, and by stiffening or supporting them at a few critical points by struts or brackets. There appears no reason why ships should not now be kept free from all unpleasant vibration, whether as regards the working of the main engines or the action of the propellers.

The tendency to increase the size of ships is strong and continuous. It has long been known, and experience proves that the power required to drive a ton of a ship's displacement at a given speed diminishes, and the working expenses become less per ton all round, with increase of size.

There is a size and speed of ship that is most appropriate and profitable for each line of steamers, or each trade, and it varies greatly in different trades. It is the managers of the various lines who know best what dimensions and speed are likely to be most profitable in their respective trades, and what are the maximum number of passengers and quantities and descriptions of cargo likely to be forthcoming. The approximate size, and the speed, of mercantile steamers depend upon commercial and economic considerations which the ship-designer usually has but an imperfect knowledge of. His part consists in producing a design that will fulfil the necessary conditions of size, draught of water, speed, carrying capacity, and accommodation for passengers in the most efficient manner and at the minimum of cost. There is one point, however, which is so important in considering further large increases of speed in ocean liners generally that I would like to direct attention to it.

Speed is limited in passenger liners, altogether independently of size, by economic considerations. High speed at sea is a costly luxury. It can be obtained by paying for it—up to 25 knots, as we see by the latest Cunard liners—but it has to be paid for by somebody. The extra cost cannot be got out of cargo freight, for as speed is increased the proportion of space available for carrying cargo becomes reduced by the increase of boilers and machinery, and therefore less cargo is carried relatively to the size of the ship. This reaches an extreme limit in the fastest Atlantic liners, the holds of which are as full as they can be stowed of engines, boilers, and coals for the voyage—their speeds only being limited by the impossibility of getting more boilers in—and it is only a few odd spaces which cannot be utilised for other purposes that are available for carrying a little cargo. In these cases cargo is reduced almost to a negligible quantity.

It may be said generally, as regards any line of steamers, that if speeds of more than 12 to 13 knots are desired the extra expenditure involved by such increase must be looked for outside the cargo. This element of earning power does not bear an increase of rate of freight. There are only two sources from which payment of the extra cost of increased speed can come. One is from passengers and the other from a mail subsidy. No mail subsidy that could be proposed would pay more than a small proportion of this extra cost; the greater part of it must come from passengers. What passengers have to pay for high speeds at sea may be seen by the rates charged in the fastest Atlantic steamers. Apart altogether from special cabins, or apartments de luxe, for which almost any prices are paid, the cost of a single first-class passage to New York varies from 22*l.* 10*s.* to 48*l.* 10*s.* for a run of six days, in one of the fastest liners, according to the position of the cabin in the ship and the time of year, or from $1\frac{3}{4}d.$ to nearly 4*d.* per mile travelled. The prices have risen rapidly during recent years as speed has been increased, and passengers across the Atlantic appear to be forthcoming in ever-increasing numbers who are ready to pay them. If that were not the case such high speeds could never have been reached. No great improvement of speed is to be looked for upon the other main lines of ocean traffic, unless some revolutionary change is made in the mode of propulsion which will cut down the cost, or a sufficient number of passengers are found, as in the Atlantic trade, who will pay the higher rates it necessitates.

I have not done anything this evening towards reducing the number of the many and difficult unsolved problems that trouble the mind and tax the skill and judgment of the ship-designer, but if I have succeeded in conveying some idea to you of their nature, and of the interdependence of science and engineering in all wise attempts at their solution, I shall have accomplished my object.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LIVERPOOL.—Mr. J. Mercer has been appointed assistant lecturer in mathematics and Mr. T. E. Gardner assistant lecturer in organic chemistry.

A lectureship in plant physiology has been established in the botanical department through the generosity of Mr. W. P. Hartley (the donor of the laboratories).

Prof. Ronald Ross has been granted leave of absence for five months to enable him to report on measures for the prevention of malaria in Mauritius for the Colonial Office.

Prof. A. W. Mayo Robson will deliver the Mitchell Banks Memorial Lecture during the session 1907–8.

At the graduation ceremony held in St. George's Hall on July 13, *ex officio* degrees were conferred on several members of the staff, including Emeritus Prof. Paul, Dr. E. A. Browne, Prof. Watkinson, Mr. J. Wemyss Anderson, Associate Profs. Aspinall, Brodie, and Bromley Holmes. The dean of the faculty of science (Prof. Harvey-Gibson) presented the following for the degree of Doctor of Science, *honoris causa*, viz.:—Prof. A. R. Forsyth, Prof. F. Gotch, Sir Oliver Lodge, Sir Henry Roscoe, Sir William Ramsay, Sir John Murray, Prof. Ostwald, Prof. Osler, and (*in absentia*) Dr. C. L. A. Laveran. Sir Alexander Kennedy was presented for the degree of Doctor of Engineering by Prof. Watkinson.

MR. ADAM SEDGWICK, F.R.S., has been elected professor of zoology and comparative anatomy in the University of Cambridge in succession to the late Prof. Newton.

SIR DOUGLAS FOX will deliver the inaugural address of a nature-study course for women, to be held at the Horticultural College, Swanley, from Saturday, July 27, to Saturday, August 10.

THE council of the City and Guilds of London Institute has conferred the fellowship of the institute upon Mr. Alfred E. Young, chief surveyor of the Federated Malay States, for his original and valuable work in the trigonometrical survey of the Malay States.

THE annual meeting of the Midland Agricultural and Dairy College will be held on Monday, July 29, at 3.15 p.m., when the report on the year's work will be presented. Sir John Rolleston will address the meeting and present the certificates gained during last session.

AT Bedford College for Women (University of London) the following courses, open free to teachers in secondary and elementary schools in the county of London, will be given in the Michaelmas term:—"Geology for Teachers of Physical Geography," by Dr. C. A. Raisin, beginning Wednesday, October 9, 6 p.m.; "The Organisation of Nature-study Courses in London Schools," by Miss M. R. N. Holmer, beginning Saturday, October 5, 10.30 a.m. Syllabuses of the lectures can be obtained on application to the principal.

THE East London College, which has gradually been evolved from the educational work connected with the "People's Palace," has been accorded the position of a school of the University of London by the Senate of that body. It has long been felt that there should be a school of the University in the eastern half of London; and for this position the East London College is admirably suited. The chemical department, under the charge of Dr. J. T. Hewitt, has done valuable work. Prof. C. H. Lees, F.R.S., was recently appointed head of the physics department, and the laboratories have been re-equipped and extended, while large grants have been made for the mechanical and electrical engineering departments by the Drapers' Company. Much research work has been accomplished under the professor of electrical engineering, Prof. J. T. Morris, and mathematics is showing signs of considerable development at the college.

THE need of reform at Oxford is urged in a letter signed by leading advocates of progressive learning in Wednesday's *Times*. It is pointed out that many members of the University are of the opinion:—(1) That the constitution and machinery of Oxford, both legislative and executive, need revision; (2) that the relations between the University and its colleges, both constitutional and financial, require modification; (3) that a central direction of our studies is required enabling the faculties to have the authority assigned to them in other seats of learning; (4) that the studies of the University are themselves too narrow in scope and that fresh endowments of various branches of study are necessary, and especially that a greater encouragement should be given to research, which at Oxford is probably to a larger extent divorced from teaching than in any other great university. As attempts at reform have again and again proved abortive, the signatories consider that either a fresh commission, or, if that suffices, legislation by the King in Council, as contemplated by the last commission, are the only practical ways of carrying out the necessary changes.

"THE influence of a body of thoroughly competent, zealous, and conscientious teachers in our public elementary schools may plainly be an important factor in our national life," says Sir Robert Morant in his prefatory memorandum to the new regulations (Cd. 3597) for the training of teachers and for the examination of students in training colleges. The general spirit of the regulations is likely to encourage work which will produce teachers of the right kind. The time for training is at best short, and it is important that the essential needs of the future teacher should receive primary consideration; the Board rightly warns college authorities against undertaking any too ambitious scheme. Where a university course of work is permitted to a student training to become an elementary-school teacher, the regulations insist that it shall not be at the sacrifice of some fundamental study or of facilities for obtaining practice in the art of teaching. Following the regulations of previous years, the necessity for inculcating the scientific method in the teaching of all subjects, and not confining such attempts to the instruction in science, is insisted upon. The memorandum admirably urges also that:—"The study of natural objects . . . should be so conducted as to encourage accurate observation and the careful recording of what is seen, with a view to the growth of an independent habit of thought, and the furnishing of a well-defined field of knowledge derived from immediate observation by the scholar." The necessity for lessons in elementary schools designed to familiarise children with the chief laws of health is now recognised by everyone, and great importance is to be attached by the Board to the education in this subject received by the student in training. The regulations as a whole will be read with satisfaction by all who have at heart the educational welfare of elementary-school children.

IN the third of the annual Harvard lectures, delivered at Yale University last April, Prof. A. Lawrence Lowell, the lecturer for the year, dealt with the subject of American universities. These lectures are the outcome of a fund provided by an anonymous Harvard graduate. In his lecture, which is published in *Science* for June 28, Prof. Lowell raises many points of wide interest. After directing attention to the value to civilisation of the great European universities at the close of the Middle Ages, he said that American universities are not only growing larger, but their influence is extending more widely through the body politic. In addition to being training places for young men, the universities in the States aim at diffusing learning directly or indirectly through all strata of society, helping to bring light to anyone who wants it. It is being more fully understood, too, that a university should not be merely a local institution, but one bringing together students from all parts of the country. As Prof. Lowell remarked, "should a general custom arise for every man to attend exclusively the university in his own neighbourhood, it would be a great misfortune to education in America." Referring to the two classes of universities in the United States, Prof. Lowell instituted an interesting comparison between State universities and those not supported by taxation. He comes to a similar conclusion to that arrived at by President Pritchett in the first bulletin of the Carnegie Foundation, that the most vigorous of the State universities have been, as a rule, those which have thrown themselves most completely upon the State and obtained the smallest fraction of their support from private benefaction. We commend this experience to British statesmen in the hope that American experience of the great value to the community of universities endowed from State funds may lead them to emulate American practice in this respect.

THE regulations for secondary schools (Cd. 3592) issued by the Board of Education, to come into force on August 1, mark a distinct advance in educational administration. More elasticity is to be allowed in the Board's dealings with secondary schools; more encouragement is to be given to local initiative and local effort; and certain defective features in older regulations are removed. The additional funds now available for secondary education have made it possible to abolish the limited four years' course on which alone grants have been paid hitherto. A uniform grant will in future be paid on pupils between twelve and eighteen years of age who are following an approved curriculum, and, what is of prime importance from the point of view of the schoolmaster, the term instead of the year is to be taken as the unit in assessing grants. The subjects to be studied and the time to be devoted to each has in the past been prescribed by the Board; for the future the head teacher and local authorities are to be encouraged to submit to the inspector for approval courses of work designed precisely to suit local needs and conditions. In the payment of grants it is interesting to note that the Board is prepared in certain cases to augment the grant due to a school by a further sum towards meeting expense incurred by the school in respect of approved educational experiments. There is ground for hope that this arrangement may hasten the methodical building up of a science of education. This adoption of the plan followed in all other scientific work of basing conclusions upon experiment and observation should lead to many improvements, and it is to be hoped that much thought and the best talent will be devoted to the inauguration of the age of scientifically arranged experiments in education. The regulations will, if sympathetically and intelligently interpreted, greatly improve English secondary education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 6.—"The Mechanical Effects of Canal Rays." By A. A. Campbell **Swinton**. Communicated by Sir William Crookes, F.R.S.

This investigation was undertaken in order to discover whether the so-called canal rays, which at suitable pressures can be seen streaming through the apertures in a perforated kathode, backward away from the anode, share with kathode rays the property of causing small and light mill-wheels to rotate.

Experiments were conducted with tubes in which there were a number of perforations in the kathode, so that the canal rays, after passing through these, impinged on the vanes of a mill-wheel of screw-propeller form, and also with other tubes in which there was only a single perforation in the kathode, and the canal rays acted on the vanes of a mill-wheel of water-wheel type. In both these forms of tubes mill-wheels with vanes of mica, as also with vanes of aluminium, were employed, and in every case rapid rotation of the mill-wheel occurred at suitable pressures in the direction corresponding with that of the canal rays. That this was due to the canal rays was proved by closing the apertures in the kathodes by means of aluminium shutters, when rotation could not be produced, as also by subjecting the tube to a powerful magnetic field so as to deflect to one side all direct or reflected kathode rays.

Experiments were also made with screw-propeller mill-wheels mounted in front of the kathode. In this case, when the vanes of the mill-wheel were of mica, the rotation obtained always corresponded with the result being due to bombardment by kathode rays proceeding away from the kathode; whereas, when the vanes were of aluminium, rotation in the contrary direction invariably took place, this corresponding with the effect being due to canal rays proceeding towards the kathode.

It was further ascertained by means of two thermo-junctions of Constantan copper—one on each side of a mica vane, arranged so as to oppose their E.M.F.'s, and connected to a mirror galvanometer—that under canal-ray bombardment the two sides of a mica vane may acquire differences of temperature amounting to as much as 200° F. It is suggested that the heat insulating properties of mica and the high thermal conductivity of aluminium have probably an important bearing on the divergent results obtained with these two materials, as mentioned above.

Physical Society, June 28.—Prof. W. E. Ayrton, F.R.S., past-president, in the chair.—Experiments on the production of sand ripples on the sea shore: Mrs. **Ayrton**. The sand-ripples of the sea-shore, although parallel to the line of the breakers, are not produced by their edges, but entirely under water. The long see-saw motion of the water produces the ripples, as was observed in 1882 by Mr. A. Hunt. To show this, a glass trough, in which was level sand, covered with a foot of water, was pushed to and fro on rollers. This motion set the water oscillating, and soon small ridges were seen in the sand, at nearly equal distances from one another, growing larger as the oscillation continued. By deduction from the shape of certain sand vortices, it appears that every ridge in otherwise smooth sand must produce two other ridges, one on either side of the first, and that these two give rise to two other ripples, until the whole becomes ripple-marked. Experiments were shown to demonstrate this fact. To show that the vortices generated by the original ripple swept out those succeeding, an artificial barrier was put across the trough to increase the size of the vortices, a handful of moist black pepper was thrown in, and the water oscillated. Immediately the actual process by which the water started and built up the ripples was shown. The way was illustrated in which the ripples on the sea-shore could be imitated, even when the water ran in one direction alone, if only the sand were sloped so that the water ran up it, and if, by means of a paddle, a series of waves were sent along the water in the direction in which it was running. The whole of the sandy shore is ripple-marked when the tide is high, but the waves at the edge of the retreating tide wipe out the ripples except where there is a pool, so that the water is left over the ripples until after the sea has retired. The greatest depth at which ripple-mark can be formed at the bottom of the sea depends on the violence of the motion of the water. At depths of 60 feet or 70 feet the sand is said to have been found ripple-marked. If the depth of a vessel is large compared with its cross-section, a depth of water can be found beneath which no sand-ripples can be formed. On sprinkling a little sand in the water in a small trough, and rocking it to and fro, the sand was seen to assemble quickly in a straight line across its middle. Watching these grains, it was noticed that the result arose from every swing carrying each grain on one side of the centre nearer to the middle than the next swing carried it away again. Each ripple as a whole tends to move towards the middle of the trough. In troughs, the water was kept oscillating so as to form a stationary wave twice the length of the trough, and the place where the heap of sand was formed was where the level of the water changed least, and its horizontal velocity was the greatest. Referring to the Goodwin Sands, Mrs. Ayrton said she found it impossible to avoid recognising the resemblance between the hillocks and hollows of these sands and those made in her glass troughs, and it seemed possible that they were also produced by stationary waves.

CAMBRIDGE.

Philosophical Society, May 20.—Dr. Hobson, president, in the chair.—Exhibition of photomicrographs of wood-sections made by Mr. J. A. Weale: E. R. **Burdon**.—Parasitic trees of southern India: C. A. **Barber**. The sandal tree, *Santalum album*, was discussed; although a large tree with abundant foliage and thick stem, it is dependent for its water and mineral salts on the roots of other plants. The disease called locally "spike" was illustrated by a series of lantern-slides. Four genera of Olacaceæ, Olax, Ximenia, Opilia, and Cansjera, large green climbers or shrubs, are now known to be parasitic like the sandal. The arrangement of the subgroups of the Olacaceæ has been unsatisfactory for a long time. The study of the haustoria endorses the arrangement proposed by Van Tieghem whereby the Opilieæ are transferred to near the Santalaceæ. Special attention was directed to the presence of a complicated gland in the haustoria of *Santalum album* not hitherto described in any root-parasite. The gland is present in most, if not all, of the haustoria dealt with. Diagrams were shown of the haustoria of *Thesium Wightianum*, *Buckleya Quadriala* from Japan, *Osyris arborea*, *Cansjera Rheedii*, *Ximenia americana*, *Olax scandens*, and *Opilia amentacea*.—Physiology of plants in the tropics: A. M. **Smith.** (*a*) The internal temperature of leaves under tropical insolation. In still air, with black bulb vacuum thermometer at from 55° C. to 62° C., the air temperature in the shade being from 25° C. to 28° C., and the humidity about 70 per cent., leaves, whether thick and fleshy, or thinner and coriaceous, or thin and pliable, when placed normal to the sun's rays reach a temperature of 15° C. above that of the surrounding air, a temperature often considered injurious to the functions carried on in the leaf. In the shade the internal temperature varies from 1°·5 below to 4° above that of the surrounding air. Breezes reduced the temperature in the sun by amounts varying from 2° C. to 10° C. An attempt was made to estimate the magnitude cooling due to transpiration. Two leaves with stomata outwards were consistently lower in temperature than two with their stomatal surfaces facing each other. The difference was on an average 2°·5 C. Investigations into leaves with red or red-brown colouring matters showed that the red pigment raised the internal temperature of the leaf from 2° C. to 4° C. above that of similar leaves which were white or nearly so. (*b*) Periodicity of growth in Ceylon. Monthly observations showed that there was the largest amount of young growth in February, the driest month of the year. The theory is suggested that only then is there sufficient transpiration to supply the necessary mineral food for rapid growth. (*c*) Respiration of *Hydrilla verticillata*, a tropical water-weed. Values for the respiration from 7° C. to 50° C. were obtained. These when plotted produce a curve which shows increase of respiration with temperature according to the van 't Hoff rule, the coefficient for an increase of 10° C. being 2·2. The values go on increasing up to the death-point of the plant.—Notes on the parasitism of Botrytis: F. T. **Brooks.** The conidia of Botrytis are unable to infect healthy green leaves, whereas if a young mycelium, nourished saprophytically, is placed upon a normal leaf of such a plant as lettuce, infection rapidly spreads. Experiments have been undertaken to ascertain whether the conidia can cause the infection of weakened plants. Lettuce plants were grown in sterilised sand, watered from time to time with mineral solutions. After these plants had been growing six weeks the conidia had no power of infecting them. By tearing healthy green leaves of lettuce plants direct infection is caused by placing the spores upon the torn portion. The conidia are able also to infect leaves just beginning to turn yellow.—A representation of the exponential function as an infinite product: G. B. **Mathews.**—Some theorems on integral equations: H. **Bateman.**—The theory of the rotation of the plane of polarisation by solutions: Prof. **Thomson.**

EDINBURGH.

Royal Society, June 10.—Dr. Robert Munro, vice-president, in the chair.—A contribution to the craniology of the natives of Borneo, the Malays, the natives of Formosa, and the Tibetans: Sir William **Turner.** The paper contained a full discussion of the characters of the skulls of the various peoples and races inhabiting the regions named; and one fact of general significance was the prevalence of the dolichocephalic type in the people of the interior of Borneo, Sumatra, Formosa, and the Philippines, and in the inhabitants of eastern Tibet, while the brachycephalic skull was characteristic of the sea-board peoples.—The histology of the Ephedreæ, with special reference to the value of histology for systematic purposes: R. J. D. **Graham.** The primary structures of sixteen species or varieties were examined. The outer walls of the epidermal cells have a middle stratum containing crystals of calcium oxalate. Certain papillose epidermal cells act as ocelli, giving the light-spot and image described by Haberlandt for leaves. The cortex is differentiated into an outer palisade and inner lacunar chlorenchyma. The stereon system is built on a girder principle, the outer flanges of each girder hypodermal, the inner pericyclic. Tannin sacs occur in the pith and cortex. The stelar system resembles somewhat that of Equisetæ, but differs in each leaf having two bundles which extend through two stem internodes. The characters which the author regarded as of use in determining subgeneric groups and in distinguishing varieties were the stereon distribution and degree of development, the distribution of the tannin sacs, and partially the character of the stelar system taken at a given level (the second internode below the apical bud).—The variation of Young's modulus under an electric current: H. **Walker.** Wires of steel, iron, platinum, and copper were heated by an electric current of gradually increasing and decreasing strength, and corresponding measurements of Young's modulus made. In steel, iron, and copper there was a decrease in the modulus for weak currents, then an increase to a maximum as the current increased and the temperature rose, finally falling off again as higher temperatures were reached. The return for decreasing currents followed a somewhat similar course, but not coincident with the course of the change during the increasing current. In the case of platinum, there was no initial decrease of the modulus for weak currents.

June 17.—Prof. A. Gray, F.R.S., vice-president, in the chair. At the request of the council, Baron **Kikuchi** gave an address on Japanese national development, more especially with reference to education. The main purpose of the address was to show that the Japanese national spirit, which consisted of intense love of country and reverence for the Imperial house, had remained intact through the long centuries of change and growth, largely influenced as these had been by Chinese literature and philosophy, Indian religion, and in later days by Western learning.

June 24.—Dr. R. H. Traquair, F.R.S., in the chair.—The evolution of the eyebrow region of the forehead, with special reference to the significance of its excessive development in the Neanderthal race: Prof. D. J. **Cunningham.** The usual types of supra-orbital arch in recent man are what are seen in the baboon. The Neanderthal type, which approximates to that of the anthropoid apes, is also to be found, but rarely in a highly developed state, in individual members of certain races such as the Aboriginal Australians and New Guineans, and the Maories. These facts, which have an important bearing on Schwalbe's recent theories, were fully demonstrated from specimens by means of ordinary photographs and Röntgen-ray photographs.—The origin of the amnintic and allantoic fluids: Prof. D. Noel **Paton** and Dr. B. P. **Watson.** Anatomical, pathological, and experimental evidence was brought forward in support of the view that both fluids are derived from the fœtus and not from the maternal blood vessels, and as a result of an extensive series of chemical examination of the fluids it was concluded that they are both derived from the fœtal kidneys.—The application of a differential densimeter to the study of some Mediterranean waters: J. J. **Manley.** The instrument is an adaptation of Hare's hydrostatic method for comparing the densities of two liquids, and was found to be capable of great accuracy. A series of results showed the effects of variation of temperature upon the relative densities of normal sea water.—The electric conductivity and angles of minimum deviation of ninety samples of sea water, and a comparison of these with the salinity and density: Prof. E. G. **Hill.** The purpose of the comparison was to see if these physical properties could be used for measuring the salinity and density. The conclusion was that, though the physical properties were not exact measures of the chlorine in sea waters, the differences between the values for chlorine calculated from the physical constants and that measured by titration were so small that for purposes of oceanography it may be assumed that the values are identical.

July 2.—Prof. Crum Brown, F.R.S., in the chair.—Address on the work at the solar observatory, Kodaikánal, S. India: Prof. C. Michie **Smith.** The address began with a discussion of the conditions which must be fulfilled by a good solar observatory, and of the practical difficulties in the way of realising these conditions. Kodaikánal, from its steady climatic conditions and its elevation, was probably on the whole as well fitted for this kind of work as any other single observatory. In some years there was sunshine for 346 days out of the year. The general arrangements of the observatory were described, but especially the methods for conducting solar research. A series of spectroheliograms showing the distribution of calcium vapour in the sun's atmosphere was exhibited; also photographs of the sun's disc and of the marginal prominences. Some interesting questions were touched upon as to the interpretation of certain markings in the spectroheliograms.

Dublin.

Royal Dublin Society, June 18.—Dr. J. H Pollok in the chair.—Injurious insects and other animals observed in Ireland during the year 1906: Prof. G. H. **Carpenter.** In addition to records of well-known orchard and forest pests, this paper gives an account of damage to barley by maggots of the small fly *Elachyptera cornuta*, and to young cabbage plants by grubs of the beetle *Psylliodes chrysocephala*.—The densities and specific heats of some alloys of iron: W. **Brown.** The author has investigated the change in the densities and specific heats of about fifty different specimens of iron alloyed with various percentages of carbon, manganese, nickel, tungsten, silicon, copper, chromium, cobalt, and aluminium. The more important results are graphed, and the effect of adding 1 per cent. of an element to iron estimated.—A simple and rapid method of determining the rate of absorption of oxygen by polluted waters: Dr. W. E. **Adeney.**

Paris.

Academy of Sciences, July 16.—M. A. Chauveau in the chair.—The structural stability of ethylene oxide: Louis **Henry.**—How far it is possible to justify the use of the arithmetic mean in calculations on the results of observations: Giovanni **Schiaparelli.** A report on the scientific mission to the gardens and public zoological establishments of the United Kingdom, Belgium, and Holland: Gustave **Loisel.**—The method of M. Loewy for the study of divided circles: MM. **Gonnessiat** and **Drayet.** Results show that it would be a mistake to limit the use of the division to entire degrees, leaving the remainder to a simple interpretation; this would involve, even in the mean of six microscope readings, errors of more than $0''\cdot2$.—The surfaces generated by a circular helix: M. **Barré.**—Remarks on the theorem of Jensen: C. **Carathéodory** and L. **Féjer.**—A fundamental problem in the theory of elasticity: A. **Korn.**—The difference of potential in an arc running continuously between metallic electrodes: C. E. **Guye** and L. **Zébrikoff.**—The influence of pressure on the absorption spectra of gases: A. **Dufour.** Some rays remain of the same wave-length under increased pressure; others are displaced in the spectrum towards the red, according as the pressure is increased. All sensible rays under pressure show the Zeeman effect to a very feeble extent.—Synchronising in multiple reflections: Henri **Abraham.**—The valency of the molecule in salt solutions deduced from the dispersive properties of the solution and the theory of electrons: C. **Chéneveau.**—The origin of series spectra: W. **Ritz.**—The scale of molecular weights of gases: Daniel **Berthelot.** The table of molecular weights defined by the densities of gases only represents a system of numbers, and must be fixed by relation to a gas of reference.—Some new characteristic constants of oils: E. **Louise** and E. **Sauvage.** Observation of the miscibility with acetone gives rapid determining characteristics for many oils. The hydrolysis of iron perchloride: G. **Malfitano** and L. **Michel.** It is probable that the hypothetical products $FeCl_2(OH)$ and $FeCl(OH)_2$ exist, while $Fe(OH)_3$ can only exist temporarily in solution.—The production of high temperatures in laboratory research: C. **Chabrié.**—The analysis of selenium hexafluoride: Paul **Lebeau.**—Ethyl hexahydrobenzoylacetate: A. **Wahl** and A. **Meyer.** The action of diazo-chlorides on γ-chloro-aceto-acetic esters: G. **Favrel.**—Triphenylcarbinol. The action of malonic and cyanacetic acids: R. **Fosse.**—The oxidation of oxyhæmoglobin: I. **Szreter.**—A contribution to the study of the brandies of Charentes: E. **Kayser** and A. **Demolon.**—The neo-volcanic formations anterior to the Miocene in the north-west of Sardaigne: M. **Deprat.** The first eruptions were characterised by the emission of rhyolites, but the greater part of the region is marked by the presence of the less acid trachytes and andesites.—An investigation on the foreign fats in lard: Alexandre **Leys.** The fraudulent addition of oil to genuine lard only changes the melting point, without reducing the specific gravity.—The separation of odorous principles in plants: Eug. **Charabot** and G. **Laloue.** Some new observations on the Carboniferous earths of the Sahara: G. B. M. **Flamand.**—Some experiments made with radium bromide: A. **Jost.**

New South Wales.

Royal Society, May 1.—Prof. T. P. Anderson Stuart, president, in the chair.—Presidential address: Prof. T. P. Anderson **Stuart.** The address reviewed matters chiefly connected with medical questions. The true value of the Danysz rabbit experiments was set out, showing that, even if successful to the fullest possible extent, this method of coping with the pest could never be more than auxiliary to the methods already known and in use. The Danysz rat-virus, and its complete failure under the most favourable conditions, in New South Wales, was next described, and the question asked—if this virus has been such a failure what grounds have we for expecting a better result with the rabbit-virus? The bubonic plague was referred to in connection with the recent report of the Indian Plague Commission, and the apathy of the people in Sydney as regards the destruction of rats was condemned. In connection with the death of Schaudinn, the discoverer of the *Spirochaeta pallida*, the long-sought virus of syphilis, the most successful experience of an entirely free and unrestricted treatment of female patients suffering from contagious diseases in Sydney was described. Reference was now made to the opsonin treatment, and to its introduction in Sydney at the Royal Prince Alfred Hospital. The movement for establishing a school of tropical medicine in Australia was fully discussed and commended.

CONTENTS.

THURSDAY, AUGUST 1, 1907.

ZOOLOGY AS AN EXPERIMENTAL SCIENCE.

Experimental Zoology. By Prof. Thomas Hunt Morgan. Pp. xii+454; illustrated. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1907.) Price 12*s.* net.

THIS welcome book may be regarded as a landmark, since it vindicates the position of zoology as an experimental science. It is the modern successor of Semper's famous "Animal Life," and it has had its forerunners in various smaller books, such as De Varigny's "Experimental Evolution." But it is, we believe, the first scholarly and critical review of a large part of the enormous mass of experimental investigations which have been a feature of zoological science during the last fifteen years. Thus it gives the student a comprehensive and orderly survey (with well-selected bibliography) of a widely-scattered scientific literature; it enables him rapidly to bring himself up to date as regards experiments on the influence of environment, on hybridising, on inbreeding, on the conditions of growth and reproduction, on the determination of sex, and so on; and the data are presented in a manner so critical and stimulating that the book is bound to have a great influence in promoting experimental research, which is likely to be prominent in zoological laboratories for centuries to come. For

"while the historical study of zoology must always remain a legitimate field for activity, as human history has been a time-honoured study, there can be little doubt that the more promising and searching method of zoological study in the future will be found in experiment."

To have furthered this movement is sure to be the reward of Prof. Morgan's book, which is at once a careful balance-sheet of past results and an incentive to add to them. The author has made all zoologists his debtors, for the work is uncommonly well done. It is an interesting sign of the times that the author is "professor of experimental zoology" in one of the leading universities of the world.

The author's general point of view is thus indicated:—

"The branches of biology that have made most extensive use of the experimental method are physiology, bacteriology, and physiological chemistry. The zoologist and the embryologist have also to deal with physiological problems, and already the beginning of important experimental work has been carried out in this field; but *the most distinctive problem of zoological work is the change in form that animals undergo, both in the course of their development from the egg (embryology) and in their development in time (evolution).*"

It is to an examination of the experimental study of these changes in form that the book is mainly devoted.

"Experimental morphology would perhaps nearly indicate the field to be examined; but since the line between experimental physiology and experimental morphology is often hard to draw, and since I shall not hesitate at times to enter upon the physiological side of many problems, I have chosen the somewhat broader title of Experimental Zoology to include the subjects to be treated."

The principal topics discussed fall under six headings:—evolution, growth, grafting, the influence of the environment on the life-cycle, the determination of sex, and the secondary sexual characters; and if there are any zoologists who have not been following the recent development of experimental work, they will be amazed at the amount of profoundly interesting work that has already been done. New vistas are being opened out on all sides, and zoology is entering upon a fresh and most promising phase. It should be noted, too, that Prof. Morgan tells his tale in a style so lucid and graphic that even the uninitiated cannot fail to follow what is certainly one of the most fascinating zoological books ever published.

The main theme of the book is "the central problem of morphology—the causes of the changes in form, or at least the determination of the conditions under which changes in form occur." It must be noted, however, as the author is well aware, that the title "Experimental Zoology" is much wider than the contents of the book. He has deliberately refrained from discussing, (*a*) recent experimental work on the psychical aspects of vital phenomena as dealt with in recent works by Loeb, Lloyd Morgan, Jennings, Bethe, and others; (*b*) the study of regeneration (to which he devoted a previous excellent treatise); and (*c*) experimental embryology, which has also received comprehensive treatment in more than one recent volume. The exclusion of the last-named department is especially regrettable, though it is ungracious to say so. For, after all, the central problem of morphology is not so much concerned with the environmental production of modifications, or with the Mendelian phenomena of inheritance, or with the determination of sex, but with *morphogenesis.* Thus a treatise on experimental zoology which refrains from a thorough-going discussion of the fundamental researches of men like Roux and Wilson, Driesch and Herbst, illustrates what the experimentalists have called "autotomy." Let us hope that in subsequent editions the missing parts—absolutely necessary to completeness—may be regenerated. The author's competence to secure this is well known. Of course, a book should always be received with due consideration of the author's aim and prescribed limits, and what we have ventured to say is in no sense intended as criticism, but we may further remark that under the title of "Experimental Zoology" we may justly include not only experiments bearing on morphogenesis (individual and racial), but also those which enable us better to understand the daily life of the fully formed creature. Much of the work that has been done in comparative physiology and psychology is definitely experimental, and just as essential to an all-round outlook as the work of Mendel and de Vries.

It is of course impossible to give a summary of the author's conclusions, but we may give two or three samples.

"The experimental evidence in favour of the inheritance of acquired characters is unsatisfactory." "Used with discretion Mendel's law may still unlock many

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problems, but if attempts are made to force it to interpret cases that do not belong to its proper field of action, especially in regard to dissociation in the germ-cells, harm rather than good may temporarily result." "It seems arbitrary to speak of unit characters as immutable and quite unnecessary to make this idea a cardinal point of the mutation theory." "On the mutation theory selection destroys species; it does not originate them." "Admitting that all eggs and all sperm carry the material basis that can produce both the male and female, the two conditions being mutually exclusive when development occurs, the immediate problem of sex determination resolves itself into a study of the conditions that in each species regulate the development of one or the other sex. It seems not improbable that this regulation is different in different species, and that, therefore, it is futile to search for any principle of sex determination that is universal for all species with separate sexes; for while the fundamental internal change that stands for the male or the female condition may be the same in all unisexual forms, the factor that determines which of the alternate states is realised may be very different in different species."

We may be allowed to compliment the author on his highly successful execution of an arduous task; his workmanship is marked by carefulness, lucidity, and impartiality, by the salt of good-tempered criticism, and by a stimulating suggestion throughout that the whole business of experimental zoology is only beginning.

J. A. T.

BOOKS ON PATENT LAW.

(1) *The Inventors' Guide to Patent Law and the New Practice.* By J. Roberts. Pp. viii+109. (London: John Murray, 1906.) Price 1s. net.

(2) *Notes on the New Practice at the Patent Office.* By J. Roberts. Pp. 32. (London: Eyre and Spottiswoode, Ltd., n.d.) Price 1s.

(1) THIS book is intended to give inventors an explanation of the law and rules relating to the grant of patents in the United Kingdom, and information as to the proper manner of protecting inventions. The book is to a great extent an abstract from the larger book of Mr. Roberts, and, as a guide to the student of patent law, should be extremely useful. In addition to the parts of the book dealing directly with the Patent law, information is given specially for the use of an inventor who is in possession of an invention which he considers it desirable to protect; but the ordinary inventor, even with this book in his hand, would meet with considerable difficulty in drafting his specification in the best manner. It is frequently noticed that inventors themselves are quite unable to appreciate and describe what is the real point of their invention; and this difficulty cannot be met by any guide-book. The various matters dealt with in the book comprise practically the whole of the Patent Law, and the questions of the application for a patent, and procedure at the Patent Office, as well as proceedings for infringement, and other proceedings, on a patent already granted, are all referred to, and references given to other works in which fuller information is contained.

It is, of course, impossible in such a small space—about one hundred pages—to give any full account of the Patent Law, and Mr. Roberts has perhaps given as much information as possible in the space at his disposal. The reader, however, will have to refer to the larger works to get any clear ideas on the different points dealt with. It is impossible, for instance, to explain the difference between patentable and non-patentable inventions in a few pages. Every particular case must be judged on its own merits, and reference to a few cases is of little or no use on the question of sufficiency of invention.

At the end of the book, the Patents Act, 1902, is fully set out, together with the rules made under the Act. An index is given which appears to be fairly complete.

(2) This publication deals shortly with the alterations in the Patent Law introduced by the Patents' Act of 1902, and the rules made under that Act. The effect of the new provisions is given very clearly, and certain controversial points arising on the construction of the Act and the rules are very fully dealt with. Among these may be mentioned the question of post-dating the specification, which is the subject of Rule 5 of 1905. This rule gives the comptroller power to post-date the application, and this power, if used against the applicant, is no doubt outside the scope of the Act of 1902. There is, however, little reason to suppose that the rule will be exercised by the comptroller to the prejudice of an applicant, and in practice the applicant may find the power of the comptroller to post-date extremely convenient in cases where he is unable to meet the Patent Office objections within the prescribed time.

Another point very fully dealt with is the question of the meaning to be given to the words "in part described" in Section 1 of the Act of 1902. The author suggests that these words should be narrowly read, and that the words "partly described" should mean that part of the invention as claimed by the applicant has already been described, so that one claim at least includes what is old. This is a reasonable construction, and is practically that adopted by the Office under the new practice.

The author also deals with the question of the compulsory insertion of references at the instance of the comptroller, and the form in which the reference is to be inserted. In the Act of 1902 there is an ambiguity as to whether the comptroller should have power to settle the form of the reference or whether he could decide only what specifications should be referred to. The view taken by the Patent Office is that they are entitled to settle the form, but the author does not consider they are justified in this interpretation. The official view, however, does not really cause any hardship to the patentee, as if there is really an invention the specification can be quite well drafted in such a way that all necessity for the compulsory reference is avoided, and the officials at the Patent Office always give great facilities for amendment to define the invention more clearly, if there is any invention of any sort contained in the application.

Mr. Roberts's notes give a very clear idea of the changes introduced in the Patent Law by the new Act and rules.

OUR BOOK SHELF.

The Efficient Life. By Dr. Luther H. Gulick. Pp. xvi + 195; illustrated. (London: W. Heinemann, 1907.) Price 3*s.* 6*d.* net.

THE "Efficient Life" is a useful addition to our stock of knowledge of how to maintain health and vigour under the conditions of the present-day manner of living. Man has become in civilised countries mostly a dweller in cities during the past fifty years, and even the small portion of human beings who follow a country life is tinged by the customs and ways of the city.

Dr. Gulick applies himself to telling us how to counteract the deteriorating effects of (town) life, and he has executed his task well. It is an artificial life we lead, and the means of ameliorating its evils must necessarily be by artificial devices. Following the chase and tilling the soil were the natural avocations of man, but these natural means of physical development cannot be followed by the majority nowadays, and we have to be content with bodily exercises, breathing exercises, games, and such substitutes as we can devise to make up for nature's plan. That we are to succeed is another question, but if we are it is by following the ideals and methods Dr. Gulick has set before us. In "The Efficient Life" the author deals with almost every phase of our daily round of life. Food, drink, fatigue, sleep, exercise, baths, and general physiological states are dealt with in an attractive and masterly style which everyone can understand and no one can study without benefit.

Although by neither proverbial quotations nor by lectures can we gain health, yet, by dint of persistence in teaching the public by means of these, great good may come; and in time the thoughts they give rise to come to be, imperceptibly perhaps, part and parcel of our daily life. In this way a better perception of how to counteract the deteriorating effects of the modern manners of living may be attained, and with such efficient guides before us as the one given by Dr. Gulick, the end may be hoped to be attained, gradually, perhaps, yet none the less surely.

Flowers of the Field. By the Rev. C. A. Johns. Revised and edited by C. Elliott. Pp. xx + 316. (London: G. Routledge and Sons, Ltd., 1907.) Price 7*s.* 6*d.* net.

JUDGING by the useful purpose it has served in the past, Johns's "Flowers of the Field" may almost be regarded as a "classic," and now it shares with the classics the fate of being produced in two versions. The opinion is often expressed that the editions bearing a date antecedent to 1899 were excellently adapted to the use of amateur collectors of flowers, but the publishers, considering it advisable to bring the book up to date, remodelled it at the same time. In the version now before us, Mr. Elliott claims that the old form is maintained except for revision, the augmentation of descriptions and the addition of new coloured plates. It is evident that the text has been subjected to considerable revision, especially in the matter of rearranging the species of some of the larger genera, but there are other places where emendations were required, such as assigning Paris to the Trilliaceæ and Acorus to the Orontiaceæ, retaining the genera Apargia and Fedia, and the binomial *Lactuca alpina.* Where the present edition differs from, and falls short of the original work is in the size and number of the cuts, and the elimination of guiding headlines under the large genera. The coloured plates are good reproductions, but in many instances the drawings are scrappy and attenuated. An apparently unimportant and yet important change is the increase in size and bulk of the volume. While recognising that Mr. Elliott has made changes for the better in the text, mistakes such as "aureole," "Hiberna," "paralias," are not infrequent. It is probable that the botanist who possesses an old edition of the book will be satisfied with his antique.

Cyclopedia of American Agriculture. Edited by L. H. Bailey. In four volumes. Vol. I.: Farms. Pp. 618 + xviii. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1907.) Price 21*s.* net.

CYCLOPEDIAS seem to be coming into fashion again; Morton's "Cyclopedia of Agriculture" was one of the best books dealing with the old high farming of the middle of the last century, but it has found no successor, though we understand one is under preparation at the present time, and now we receive the first instalment of a monumental work from America. The book opens with a description of the various districts into which the continent may be divided, the cotton States, the corn-belt States, the arid States, &c., each section being contributed by a writer specially acquainted with the locality in question. Then follows an exceedingly interesting and valuable chapter on planning, stocking, and equipment of various types of farm, with a discussion of the capital required in each case. Other sections of this chapter deal with water supply, farm buildings, and machinery, this latter an article that would be of service to the English farmer. Further chapters treat of soils and fertilisers, and are of a more ordinary text-book type, as again is the last chapter dealing with the atmosphere. This, indeed, is too much a general essay on meteorology, and not at all of a character to draw the farmer to a more intelligent personal study of the weather and the forecasting which is within his own power.

The book is profusely illustrated with wood-cuts and process blocks, but while many of the photographs are of interest and are necessary to develop the text, a great many seem to have been inserted on the general encyclopedia principle of stick a picture in wherever you can, however diagrammatic and irrelevant it may be. Indeed, we are at times reminded of the delicious illustrations to "Wisdom while you wait." While we cannot recommend this cyclopedia to the English farmer, so different is the agriculture of the two countries, it should find its place on the shelves of the teacher, who can obtain from it a good many hints and suggestions for application on this side.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Root Action and Bacteria.

THE experiments mentioned by Mr. F. Fletcher in NATURE of July 18 (p. 270) bear only on the functioning of roots once they have come into activity, not on their passage from the dormant to the active condition.

The probable analogy between the bursting of a dormant root-bud and the germination of a seed has led me to investigate the latter, and some of the results already obtained tally exactly with those obtained with trees. Seeds of *Lolium perenne*, sterilised by carbon disulphide, were planted in soil or sand which had been previously treated in various ways; the water-contents of the medium were the same in every case, and re-inoculation from the air was prevented. All the experiments were made in duplicate, and all the duplicates were remarkably concordant. The results were, that seeds in unheated earth began to germinate on the ninth day, the total germination being 65 per cent.; in earth heated to 250°, 150°, 95°, and 80°, no germination has occurred yet, although twenty-two days have now elapsed, while in the case of earth heated to only 60°, germination did not occur until the eighteenth day, and the total germination is only 30 per cent.

Dr. Russell mentioned that in his experiments he had not noticed any retardation to be produced by the sterilisation of the soil; but in his experiments, as well as in my own with apple trees, no steps were taken to guard against re-inoculation from the air, and such re-inoculation would be very easy in the case of seeds just below the surface of the soil. Another explanation may be that we have not used similar seeds; and from some experiments with mustard, now in progress, it is evident that different seeds behave differently, though the difference may be due to the imperfect sterilisation of the seeds themselves in some cases. Dr. Russell has been good enough to examine my experiments whilst in progress, and I believe that he is satisfied with the results so far as they go at present.

There is not sufficient evidence yet to show whether the bacterial action is a direct one on the seeds, or whether it is an indirect one, as Dr. Russell suggested, modifying some chemical change produced in the soil by heating. The very low temperature (60°) which suffices to affect the germination tells against the view that chemical change is one of the governing factors, as also does the fact that the results obtained with sand are similar to those obtained with earth. On the other hand, it was found that with soil which had been heated to 150°, and then re-inoculated, germination was much retarded, and was very feeble, this pointing to some chemical change which was not counteracted at once by the re-inoculation.

The view that plants in growing charge the soil with something which is toxic to other plants was put forward a year or two ago by Dr. Whitney, but the evidence adduced for it seems to have been very inconclusive; the details of Mr. Fletcher's results in this direction will, therefore, be expected with considerable interest. We have, during the last three years, been endeavouring to ascertain whether any action of this sort can account for the effect of grass on trees, trees having been grown in earth or sand in pots and watered with leachings from earth or sand in which grass was growing. The results, however, have been entirely negative.

SPENCER PICKERING.

Biological Expedition to the Birket el Qurun.

THE lake in the Fayum province of Egypt known as the Birket el Qurun has a very unique interest as the remains of the historic Lake Moeris, which was used as an artificial regulator of the Nile floods by the monarchs of the twelfth dynasty. During the last few years a good deal of attention has been paid to the lake and the whole Fayum province by Captain Lyons, F.R.S., and the staff of the Egyptian Survey Department. No detailed examination of the flora and fauna had, however, been undertaken, and it was to furnish the desired biological information that we were invited to make investigations in the spring of this year.

The Birket el Qurun is now reached with great ease from Cairo, as the railway comes within a distance of some seven miles. Consequently we had no difficulties of transport to contend with, and began our work on the lake shore on March 26. During a period of eight weeks we made careful collections in a number of different parts of the lake, and being provided with a sailing-boat of moderate size we were able to make our way about by water, camping in a number of likely places on the shore sufficiently far apart.

The lake seems to be remarkable more for the quantity of life which its waters contain than for the number of different species inhabiting it. The tow-net revealed immense swarms of entomostraca—mostly copepods and cladocera—as well as vast numbers of rotifers, while the smaller organisms form the food supply of the fish, which occur in astonishing abundance. Although the tow-nettings usually afforded a plentiful supply of the smaller animals, they contained relatively little in the way of phyto-plankton. Algæ were collected from the rocks and stones and the submerged stems of plants, while the larger representatives of the flora were also collected.

The fish were for the most part obtained from the native fishermen, and while some thirteen different species were brought home, the overwhelming majority of those taken belong to two species of the genus Tilapia. A large specimen of the Nile perch (*Lates niloticus*) was examined, which measured 120 cm. and weighed 54 lb. Only a few species of mollusca were found, with but a single lamellibranch amongst them, while the worms are represented by certain small oligochætes. The collection contains a polyzoan with circular lophophore, while among the hydrozoa, Cordylophora is found growing abundantly. Perhaps the most interesting discovery is that of a medusa, and the hydroid form with which it is associated. While the water of the lake is now slightly brackish, there is evidence that it was perfectly fresh even in historic times, so that the existence of this form here is rendered more than ever remarkable. It is a typical anthomedusan, and finds its nearest ally in the marine genus Sarsia. There are several animal groups apparently unrepresented in the Birket el Qurun which we might well expect to find, since they are common in the Nile, with which the lake is in direct communication. Such are the crabs, prawns, and sponges, of which no specimens were procured. Similarly we obtained no examples of argulidæ, leeches, or turbellaria.

In addition to the actual collecting, certain physical observations were made. The seiche alterations in water-level appear to be very slight, as is only natural where the greatest depth is but four or five fathoms. A number of readings of the water temperature were taken which prove unexpectedly interesting. The temperatures recorded show a maximum of 94°·2 in very shallow water close to shore about 2.0 p.m., and a minimum of 54°·8 as a surface reading in the early morning. The difference between the surface temperature and that of the water below may also be very considerable, as was shown in one case by a difference of 8°·8 between the reading at a fathom and that at the surface. All these figures are doubtless explained by the shallowness of the lake and the extremes of heat and cold to which it is often exposed.

W. A. CUNNINGTON, Christ's College, Cambridge.
C. L. BOULENGER, King's College, Cambridge.

The Atomic Weight of Cobalt.

IT has recently been suggested by Prof. J. J. Thomson that the accepted atomic weight of cobalt, namely 59·0, is probably too high, and that the true atomic weight of cobalt is less than that of nickel. Prof. Thomson's suggestion was founded on the results observed with secondary radiation.

We have made an attempt to determine the atomic weight electrolytically by direct comparison with silver, and obtain as the mean of fifteen determinations a value of 57·7 for the atomic weight.

We have also attempted to compare the atomic weights of cobalt and nickel directly with each other and with that of silver by placing three voltameters in series and passing the same current through them, but on account of unexpected difficulties due to secondary reactions in the case of nickel we have not yet obtained satisfactory results.

We hope later to complete the investigation and give details of the experiments.

One of us ("F. H. P.") has also compared the absorption of cobalt and nickel for the β radiation from uranium, and the results indicate a smaller atomic weight for cobalt than for nickel.

F. H. PARKER.
F. PEAKE SEXTON.
Physical Laboratories, Woolwich Polytechnic.

SINGLE-PLATE COLOUR-PHOTOGRAPHY.

THE desire has often been expressed to have a sensitive plate that might be exposed in any ordinary camera, and that would yield what has so often been called a photograph "in natural colours." Such plates are now on the market in France, and will doubtless be obtainable in this country as soon as the makers are able to meet the demand for them. It has taken the enterprising firm of Messrs. Lumière more than three years to perfect their invention and reduce the manufacture of the plates into a system suitable for the factory.

Colours are reproduced by these plates only in that limited sense which applies to all three-colour processes. The natural colours are imitated by tints, which, if successfully produced and seen by a suitable light, are not distinguishable by the unassisted eye from the original. The accuracy of the imitation depends on the choice of the dyes used, and also on the colour-sensitiveness of the emulsion taken in conjunction with the compensating screen used to reduce its excessive sensitiveness to the more refrangible light that characterises all photographic plates.

In the ordinary methods of three-colour photography the three colours are separately photographed, using coloured media that transmit only the light required, a print from each negative is obtained in its proper colour, and the three prints are superposed. For one plate to contain in itself the necessities for such a process it is obvious that its surface must be divided among the three colours, and that the separate patches of each must be so small that, as ordinarily viewed, they are not distinguishable, must be comparable, in fact, to the lines in a wood cut or the dots or grain in a photomechanical print. Further, if the print is to be complete in itself, the three colours must be an integral part of it, and not, as in Prof. Joly's method, form a separate "viewing screen."

The new plates fulfil these conditions. The coloured grained screen that has the three colours in invisibly small patches, forming a tricolour mosaic with the three colours so proportioned that the general impression they give is a neutral grey, is obtained by means of starch granules. These are selected of fairly uniform size, and dyed in separate quantities red, green, and violet. The three lots are mixed as thoroughly as possible, and in such proportions that no colour predominates, and spread upon glass as a film one layer thick. The interstices between the rounded granules are filled up by pressing and more or less crushing the grains, an improvement on the original method of filling them up with a black pigment. This three-coloured irregular mosaic is varnished, and a specially sensitised emulsion is spread on the top of it. The plate is then ready for the camera.

The exposure is made with a suitable colour screen at the lens so that the red, green, and violet lights may act upon the plate in their proper proportions in spite of the want of orthochromatism of the emulsion. The glass side of the plate is presented towards the lens, so that the light that forms the image passes first through the layer of dyed starch granules. The sensitive layer will obviously be affected behind each coloured granule so far as the light from the object is of the same colour as the granule. After development the image has to be reversed, or changed from the negative first produced into a positive. Therefore, instead of fixing in the ordinary way, the metallic silver image is dissolved out by an acid oxidising solution, and the remaining silver bromide is reduced to the metallic state by a developer. Intensification may be necessary. The result is a three-coloured grained transparency in which the truth of the colours depends upon the conditions stated above.

It is obvious that such plates must be comparatively costly, but then only one is required, while some methods of colour photography need six, or even more. The reversal of the image is more trouble than simple fixing, but only one plate has to be dealt with instead of many. The image is granulated, while other methods give results free from grain. It is therefore impossible to say much as to the practical advantage of the method until the plates can be put to actual use. There can, however, be very little doubt that this method, or a modification of it, has a future of usefulness, and no doubt at all as to the ingenuity of the idea that has given rise to it, and the admirable perseverance that has overcome innumerable difficulties in practically working it out.

C. J.

CENTENARY OF THE GEOLOGICAL SOCIETY.

IN September next the Geological Society will celebrate its hundredth birthday. In honour of this interesting occasion preparations have for some time been in progress. Invitations to the celebration have been issued to all the foreign members and foreign correspondents of the society; the various geological surveys all over the globe, universities having chairs of geology or mineralogy, scientific academies, societies and museums at home and abroad have been invited to send delegates to London. The large number of acceptances already received include the names of many of the most distinguished geologists of the present day, both in the old and the new world.

It has been arranged that a series of excursions to various parts of this country shall take place before the centennial meeting, under the conduct of fellows of the society conversant with the geology of the several selected districts. These excursions will begin on Wednesday, September 18, and the excursionists will all be back in London by the evening of September 25. The celebration of the centenary, which will extend over three days, will begin on Thursday, September 26, at 11 o'clock, in the Hall of the Institution of Civil Engineers, when the chair will be taken by Sir Archibald Geikie, who has been elected president of the society for the second time in order that he may preside on this occasion. The foreign members and foreign correspondents, and the delegates from institutions at home and abroad, will then be received by him, and will present their addresses. In the afternoon, at 3 o'clock, in the same hall, the president will deliver an address, while in the evening a banquet will be given by the society to its colonial and foreign guests.

Friday, September 27, will be chiefly devoted to visits to museums, galleries, &c., concluding with an evening reception. On Saturday, September 28, short excursions have been projected to places of geological interest within easy reach of London. On Monday, September 30, the visitors will be divided into two sections, one of which will go to Oxford, the other to Cambridge. It is understood that the universities will confer honorary degrees on some of the more distinguished geologists from beyond the seas, and that college hospitality will be as abundant and hearty as usual, while those visitors who may still have energy enough left for field-work will be taken on geological excursions from both the university towns. This well-planned combination of scientific intercourse with social pleasure can hardly fail to have a lasting effect in forming and confirming friendships by bringing the geologists of many different countries into close personal relations with each other.

DR. AUGUST DUPRÉ, F.R.S.

A WELL-KNOWN name vanishes from the list of living analytical chemists by the death of Dr. A. Dupré, which occurred at Sutton on July 15.

Like a number of chemists whose names readily come to mind—Hoffmann, Schorlemmer, and Lunge, for example—Dupré was born and educated in Germany, but in early manhood crossed the North Sea to seek a sphere for his talents in England. He had studied chemistry under Bunsen; and in 1855, at the age of twenty, he graduated at Heidelberg with the degree of Ph.D. Coming soon afterwards to this country, his first appointment of importance was that of lecturer in chemistry at Westminster Hospital, in 1864. Two years later he became a naturalised British subject. Concurrently with his lecturing duties, Dupré also undertook those of chemical referee to the medical department of the Local Government Board and public analyst for Westminster; and for many years he was chemical adviser to the explosives department of the Home Office, a position which he held at the time of his death.

As might be expected, Dupré's original work in chemistry bore chiefly upon points arising in his own domain of chemical analysis. Some two dozen communications appeared during the period 1876–1902 in the *Analyst*, the Journals of the Chemical Society and the Society of Chemical Industry, and in the Proceedings of the Royal Society. None were epoch-making, but all were useful; their general character will be shown by the titles of a few of them:—"The Composition and Analysis of Butter Fat" (1876); "On Copper in Food" (1877); "The Estimation of Urea by Means of Hypobromite" (1877); "On the Estimation of Dissolved Oxygen in Water" (1885); "Changes in the Proportion of Acid and Sugar present in Grapes during Ripening"; "The Specific Heat and other Physical Characters of Mixtures of Methyl Alcohol and Water"; "The Explosion of Potassium Chlorate by Heat" (1902). In addition, Dupré made various reports upon explosives, and was joint author with Drs. Thudichum and Hake respectively of two well-known treatises, viz., "The Origin, Nature, and Varieties of Wines," and "A Short Manual of Inorganic Chemistry."

The crown of Dupré's professional career was his election to the Royal Society in 1875. To the general public, however, he was probably best known as the analyst whose dangerous duty it was to examine the explosives used in the Fenian scares of a generation ago—notably the one in which nitroglycerine was found in process of manufacture on a large scale at Birmingham in 1883.

Concerned chiefly with the practical applications of chemistry, Dupré was no leader in its philosophy, but his name is honourably associated with the advancement in this country of the profession he adopted when making this country his home.

C. S.

THE BRITISH ASSOCIATION AT LEICESTER.

THIS week sees the opening of the seventy-seventh annual meeting of the British Association, and there are indications that at Leicester the Association will receive the heartiest of welcomes, and that the deliberations of its members will be followed with deep interest by the inhabitants generally. The financial position must be very gratifying to all concerned; the whole of the promised subscriptions are in the bank, and have earned quite a good sum as interest. When it is borne in mind that no public appeal has been made, but that the money has readily been subscribed, this happy result speaks highly as to the generosity of the townspeople and the manner in which they have been approached.

The Mayor (Sir Edward Wood) is most anxious that Leicester should prove its full appreciation of having been chosen as this year's meeting place, and that the many visitors to the ancient borough should carry away a lasting impression of its hospitality and desire for comfort. The local programme tells of Sir Edward Wood's wish to come into as close touch as possible with every visitor, in its record of an evening *fête* in the Abbey Park at which it is anticipated 3000 will be present. His Worship is supplementing this by entertaining on the following evening the officials of the Corporation, the teachers of the town, infirmary nurses, &c., and he has invited the old people from the Trinity Hospital, almshouses, the cripples of the town, and others, to meet him in the same park on the Saturday—all this in commemoration of the visit—which he desires should be a lasting, pleasurable recollection.

We have already spoken of the excellent arrangements made by the local executive, with Mr. Alfred Colson as its chairman, of the sectional meetings, interesting excursions and visits to works planned to add to the enjoyment of the men of science. Each member attending the meeting is to receive a copy of the special edition of "Glimpses of Ancient Leicester," a book written by a Leicester lady, and also to have a capital guide to Leicester and neighbourhood, with a map, prepared under the direction of the publications subcommittee, and containing specially written articles by experts on Charnwood Forest; stone roads, canals, edge-railways, outramways, railways, &c., of Leicestershire; geology; the pre-Cambrian rocks; palæontology, cryptogamic flora of Leicestershire; botany; zoology; entomology; and a bibliography of town and county. These, it is hoped, will serve as memoirs of the town's welcome and a most successful week's work.

The Mayor, Recorder, Town Clerk, and others will attend the official service at St. Martin's Church on the Sunday morning, at which the Bishop of Southwark (Dr. Talbot) will preach. The Bishop of the diocese (Dr. Carr Glynn) is giving an address at St. Peter's Church, and other eminent men are preaching at various churches and chapels, so that the harmony of religion and science will doubtless receive every justice. The leading clubs of the town have freely opened their doors to "temporary members," and the full advantages of golfing and bowls are offered to all interested.

The tramcar service of the town is a most complete one, and every facility for quick transit is given. A favourite daily rendezvous will undoubtedly be the "loggia" erected adjacent to, and connected with, the town museum buildings, and here, if the weather is fine, a quiet rest, a cup of tea, and the music of the band of the Seaforth Highlanders will prove thoroughly enjoyable, and a relief to the heavier work of the sectional meetings.

Next year the Association is to meet at Dublin, and by a happy thought a deputation of the following gentlemen, Sir Howard Grubb, F.R.S., Rev. Dr. W. Delaney, and Prof. W. H. Thompson, will be the guests of the local executive at Leicester.

We hope that in a future issue we may be able to congratulate the Association on the complete success of its last annual meeting, the large attendance of its members, the high quality of the papers read and discussed and lectures given; and Leicester upon its generous welcome and hospitality.

INAUGURAL ADDRESS BY SIR DAVID GILL, K.C.B., LL.D., D.Sc., F.R.S., HON. F.R.S.E., &c., PRESIDENT OF THE ASSOCIATION.

TO-NIGHT, for the first time in its history, the British Association meets in the ancient city of Leicester; and it now becomes my privilege to convey to you, Mr. Mayor, and to the citizens generally, an expression of our thanks for your kind invitation and for the hospitable reception which you have accorded to us.

Here in Leicester and last year in York the Association has followed its usual custom of holding its annual meeting somewhere in the United Kingdom; but in 1905 the meeting was, as you know, held in South Africa. Now, having myself only recently come from the Cape, I wish to take this opportunity of saying that this southern visit of the Association has, in my opinion, been productive of much good: wider interest in science has been created amongst colonists, juster estimates of the country and its problems have been formed on the part of the visitors, and personal friendships and interchange of ideas between thinking men in South Africa and at home have arisen which cannot fail to have a beneficial influence on the social, political, and scientific relations between these colonies and the mother country. We may confidently look for like results from the proposed visit of the Association to Canada in 1909.

One is tempted to take advantage of the wide publicity given to words from this chair to speak at large in the cause of science, to insist upon the necessity for its wider inclusion in the education of our youth and the devotion of a larger measure of the public funds in aid of scientific research; to point to the supreme value of science as a means for the culture of those faculties which in man promote that knowledge which is power; and to show how dependent is the progress of a nation upon its scientific attainment.

But in recent years these truths have been prominently brought before the Association from this chair; they have been exhaustively demonstrated by Sir William Huggins from the chair of the Royal Society, and now a special guild [1] exists for their enforcement upon the mind of the nation.

These considerations appear to warrant me in following the healthy custom of so many previous presidents—viz., of confining their remarks mainly to those departments of science with which the labours of their lives have been chiefly associated.

The Science of Measurement.

Lord Kelvin in 1871 made a statement from the presidential chair of the Association at Edinburgh as follows: "Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than the looking for something new. But nearly all the grandest discoveries of science have been the reward of accurate measurement and patient, long-continued labour in the minute sifting of numerical results."

Besides the instances quoted by Lord Kelvin in support of that statement, we have perhaps as remarkable and typical an exemplification as any in Lord Rayleigh's long-continued work on the density of nitrogen which led him to the discovery of argon. We shall see presently that, true as Lord Kelvin's words are in regard to most fields of science, they are specially applicable as a guide in astronomy.

One of Clerk Maxwell's lectures in the Natural Philosophy Class at Marischall College, Aberdeen, when I was a student under him there, in the year 1859, ran somewhat as follows:—

"A standard, as it is at present understood in English, is not a real standard at all; it is a rod of metal with lines ruled upon it to mark the yard, and it is kept somewhere in the House of Commons. If the House of Commons catches fire there may be an end of your standard. A copy of a standard can never be a real standard, because all the work of human hands is liable to error. Besides, will your so-called standard remain of a constant length? It certainly will change by temperature, it probably will change by age (that is, by the rearrangement or settling down of its component molecules), and I am not sure if it does not change according to the azimuth in which it is used. At all events, you must see that it is a very impractical standard—impractical because, if, for example, any one of you went to Mars or Jupiter, and the people there asked you what was your standard of measure, you could not tell them, you could not reproduce it, and you would feel very foolish. Whereas, if you told any capable physicist in Mars or Jupiter that you used some natural invariable standard, such as the wave-length of the D-line of sodium vapour, he would be able to reproduce your yard or your inch, provided that you could tell him how many of such wave-lengths there were in your yard or your inch, and your standard would be available anywhere in the universe where sodium is found."

That was the whimsical way in which Clerk Maxwell used to impress great principles upon us. We all laughed before we understood; then some of us understood and remembered.

Now the scientific world has practically adopted Maxwell's form of natural standard. It is true that it names that standard the metre; but that standard is not one-millionth of the earth's quadrant in length, as it was intended to be; it is merely a certain piece of metal approximately of that length.

It is true that the length of that piece of metal has been reproduced with more precision, and is known with higher accuracy in terms of many secondary standards, than is the length of any other standard in the world; but it is, after all, liable to destruction and to possible secular change of length. For these reasons it cannot be scientifically described otherwise than as a piece of metal whose length at 0° C. at the epoch A.D. 1906 is =1,553,164 times the wave-length of the red line of the spectrum of cadmium when the latter is observed in dry air at the temperature of 15° C. of the normal hydrogen-scale at a pressure of 760 mm. of mercury at 0° C.

This determination, recently made by methods based on the interference of light-waves and carried out by MM. Perot and Fabry at the International Bureau of Weights and Measures, constitutes a real advance in scientific metrology. The result appears to be reliable within one ten-millionth part of the metre.

The length of the metre, in terms of the wave-length of the red line in the spectrum of cadmium, had been determined in 1892 by Michelson's method, with a mean result in almost exact accordance with that just quoted for the comparisons of 1906; but this agreement (within one part in ten millions) is due in some degree to chance, as the uncertainty of the earlier determination was probably ten times greater than the difference between the two independent results of 1892 and 1906.

We owe to M. Guillaume, of the same International Bureau, the discovery of the remarkable properties of the alloys of nickel and steel, and from the point of view of exact measurement the specially valuable discovery of the properties of that alloy which we now call "invar." He has developed methods for treatment of wires made from this alloy which render more permanent the arrangement of their constituent molecules. Thus these wires, with their attached scales, may, for considerable periods of time and under circumstances of careful treatment, be regarded as nearly invariable standards. With proper precautions, we have found at the Cape of Good Hope that these wires can be used for the measurement of base lines of the highest geodetic precision with all the accuracy attainable by the older and most costly forms of apparatus; whilst with the new apparatus a base of 20 kilometres can be measured in less time and for less cost than one of a single kilometre with the older forms of measurement.

The Great African Arc of Meridian.

In connection with the progress of geodesy, time only permits me to say a few words about the Great African arc on the 30th meridian, which it is a dream of my life to see completed.

The gap in the arc between the Limpopo and the previously executed triangulation in Rhodesia, which I reported to the Association at the Johannesburg meeting in 1905, has now been filled up. My own efforts, at

[1] The British Science Guild.

6000 miles distance, had failed to obtain the necessary funds, but at Sir George Darwin's instance contributions were obtained from this Association, from the Royal Society and others, to the extent of half the estimated cost; the remaining half was met by the British South Africa Company. But for Darwin's happy intervention, which enabled me to secure the services of Captain Gordon and his party before the Transvaal Survey Organisation was entirely broken up, this serious gap in the great work would probably have long remained; for it is one thing to add to an existing undertaking of the kind, it is quite another to create a new organisation for a limited piece of work.

Since then Colonel (now Sir William) Morris has brought to a conclusion the reductions of the geodetic survey of the Transvaal and Orange River Colony, and his report is now in my hands for publication.

Dr. Rubin, under my direction, at the cost of the British South Africa Company, has carried the arc of meridian northwards to S. latitude 9° 42′, so that we have now continuous triangulation from Cape L'Agulhas to within fifty miles of the southern end of Lake Tanganyika; that is to say, a continuous geodetic survey extending over twenty-five degrees of latitude.

It happens that, for the adjustment of the international boundary between the British Protectorate and the Congo Free State, a topographic survey is at the present moment being executed northward along the 30th meridian from the northern border of German East Africa. A proposal on the part of the Royal Society, the Royal Geographical Society, the British Association, and the Royal Astronomical Society has been made to strengthen this work by carrying a geodetic triangulation through it along the 30th Meridian, and thus adding $2\frac{1}{2}°$ to the African arc. These Societies together guarantee 1000*l.* towards the cost of the work, and ask for a like sum from Government to complete the estimated cost. The topographic survey will serve as the necessary reconnaissance. The topographic work will be completed by the end of January next, and the four following months offer the best season of the year for geodetic operations in these regions.

There is a staff of skilled officers and men on the spot sufficient to complete the work within the period mentioned, and the Intercolonial Council of the Transvaal and Orange River Colony most generously offers to lend the necessary geodetic instruments. The work will have to be done sooner or later, but if another expedition has to be organised for the purpose the work will then cost from twice to three times the present amount. One cannot therefore doubt that His Majesty's Government will take advantage of the present offer and opportunity to vote the small sum required. This done, we cannot doubt that the German Government will complete the chain along the eastern side of Lake Tanganyika, which lies entirely within their territory. Indeed, it is no secret that the Berlin Academy of Sciences has already prepared the necessary estimates with a view to recommending action on the part of its Government.

Captain Lyons, who is at the head of the survey of Egypt, assures me that preliminary operations towards carrying the arc southwards from Alexandria have been begun, and we have perfect confidence that in his energetic hands the work will be prosecuted with vigour. In any case the completion of the African arc will rest largely in his hands. That arc, if ever my dream is realised, will extend from Cape L'Agulhas to Cairo, thence round the eastern shore of the Mediterranean and the islands of Greece, and there meet the triangulation of Greece itself, the latter being already connected with Struve's great arc, which terminates at the North Cape in lat. 70° N. This will constitute an arc of 105° in length—the longest arc of meridian that is measurable on the earth's surface.

The Solar Parallax.

Much progress has been made in the exact measurement of the great fundamental unit of astronomy—the solar parallax.

Early in 1877 I ventured to predict [1] that we should not arrive at any certainty as to the true value of the solar parallax from observations of transits of Venus, but that the modern heliometer applied to the measurement of angular distances between stars and the star-like images of minor planets would yield results of far higher precision.

[1] "The Determination of the Solar Parallax," the *Observatory*, vol. i. p. 280.

The results of the observations of the minor planets Iris, Victoria, and Sappho at their favourable oppositions in the years 1888 and 1889, which were made with the cooperation of the chief heliometer and meridian observatories, fully justified this prediction.[1] The Sun's distance is now almost certainly known within one-thousandth part of its amount. The same series of observations also yielded a very trustworthy determination of the mass of the Moon.

The more recently discovered planet Eros, which in 1900 approached the Earth within one-third of the mean distance of the Sun, afforded a most unexpected and welcome opportunity for re-determining the solar parallax—an opportunity which was largely taken advantage of by the principal observatories of the northern hemisphere. Unfortunately the high northern declination of the planet prevented its observation at the Cape and other southern observatories. So far as the results have been reduced and published [2] they give an almost exact accordance with the value of the solar parallax derived from the heliometer observations of the minor planets, Iris, Victoria, and Sappho in 1888 and 1889.

But in 1931 Eros will approach the Earth within one-sixth part of the Sun's mean distance, and the fault will rest with astronomers of that day if they do not succeed in determining the solar parallax within one ten-thousandth part of its amount.

To some of us who struggled so hard to arrive at a tenth part of this accuracy under the less favourable geometrical conditions that were available before the discovery of Eros, how enviable seems the opportunity!

And yet, if we come to think of it rightly, the true opportunity and the chief responsibility is ours, for *now* and not twenty years hence is the time to begin our preparation; *now* is the time to study the origin of those systematic errors which undoubtedly attach to some of our photographic processes; and then we ought to construct telescopes specially designed for the work. These telescopes should be applied to the charting of the stars near the path which Eros will describe at its opposition in 1931, and the resulting star-coordinates derived from the plates photographed by the different telescopes should be rigorously inter-compared. Then, if all the telescopes give identical results for the star-places, we can be certain that they will record without systematic error the position of Eros. If they do not give identical results, the source of the errors must be traced.

The planet will describe such a long path in the sky during the opposition of 1931 that it is already time to begin the meridian observations which are necessary to determine the places of the stars that are to be used for determining the constants of the plates. It is desirable, therefore, that some agreement should be come to with respect to selection of these reference-stars, in order that all the principal meridian observatories in the world may take part in observing them.

I venture to suggest that a Congress of Astronomers should assemble in 1908 to consider what steps should be taken with reference to the important opposition of Eros in 1931.

The Stellar Universe.

And now to pass from consideration of the dimensions of our solar system to the study of the stars, or other suns, that surround us.

To the lay mind it is difficult to convey a due appreciation of the value and importance of star-catalogues of precision. As a rule such catalogues have nothing whatever to do with discovery in the ordinary sense of the word, for the existence of the stars which they contain is generally well known beforehand; and yet such catalogues are, in reality, by far the most valuable assets of astronomical research.

If it be desired to demarcate a boundary on the Earth's

[1] "Annals of the Cape Observatory," vol. vi., part vi., p. 29.
[2] Monthly Notices R.A.S., Hinks vol lxiv. p. 725; Christie, vol. lxvii. p. 382.

surface by astronomical methods, or to fix the position of any object in the heavens, it is to the accurate star-catalogue that we must refer for the necessary data. In that case the stars may be said to resemble the trigonometrical points of a survey, and we are only concerned to know from accurate catalogues their positions in the heavens at the epoch of observation. But in another and grander sense the stars are not mere landmarks, for each has its own apparent motion in the heavens which may be due in part to the absolute motion of the star itself in space, or in part to the motion of the solar system by which our point of view of surrounding stars is changed.

If we desire to determine these motions and to ascertain something of the general conditions which produce them, if we would learn something of the dynamical conditions of the universe and something of the velocity and direction of our own solar system through space, it is to the accurate star catalogues of widely separated epochs that we must turn for a chief part of the requisite data.

The value of a star-catalogue of precision for present purposes of cosmic research varies as the square of its age and the square of its accuracy. We cannot alter the epoch of our observations, but we can increase their value fourfold by doubling their accuracy. Hence it is that many of our greater astronomers have devoted their lives chiefly to the accumulation of meridian observations of high precision, holding the view that to advance such precision is the most valuable service to science they could undertake, and comforted in their unselfish and laborious work only by the consciousness that they are preparing a solid foundation on which future astronomers may safely raise the superstructure of sound knowledge.

But since the extension of our knowledge of the system of the universe depends quite as much on past as on future research, it may be well, before determining upon a programme for the future, to consider briefly the record of meridian observation in the past for both hemispheres.

The Comparative State of Astronomy in the Northern and Southern Hemispheres.

It seems probable that the first express reference to southern constellations in known literature occurs in the Book of Job (ix. 9): "Which maketh Arcturus, Orion, and Pleiades, and the chambers of the south." Schiaparelli's strongly supported conjecture is that the expression "chambers of the south," taken with its context, signifies the brilliant stellar region from Canopus to α Centauri, which includes the Southern Cross and coincides with the most brilliant portion of the Milky Way.

About the year 750 B.C. (the probable date of the Book of Job) all these stars culminated at altitudes between 5° and 16° when viewed from the latitude of Judæa; but now, owing to precessional change, they can only be seen in a like striking manner from a latitude about 12° further south.

The words of Dante have unquestionably originated the wonderful net of poetic fancy that has been woven about the asterism, which we now call Crux.

> To the right hand I turned, and fixed my mind
> On the other pole attentive, where I saw
> Four stars ne'er seen before save by the ken
> Of our first parents—Heaven of their rays
> Seemed joyous. O thou northern site! bereft
> Indeed, and widowed, since of these deprived.

All the commentators agree that Dante here referred to the stars of the Southern Cross.

Had Dante any imperfect knowledge of the existence of these stars, any tradition of their visibility from European latitudes in remote centuries, so that he might poetically term them the stars of our first parents?

Ptolemy catalogues them as 31, 32, 33, and 34 Centauri, and they are clearly marked on the Borgian globe described by Assemanus in 1790. This globe was constructed by an Arabian in Egypt: it bears the date 622 Hegira, corresponding with A.D. 1225, and it is possible that Dante may have seen it.

Amerigo Vespucci, as he sailed in tropical seas, apparently recognised in what we now call Crux the four luminous stars of Dante; for in 1501 he claimed to be the first European to have looked upon the stars of our first parents. His fellow-voyager, Andrea Corsali, wrote about the same time to Giuliano di Medici describing "the marvellous cross, the most glorious of all the celestial signs."

Thus much mysticism and romance have been woven about this constellation, with the result that exaggerated notions of its brilliancy have been formed, and to most persons its first appearance, when viewed in southern latitudes, is disappointing.

To those, however, who view it at upper culmination for the first time from a latitude a little south of the Canary Islands, and who at the same time make unconsciously a mental allowance for the absorption of light to which one is accustomed in the less clear skies of Northern Europe, the sight of the upright cross, standing as if fixed to the horizon, is a most impressive one. I at least found it so on my first voyage to the Cape of Good Hope. But how much more strongly must it have appealed to the mystic and superstitious minds of the early navigators as they entered the unexplored seas of the northern tropic! To them it must have appeared the revered image of the Cross pointing the way on their southward course—a symbol and sign of Hope and Faith on their entry to the unknown.

The first general knowledge of the brighter stars of the southern hemisphere we owe to Frederick de Hautman, who commanded a fleet sent by the Dutch Government in 1595 to the Far East for the purpose of exploring Japan. Hautman was wrecked and taken prisoner at Sumatra, and whilst there he studied the language of the natives and made observations of the positions and magnitudes of the fixed stars of the southern hemisphere.[1]

Our distinguished countryman Halley visited St. Helena in 1677 for the purpose of cataloguing the stars of the southern hemisphere. He selected a station now marked Halley's Mount on the Admiralty chart of the island. I have visited the site, and the foundations of the observatory still remain. Halley's observations were much hindered by cloud. On his return to England, Halley in 1679 published his "Catalogus Stellarum Australium," containing the magnitudes, latitudes, and longitudes of 341 stars, which, with the exception of seven, all belonged to the southern hemisphere.

But the first permanently valuable astronomical work in the southern hemisphere was done in 1751–2 by the Abbé de Lacaille. He selected the Cape of Good Hope as the scene of his labours, because it was then perhaps the only spot in the world situated in a considerable southern latitude which an unprotected astronomer could visit in safety, and where the necessary aid of trained artisans to erect his observatory could be obtained. Lacaille received a cordial welcome at the hands of the Dutch governor Tulbagh: he erected his observatory in Cape Town, made a catalogue of nearly 10,000 stars, observed the opposition of Mars, and measured a short arc of meridian all in the course of a single year. Through his labours the Cape of Good Hope became the birthplace of astronomy and geodesy in the southern hemisphere.

Bradley was laying the foundations of exact astronomy in the northern hemisphere at the time when Lacaille laboured at the Cape. But Bradley had superior instruments to those of Lacaille and much longer time at his disposal. Bradley's work is now the basis on which the fair superstructure of modern astronomy of precision rests. His labours were continued by his successors at Greenwich and by a long series of illustrious men like Piazzi, Groombridge, Bessel, Struve, and Argelander. But in the southern hemisphere the history of astronomy is a blank for seventy years from the days of Lacaille.

We owe to the establishment of the Royal Observatory at the Cape by an Order in Council of 1820 the first successful step towards the foundation of astronomy of high precision in the southern hemisphere.

Time does not permit me to trace in detail the labours of astronomers in the southern hemisphere down to the present day; and this is the less necessary because in a recent Presidential Address to the South African Philosophical Society[2] I have given in great part that history

[1] The resulting catalogue of 304 stars is printed as an appendix to Hautman's "Vocabulary of the Malay Language," published at Amsterdam in 1603.

[2] Trans. South African Phil. Soc., vol. xiv., part 2.

in considerable detail. But I have not there made adequate reference to the labours of Dr. Gould and Dr. Thome at Cordoba. To their labours, combined with the work done under Stone at the Cape, we owe the fact that for the epoch 1875 the meridian sidereal astronomy of the southern hemisphere is nearly as well provided for as that of the northern. The point I wish to make is that the facts of exact sidereal astronomy in the southern hemisphere may be regarded as dating nearly a hundred years behind those of the northern hemisphere.

The Constitution of the Universe.

It was not until 1718, when Edmund Halley, afterwards Astronomer Royal of England, read a paper before the Royal Society,[1] entitled "Considerations on the Change of the Latitudes of Some of the Principal Fixt Stars," that any definite facts were known about the constitution of the universe. In that paper Halley, who had been investigating the precession of the equinoxes, says: "But while I was upon this enquiry I was surprized to find the Latitudes of three of the principal Stars in heaven directly to contradict the supposed greater obliquity of the Ecliptick, which seems confirmed by the Latitudes of most of the rest."

This is the first mention in history of an observed change in the relative position of the so-called fixed stars—the first recognition of what we now call "proper motion."

Tobias Mayer, in 1760, seems to have been the first to recognise that if our Sun, like other stars, has motion in space, that motion must produce apparent motion amongst the surrounding stars; for in a paper to the Göttingen Academy of Sciences he writes: "If the Sun, and with it the planets and the Earth which we inhabit, tended to move directly towards some point in the heavens, all the stars scattered in that region would seem to gradually move apart from each other, whilst those in the opposite quarter would mutually approach each other. In the same manner one who walks in the forest sees the trees which are before him separate, and those that he leaves behind approach each other." No statement of the matter could be more clear; but Mayer, with the meagre data at his disposal, came to the conclusion that "the motions of the stars are not governed by the above or any other common law, but belong to the stars themselves."

Sir William Herschel, in 1783, made the first attempt to apply, with any measure of success, Mayer's principle to a determination of the direction and amount of the solar motion in space.[2] He derived, as well as he could from existing data, the proper motions of fourteen stars, and arrived by estimation at the conclusion that the Sun's motion in space is nearly in the direction of the star λ Herculis, and that 80 per cent. of the apparent motions of the fourteen stars in question could be assigned to this common origin.

This conclusion rests in reality upon a very slight basis, but the researches of subsequent astronomers show that it was an amazing accidental approach to truth—indeed, a closer approximation than Herschel's subsequent determinations of 1805 and 1806, which rested on wider and better data.[3]

Consider for a moment the conditions of the problem. If all the stars except our Sun were at rest in space, then, in accordance with Mayer's statement, just quoted, all the stars would have apparent motions on great circles of the sphere away from the apex and towards the antapex of the solar motion. That is to say, if the position of each star of which the apparent motion is known was plotted on the surface of a sphere and a line with an arrow-head drawn through each star showing the direction of its motion on the sphere, then it should be possible to find a point on the sphere such that a great circle drawn from this point through any star would coincide with the line of direction of that star's proper motion. The arrow-heads would all point to that intersection of the great circles which is the antapex of the solar motion, and the other point of intersection of the great circles would be the apex

[1] Phil. Trans., 1718, p. 738.
[2] *Ibid.*, 1783, p. 247.
[3] *Ibid.*, 1805, p. 233; 1806, p. 205.

that is to say, the direction of the Sun's motion in space.

But as the apparent stellar motions are small and only determinable with a considerable percentage of error, it would be impossible to find any point on the sphere such that every great circle passing through it and any particular star, would in every case be coincident with the observed direction of motion of that star.

Such discordances would, on our original assumption, be due to errors of observation, but in reality much larger discordances will occur, which are due to the fact that the other stars (or suns) have independent motions of their own in space. This at once creates a new difficulty, viz., that of defining an absolute locus in space. The human mind may exhaust itself in the effort, but it can never solve the problem. We can imagine, for example, the position of the Sun at any moment to be defined with reference to any number of surrounding stars, but by no effort of imagination can we devise means of defining the *absolute* position of a body in space without reference to surrounding material objects. If, therefore, the referring objects have unknown motions of their own, the rigour of the definition is lost.

What we call the observed proper motion of a star has three possible sources of origin:—

(1) The *parallactic motion*, or the effect of our Sun's motion through space, whereby our point of view of surrounding celestial objects is changed.

(2) The *peculiar* or particular motion of the star, *i.e.*, its own *absolute* motion in space.

(3) That part of the observed or tabular motion which is due to inevitable error of observation.

In all discussions of the solar motion in space, from that of Herschel down till a recent date, it has been assumed that the peculiar motions of the stars are arranged at random, and may therefore be considered zero in the mean of a considerable number of them. It is then possible to find such a value for the Precession, and such a common apex for the solar motion as shall leave the residual peculiar motions of the stars under discussion to be in the mean=zero. That is to say, we refer the motion of the Sun in space to the centre of gravity of all the stars considered in the discussion, and regard that centre of gravity as immovable in space.

In order to proceed rigorously, and especially to determine the amount as well as the direction of the Sun's motion in space, we ought to know the parallax of every star employed in the discussion, as well as its proper motion. In the absence of such data it has been usual to start from some such assumption as the following: the stars of a particular magnitude are roughly at the same distance; those of different classes of magnitude may be derived from the hypothesis that on the average they have all equal absolute luminosity.

The assumption is not a legitimate one—

(1) Because of the extreme difference in the absolute luminosity of stars.

(2) Because it implies that the average absolute luminosity of stars is the same in all regions of space.

The investigation has been carried out by many successive astronomers on these lines with fairly accordant results as to the position of the solar apex, but with very unsatisfactory results as to the distances of the fixed stars.[1] In order to judge how far the magnitude (or brightness) of a star is an index of its probable distance, we must have evidence from direct determinations of stellar parallax.

Stellar Parallax.

To extend exact measurement from our own solar system to that of other suns and other systems may be regarded as the supreme achievement of practical astronomy. So great are the difficulties of the problem, so minute the

[1] Argelander, *Mém. présentés à l'Acad. Imp des Sciences St. Pétersbourg*, tome iii.; Lundahl, *Astron. Nachrichten*, 398, 200; Argelander, *Astron. Nachrichten*, 398, 210; Otto Struve, *Mém. Acad. des Sciences St. Pétersbourg*, vi^e série, Math. et Phys., tome iii., p. 17; Galloway, Phil. Trans., 1847, p. 79; Mädler, Dorpat Observations, vol. xiv., and *Ast. Nach.*, 566, 213; Airy, Mem. R.A.S., vol. xxviii., p. 143; Dunkin, Mem. R.A.S., vol. xxvii., p. 19; Stone, Monthly Notices R.A.S., vol. xxiv., p. 36; De Ball, Inaugural Dissertation, Bonn, 1877; Rancken, *Astron. Nachrichten*, 2482, 149; Bischoff, Inaugural Dissertation, Bonn, 1884; Ludwig Struve, *Mém. Acad. St. Pétersbourg*, vii^e série, tome xxxv., No. 3.

angles involved, that it is but in comparatively recent years that any approximate estimate could be formed of the true parallax of any fixed star. Bradley felt sure that if the star γ Draconis had a parallax of $1''$ he would have detected it. Henderson by "the minute sifting of the numerical results" of his own meridian observations of α Centauri, made at the Cape of Good Hope in 1832–3, first obtained certain evidence of the measurable parallax of any fixed star. He was favoured in this discovery by the fact that the object he selected happened to be, so far as we yet know, the nearest sun to our own. Shortly afterwards Struve obtained evidence of a measurable parallax for α Lyræ and Bessel for 61 Cygni. Astronomers hailed with delight this bursting of the constraints which our imperfect means imposed on research. But for the great purposes of cosmical astronomy what we are chiefly concerned to know is not what is the parallax of this or that particular star, but rather what is the average parallax of a star having a particular magnitude and proper motion. The prospect of even an ultimate approximate attainment of this knowledge seemed remote. The star α Lyræ is one of the brightest in the heavens; the star 61 Cygni one that had the largest proper motion known at the time; whilst α_2 Centauri is not only a very bright star, but it has also a large proper motion. The parallaxes of these stars must therefore in all probability be large compared with the parallax of the average star; but yet to determine them with approximate accuracy long series of observations by the greatest astronomers and with the finest instruments of the day seemed necessary.

Subsequently various astronomers investigated the parallaxes of other stars having large proper motions, but it was only in 1881, at the Cape of Good Hope, that general research on stellar parallax was instituted.[1] Subsequently at Yale and at the Cape of Good Hope the work was continued on cosmical lines with larger and improved heliometers.[2] By the introduction of the reversing prism and by other practical refinements the possibilities of systematic error were eliminated, and the accidental errors of observation reduced within very small limits.

These researches brought to light the immense diversity in the absolute luminosity and velocity of motion of different stars. Take the following by way of example:—

Our nearest neighbour amongst the stars, α_2 Centauri, has a parallax of $0''\cdot 76$, or is distant about $4\frac{1}{3}$ light-years. Its mass is independently known to be almost exactly equal to that of our Sun; and its spectrum being also identical with that of our Sun, we may reasonably assume that it appears to us of the same magnitude as would our Sun if removed to the distance of α_2 Centauri.

But the average star of the same apparent magnitude as α_2 Centauri was found to have a parallax of only $0''\cdot 10$, so that either α_2 Centauri or our Sun, if removed to a distance equal to that of the average fixed star of the first magnitude, would appear to us but little brighter than a star of the fifth magnitude.

Again, there is a star of only $8\frac{1}{2}$ magnitude[3] which has the remarkable annual proper motion of nearly $8\frac{3}{4}$ seconds of arc—one of those so-called runaway stars—which moves with a velocity of 80 miles per second at right angles to the line of sight (we do not know with what velocity in the line of sight). It is at about the same distance from us as Sirius, but it emits but one ten-thousandth part of the light energy of that brilliant star. Sirius itself emits about thirty times the light-energy of our Sun, but it in turn sinks into insignificance when compared with the giant Canopus, which emits at least 10,000 times the light-energy of our Sun.

Truly "one star differs from another star in glory." Proper motion rather than apparent brightness is the truer indication of a star's probable proximity to the Sun. Every star of considerable proper motion yet examined has proved to have a measurable parallax.

This fact at once suggests the idea, Why should not the apparent parallactic motions of the stars, as produced by the Sun's motion in space, be utilised as a means of determining stellar parallax?

1 Mem. R.A.S., vol. xlviii.
2 Annals of the Cape Observatory, vol. viii., part ii., and Trans. Astron. Observatory of Yale University, vol. i.
3 Gould's Zones, Vh 243

Secular Parallactic Motion of Stars.

The strength of such determinations, unlike those made by the method of annual parallax, would grow with time. It is true that the process cannot be applied to the determination of the parallax of individual stars, because the peculiar motion of a particular star cannot be separated from that part of its apparent motion which is due to parallactic displacement. But what we specially want is not to ascertain the parallax of the individual star, but the mean parallax of a particular group or class of stars, and for this research the method is specially applicable, provided we may assume that the peculiar motions are distributed at random, so that they have no systematic tendency in any direction; in other words, that the centre of gravity of any extensive group of stars will remain fixed in space.

This assumption is, of course, but a working hypothesis, and one which from the paper on star-streaming communicated by Prof. Kapteyn of Groningen to the Johannesburg meeting of the Association two years ago we already know to be inexact.[1] Kapteyn's results were quite recently confirmed in a remarkable way by Eddington,[2] using independent material discussed by a new and elegant method. Both results showed that, at least for extensive parts of space, there are a nearly equal number of stars moving in exactly opposite directions. The assumption, then, that the mean of the peculiar motions is zero may, at least for these parts of space, be still regarded as a good working hypothesis.

Adopting an approximate position of the apex of the solar motion, Kapteyn resolved the observed proper motions of the Bradley stars into two components, viz., one in the plane of the great circle passing through the star and the apex, the other at right angles to that plane.[3] The former component obviously includes the whole of the parallactic motion; the latter is independent of it, and is due entirely to the real motions of the stars themselves. From the former the mean parallactic motion of the group is derived, and from the combination of the two components, the relation of velocity of the Sun's motion to that of the mean velocity of the stars of the group.

As the distance of any group of stars found by the parallactic motion is expressed as a unit in terms of the Sun's yearly motion through space, the velocity of this motion is one of the fundamental quantities to be determined. If the mean parallax of any sufficiently extensive group or class of stars was known we should have at once means for a direct determination of the velocity of the Sun's motion in space; or if, on the other hand, we can by independent methods determine the Sun's velocity, then the mean parallax of any group of stars can be determined.

Determination of Stellar Motion in the Line of Sight.

Science owes to Sir William Huggins the application of Doppler's principle to the determination of the velocity of star-motion in the line of light. The method is now so well known, and such an admirable account of its theory and practical development was given by its distinguished inventor from this Chair at the Cardiff meeting in 1891, that further mention of that part of the matter seems unnecessary.

The Velocity of the Sun's Motion in Space.

If by this method the velocities in the line of sight of a sufficient number of stars situated near the apex and antapex of the solar motion could be determined, so that in the mean it could be assumed that their peculiar motions would disappear, we have at once a direct determination of the required velocity of the Sun's motion.

The material for this determination is gradually accumulating, and indeed much of it, already accumulated, is not yet published. But even with the comparatively scant material available, it now seems almost certain that the true value of the Sun's velocity lies between 18 and 20 kilometres per second;[4] or, if we adopt the mean value, 19 kilometres per second, this would correspond almost

1 Rep. Brit. Assoc., 1905, p. 257.
2 Monthly Notices R.A.S., vol. lxvii., p. 34.
3 Publications Astron. Laboratory, Groningen, Nos. 7 and 9.
4 Kapteyn, *Ast. Nach.*, No. 3487, p. 108; and Campbell, *Astrophys. Journ.*, xiii., p. 80.

exactly with a yearly motion of the Sun through space equal to four times the distance of the Sun from the Earth.

Thus the Sun's yearly motion being four times the Sun's distance, the parallactic motion of stars in which this motion is unforeshortened must be four times their parallax. How this number varies with the amount of foreshortening is of course readily calculated. The point is that from the mean parallactic motion of a group of stars we are now enabled to derive at once its mean parallax.

This research has been carried out by Kapteyn for stars of different magnitudes. It leads to the result that the parallax of stars differing *five* magnitudes does *not* differ in the proportion of one to ten, as would follow from the supposition of equal luminosity of stars throughout the universe, but only in the proportion of about one to five.[1]

The same method cannot be applied to groups of stars of different proper motions, and it is only by a somewhat indirect proof, and by calling in the aid of such trustworthy results of direct parallax determination as we possess, that the variation of parallax with proper motion could be satisfactorily dealt with.

The Mean Parallaxes of Stars of Different Magnitude and Proper Motion.

As a final result Kapteyn derived an empirical formula giving the average parallax for stars of different spectral types, and of any given magnitude and proper motion. This formula was published at Groningen in 1901.[2] Within the past few months the results of researches on stellar parallax, made under the direction of Dr. Elkin, at the Astronomical Observatory of Yale University, during the past thirteen years,[3] have been published, and they afford a most crucial and entirely independent check on the soundness of Kapteyn's conclusions.

In considering the comparison between the more or less theoretical results of Kapteyn and the practical determinations of Yale, we have to remember that Kapteyn's tables refer only to the means of groups of a large number of stars having on the average a specified magnitude and proper motion, whilst the latter are direct determinations affected by the accidental errors of the separate determinations and by such uncertainty as attaches to the unknown parallaxes of the comparison stars—parallaxes which we have supplied from Kapteyn's general tables.

The Yale results consist of the determination of the parallax of 173 stars, of which only ten had been previously known to Kapteyn and had been utilised by him. Dividing these results into groups we get the following comparison :—

Comparison Groups arranged in order of Proper Motion.

No. of stars	Proper Motion	Magnitude	Parallax		Yale—Kapteyn
			Yale	Kapteyn	
	"		"	"	"
21	0·14	3·8	0·028	0·026	+0·002
39	0·49	6·3	0·042	0·055	−0·013
45	0·59	6·7	0·068	0·060	+0·008
46	0·77	6·5	0·047	0·074	−0·027
22	1·50	6·2	0·118	0·124	−0·006

Groups arranged in order of Magnitude.

No. of stars	Proper Motion	Magnitude	Parallax		Yale—Kapteyn
			Yale	Kapteyn	
	"		"	"	"
10	0·61	0·8	0·103	0·110	−0·007
29	0·53	3·8	0·076	0·075	+0·001
33	0·63	5·6	0·064	0·070	0·006
34	0·73	6·7	0·055	0·070	−0·017
31	0·68	7·6	0·025	0·061	−0·036
36	0·80	8·3	0·056	0·062	−0·006

[1] *Astron. Nachrichten*, No. 3487, table iii.; and *Ast. Journ.*, p. 566.
[2] Publications Astron. Laboratory, Groningen, No. 8, p. 24.
[3] Trans. Astron. Observatory of Yale Univ., vol. ii., part i.

—	No. of stars	Proper Motion	Magnitude	Parallax		Yale—Kapteyn
				Yale	Kapteyn	
		"		"	"	"
Spectral Type I.	13	0·42	4·0	0·076	0·076	0·000
,, ,, II.	81	0·67	5·3	0·067	0·074	−0·007

These results agree in a surprisingly satisfactory way, having regard to the comparatively small number of stars in each group and the great range of parallax which we know to exist amongst individual stars having the same magnitude and proper motion. In the mean perhaps the tabular parallaxes are in a minute degree too large, but we have unquestionable proof from this comparison that our knowledge of stellar distances now rests on a solid foundation.

The Distribution of Varieties of Luminosity of Stars.

But, besides the mean parallax of stars of a particular magnitude and proper motion, it is essential that we should know approximately what percentage of the stars of such a group have twice, three times, &c., the mean parallax of the group, and what percentage only one-half, one-third of that parallax, and so on. In principle, at least, this frequency-law may be obtained by means of the directly determined parallaxes. For the stars of which we have trustworthy determinations we can compare these true parallaxes with the *mean* parallax of stars having corresponding magnitude and proper motion, and this comparison will lead to a knowledge of the frequency-law required. It is true that, owing to the scarcity of material at present available, the determination of the frequency-law is not so strong as may be desirable, but further improvement is simply a question of time and the augmentation of parallax-determination.

Adopting provisionally the frequency-law found in this way by Kapteyn,[1] we can localise all the stars in space down to about the ninth magnitude.

Take, for example, the stars of magnitude 5·5 to 6·5. There are about 4800 of these stars in the whole sky. According to Auwers-Bradley, about $9\frac{1}{2}$ per cent. of these stars, or some 460 in all, have proper motions between 0″·04 and 0″·05. Now, according to Kapteyn's empiric formula, the satisfactory agreement of which with the Yale results has just been shown, the mean parallax of such stars is almost exactly 0″·01. Further, according to his frequency-law, 29 per cent. of the stars have parallaxes between the *mean* value and double the mean value; 6 per cent. have parallaxes between twice and three times the mean value; $1\frac{1}{2}$ per cent. between three and four times the mean value. Therefore of our 460 stars 133 will have parallaxes between 0″·01 and 0″·02, twenty-eight between 0″·02 and 0″·03, seven between 0″·03 and 0″·04, and so on.

Localising in the same way the stars of the sixth magnitude having other proper motions, and then treating the stars of the first magnitude, second magnitude, third magnitude, and so on to the ninth magnitude in the same way, we finally locate all these stars in space.[2]

It is true we have not localised the individual stars, but we know approximately and within certain limits of magnitude the number of stars at each distance from the Sun.

Thus the apparent brightness and the distance being known we have the means of determining the light-energy or absolute *luminosity* of the stars, *provided it can be assumed that light does not suffer any extinction in its passage through interstellar space.*

On this assumption Kapteyn was led to the following results, viz., that within a sphere the radius of which is 560 light-years (a distance which corresponds with that of the average star of the ninth magnitude) there will be found :—

[1] Publications Astron. Lab., Groningen No. 8, p. 23.
[2] *Ibid.*, No. 11, table i.

1 star giving from	100,000	to 10,000		Times the light of our Sun
26 stars ,,	10,000	,, 1,000		
1,300 ,, ,,	1,000	,, 100		
22,000 ,, ,,	100	,, 10		
140,000 ,, ,,	10	,, 1		
430,000 ,, ,,	1	,, 0·1		
650,000 ,, ,,	0·1	,, 0·01		

The Density of Stellar Distribution at Different Distances from our Sun.

Consider, lastly, the distribution of stellar density, that is, the number of stars contained in the unit of volume.

We cannot determine *absolute* star-density, because, for example, some of the stars which we know from their measured parallaxes to be comparatively near to us are in themselves so little luminous that if removed to even a few light-years greater distance they would appear fainter than the ninth magnitude, and so fall below the magnitude at which our data at present stop.

But if we assume that intrinsically faint and bright stars are distributed in the same proportion in space, it will be evident that the comparative richness of stars in any part of the system will be the same as the comparative richness of the same part of the system in stars of a particular luminosity. Therefore, as we have already found the arrangement in space of the stars of different degrees of luminosity, and consequently their number at different distances from the Sun, we must also be able to determine their relative density for these different distances.

Kapteyn finds in this way that, starting from the Sun, the star-density (*i.e.*, the number of stars per unit volume of space) is pretty constant until we reach a distance of some 200 light-years. Thence the density gradually diminishes until, at about 2500 light-years, it is only about *one-fifth* of the density in the neighbourhood of the Sun.[1] This conclusion must, however, be regarded as uncertain until we have by independent means been enabled to estimate the absorption of light in its course through interstellar space, and obtained proof that the ratio of intrinsically faint to bright stars is constant throughout the universe.

Thus far Kapteyn's researches deal with the stellar universe as a whole; the results, therefore, represent only the *mean* conditions of the system. The further development of our knowledge demands a like study applied to the several portions of the universe separately. This will require much more extensive material than we at present possess.

As a first further approximation the investigation will have to be applied separately to the Milky Way and the parts of the sky of higher galactic latitude. The velocity and direction of the Sun's motion in space may certainly be treated as constants for many centuries to come, and these constants may be separately determined from groups of stars of various regions, various magnitudes, various proper motions, and various spectral types. If these constants as thus separately determined are different, the differences which are not attributable to errors of observation must be due to a common velocity or direction of motion of the group or class of star to which the Sun's velocity or direction is referred. Thus, for example, the Sun's velocity as determined by spectroscopic observations of motion in the line of sight appears to be sensibly smaller than that derived from fainter stars. The explanation appears to be that certain of the brighter stars form part of a cluster or group of which the Sun is a member, and these stars tend to some extent to travel together. For these researches the existing material, especially that of the determination of velocities in the line of sight, is far too scanty.

Kapteyn has found that stars the proper motions of which exceed $0''{\cdot}05$ are not more numerous in the Milky Way than in other parts of the sky;[2] in other words, if only the stars having proper motions of $0''{\cdot}05$ or upwards were mapped there would be no aggregation of stars showing the existence of a Milky Way.

The proper motions of stars of the second spectral type are, as a rule, considerably larger than those of the first type; but Kapteyn comes to the conclusion that this difference does not mean a real difference of velocity, but only that the second-type stars have a smaller luminosity, the mean difference between the two types amounting to $2\frac{1}{2}$ magnitudes.[1]

[1] Publications Astron. Lab., Groningen, No. 11.
[2] Vers. Kn. Akad. Amsterdam, January, 1893.

The Future Course of Research.

In the last Address delivered from this Chair on an astronomical subject, Sir William Huggins, in 1891, dealt so fully with the chemistry of the stars that it seemed fitting on the present occasion to consider more especially the problem of their motion and distribution in space, as it is in this direction that the most striking advances in our knowledge have recently been made. It is true that since 1891 great advances have also been made in our detailed knowledge of the chemistry of the Sun and stars. The methods of astro-spectrography have been greatly improved, the precision of the determination of motion in the line of sight greatly enhanced, and many discoveries made of those close double stars, ordinarily termed spectroscopic doubles, the study of which seems destined to throw illustrative light upon the probable history of the development of systems from the original nebular condition to that of more permanent systems.

But the limitations of available time prevent me from entering more fully into this tempting field, more especially as it seems desirable, in the light of what has been said, to indicate the directions in which some of the astronomical work of the future may be most properly systematised. There are two aspects from which this question may be viewed. The first is the more or less immediate extension of knowledge or discovery; the second the fulfilment of our duty, as astronomers, to future generations. These two aspects should never be entirely separated. The first, as it opens out new vistas of research and improved methods of work, must often serve as a guide to the objects of the second. But the second is to the astronomer the supreme duty, viz., to secure for future generations those data the value of which grows by time.

As the result of the Congress of Astronomers held at Paris in 1887 some sixteen of the principal observatories in the world are engaged, as is well known, in the laborious task, not only of photographing the heavens, but of measuring these photographs and publishing the *relative* positions of the stars on the plates down to the eleventh magnitude. A century hence this great work will have to be repeated, and then, if we of the present day have done our duty thoroughly, our successors will have the data for an infinitely more complete and thorough discussion of the motions of the sidereal system than any that can be attempted to-day. But there is still needed the accurate meridian observation of some eight or ten stars on each photographic plate, so as to permit the conversion of the *relative* star-places on the plate into *absolute* star-places in the heavens. It is true that some of the astronomers have already made these observations for the reference stars of the zones which they have undertaken. But this seems to be hardly enough. In order to coordinate these zones, as well as to give an accuracy to the *absolute* positions of the reference stars corresponding with that of the *relative* positions, it is desirable that this should be done for *all* the reference stars in the sky by several observatories. The observations of well-distributed stars by Kustner at Bonn present an admirable instance of the manner in which the work should be done. Several observatories in each hemisphere should devote themselves to this work, employing the same or other equally efficient means for the elimination of sources of systematic error depending on magnitude, &c., and it is of far more importance that we should have, say, two or three observations of each star at three different observatories than two or three times as many observations of each star made at a single observatory.

The southern cannot boast of a richness of instrumental and personal equipment comparable with that of the northern hemisphere, and consequently one welcomes with enthusiasm the proposal on the part of the Carnegie Institute to establish a meridian observatory in a suitable

[1] *Ibid.*, April, 1892.

situation in the southern hemisphere. Such an observatory, energetically worked, with due attention to all necessary precautions for the exclusion of systematic errors, would conduce more than anything else to remedy in some degree that want of balance of astronomical effort in the two hemispheres to which allusion has already been made. But in designing the programme of the work it should be borne in mind that the proper duty of the meridian instrument in the present day is no longer to determine the positions of all stars down to a given order of magnitude, but to determine the positions of stars which are geometrically best situated and of the most suitable magnitude for measurement on photographic plates, and to connect these with the fundamental stars. For this purpose the working list of such an observatory should include only the fundamental stars and the stars which have been used as reference stars for the photographic plates.

Such a task undertaken by the Carnegie Observatory, by the Cape, and if possible by another observatory in the southern hemisphere, and by three observatories in the northern, would be regarded by astronomers of the future as the most valuable contribution that could be made to astronomy of the present day. Taken in conjunction with the astrographic survey of the heavens now so far advanced, it is an opportunity that if lost can never be made good; a work that would grow in value year by year as time rolls on, and one that would ever be remembered with gratitude by the astronomers of the future.

But for the solution of the riddle of the universe much more is required. Besides the proper motions, which would be derived from the data just described, we need for an ideal solution to know the velocity in the line of sight, the parallax, the magnitude, and the spectrum-type of every star.

The broad distinction between these latter data and the determination of proper motion is this, that whereas the observations for proper motion increase in value as the square of their age, those for velocity in the line of sight, parallax, magnitude, and type of spectrum may, for the broader purposes of cosmical research, be made at any time without loss of value. We should therefore be most careful not to sacrifice the interests of the future by immediate neglect of the former for the latter lines of research. The point is that those observatories which undertake this meridian work should set about it with the least possible delay, and prosecute the programme to the end with all possible zeal. Three observatories in each hemisphere should be sufficient; the quality of the work should be of the best, and quality should not be sacrificed for speed of work.

But the sole prosecution of routine labour, however high the ultimate object, would hardly be a healthy condition for the astronomy of the immediate future. The sense of progress is essential to healthy growth, the desire to know must in some measure be gratified. We have to test the work that we have done in order to be sure that we are working on the right lines, and new facts, new discoveries, are the best incentives to work.

For these reasons Kapteyn, in consultation with his colleagues in different parts of the world, has proposed a scheme of research which is designed to afford within a comparatively limited time a great augmentation of our knowledge. The principle on which his programme is based is that adequate data as to the proper motions, parallaxes, magnitudes, and the type of spectrum of stars situated in limited but symmetrically distributed areas of the sky, will suffice to determine many of the broader facts of the constitution of the universe. His proposals and methods are known to astronomers and need not therefore be here repeated. In all respects save one these proposals are practical and adequate, and the required cooperation may be said to be already secured—the exception is that of the determination of motion in the line of sight.

All present experience goes to show that there is no known satisfactory method of determining radial velocity of stars by wholesale methods, but that such velocities must be determined star by star. For the fainter stars huge telescopes and spectroscopes of comparatively low dispersion must be employed. On this account there is great need in both hemispheres of a huge reflecting telescope—six to eight feet in aperture—devoted almost exclusively to this research. Such a telescope is already in preparation at Mount Wilson, in America, for use in the northern hemisphere. Let us hope that Prof. Pickering's appeal for a large reflector to be mounted in the southern hemisphere will meet with an adequate response, and that it will be devoted there to this all-important work.

Conclusion.

The ancient philosophers were confident in the adequacy of their intellectual powers alone to determine the laws of human thought and regulate the actions of their fellow men, and they did not hesitate to employ the same unsupported means for the solution of the riddle of the universe. Every school of philosophy was agreed that some object which they could see was a fixed centre of the universe, and the battle was fought as to what that centre was. The absence of facts, their entire ignorance of methods of exact measurement, did not daunt them, and the question furnished them a subject of dispute and fruitless occupation for twenty-five centuries.

But astronomers now recognise that Bradley's meridian observations at Greenwich, made only 150 years ago, have contributed more to the advancement of sidereal astronomy than all the speculations of preceding centuries. They have learned the lesson that human knowledge in the slowly developing phenomena of sidereal astronomy must be content to progress by the accumulating labours of successive generations of men; that progress will be measured for generations yet to come more by the amount of honest, well-directed, and systematically discussed observation than by the most brilliant speculation; and that, in observation, concentrated systematic effort on a special thoughtfully selected problem will be of more avail than the most brilliant but disconnected work.

By these means we shall learn more and more of the wonders that surround us, and recognise our limitations when measurement and facts fail us.

Huggins's spectroscope has shown that many nebulæ are not stars at all; that many well-condensed nebulæ, as well as vast patches of nebulous light in the sky, are but inchoate masses of luminous gas. Evidence upon evidence has accumulated to show that such nebulæ consist of the matter out of which stars (*i.e.*, suns) have been and are being evolved. The different types of star spectra form such a complete and gradual sequence (from simple spectra resembling those of nebulæ onwards through types of gradually increasing complexity) as to suggest that we have before us, written in the cryptograms of these spectra, the complete story of the evolution of suns from the inchoate nebula onwards to the most active sun (like our own), and then downward to the almost heatless and invisible ball. The period during which human life has existed on our globe is probably too short—even if our first parents had begun the work—to afford observational proof of such a cycle of change in any particular star; but the fact of such evolution, with the evidence before us, can hardly be doubted. I most fully believe that, when the modifications of terrestrial spectra under sufficiently varied conditions of temperature, pressure, and environment have been further studied, this conclusion will be greatly strengthened. But in this study we must have regard also to the spectra of the stars themselves. The stars are the crucibles of the Creator. There we see matter under conditions of temperature and pressure and environment, the variety of which we cannot hope to emulate in our laboratories, and on a scale of magnitude beside which the proportion of our greatest experiment is less than that of the drop to the ocean. The spectroscopic astronomer has to thank the physicist and the chemist for the foundation of his science, but the time is coming—we almost see it now—when the astronomer will repay the debt by wide-reaching contributions to the very fundamenta of chemical science.

By patient, long-continued labour in the minute sifting of numerical results, the grand discovery has been made that a great part of space, so far as we have visible knowledge of it, is occupied by two majestic streams of stars travelling in opposite directions. Accurate and minute measurement has given us some certain knowledge as to the distances of the stars within a certain limited portion of space, and in the cryptograms of their spectra has been deciphered the amazing truth that the stars of both streams are alike in design, alike in chemical constitution, and alike in process of development.

But whence have come the two vast streams of matter out of which have been evolved these stars that now move through space in such majestic procession?

The hundreds of millions of stars that comprise these streams, are they the sole ponderable occupants of space? However vast may be the system to which they belong, that system itself is but a speck in illimitable space; may it not be but one of millions of such systems that pervade the infinite?

We do not know.

"Canst thou by searching find out God? canst thou find out the Almighty unto perfection?"

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PROF. A. E. H. LOVE, M.A., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

I PROPOSE to use the opportunity afforded by this Address to explain a dynamical theory of the shape of the earth, or, in other words, of the origin of continents and oceans.

The theory which has for more than a century been associated with the phrase "the figure of the earth" is the theory of the shape of the surface of the ocean. Apart from waves and currents, this surface is determined by the condition that there is no up and down upon it. This condition does not mean that the surface is everywhere at the same distance from the centre of the earth, or even that it is everywhere convex, but that a body moving upon it neither rises against, nor falls in the direction of, gravity (modified by the rotation). A surface which has this character is called an equipotential surface, and the surface of the ocean coincides with part of an equipotential surface under gravity modified by the rotation. This particular equipotential surface runs underground beneath the continents. It is named the "geoid." The height of a place above sea-level means its height above the geoid. If we knew the distribution of density of the matter within the earth it would be a mathematical problem to determine the form of the geoid. As we do not know this distribution we have recourse to an indirect means of investigation, and the chief instrument of research is the pendulum. The time of vibration of a pendulum varies with the place where it is swung, and from the observed times we deduce the values of gravity at the various places, and it was shown many years ago by Stokes that the shape of the geoid can be inferred from the variation of gravity over the surface.

The question to which I wish to invite your attention is a different one. If the ocean could be dried up, the earth would still have a shape. What shape would it be? Why should the earth have that shape rather than some other? In order to describe the shape we may imagine that we try to make a model of it. If we could begin with a model of the geoid we should have to attach additional material over the parts representing land and to remove some material over the parts representing sea. Our model would have to be as big as a battleship if the elevations and depressions were to be as much as 3 or 4 inches. In thinking out the construction of such a model we could not fail to be impressed by certain general features of the distribution of continent and ocean, and we may examine a map to discover such features. Fig. 1 is a rough map of the world drawn in such a way that to every degree of latitude or of longitude there corresponds the same distance on the map. Certain very prominent features have often been remarked: the tapering of America and Africa towards the south, the disproportion between the land areas of the northern and southern hemispheres, the excess of the oceanic area above the continental area, which occupies but little more than one-quarter of the surface; the wide extent of the Pacific Ocean, which with the adjoining parts of the Southern Ocean covers nearly two-fifths of the surface. Another prominent feature is the antipodal position of continent and ocean. South America south of an irregular line which runs from a point near Lake Titicaca to Buenos Ayres is antipodal to a portion of Asia which lies in an irregular triangle with corners near Bangkok, Kiaochau, and Lake Baikal; but no other considerable parts of the continental system have continental antipodes. The Antarctic continent is antipodal to the Arctic Ocean, Australia is antipodal to the central Atlantic, and so on. Another notable feature is the skew position of South America to the east of North America; South America lies to the east of the meridian 85° west of Greenwich; most of North America lies to the west of it. But although we may observe prominent general features of the distribution, we should find it far from easy to attribute to the form of our imaginary model any-

Fig. 1.

thing that could be called a regular geometrical figure. When we begin to think about the removal of material from the parts of the model which are to represent oceans and seas, we require a map which gives information about the depth of the sea in different places. Around all the coasts there is a margin of not very deep water. If some part of the sea could be dried up, so that more land was exposed around all the coasts, the area of the surface of the sea would be diminished; and it is known that the depth of water that would have to be removed in order to make the area of the sea just half the total area is about 1400 fathoms. The contour-line at this depth would divide the surface into two regions of approximately equal area—the continental region and the oceanic region. Fig. 2 represents the contour-line at 1400 fathoms, or the

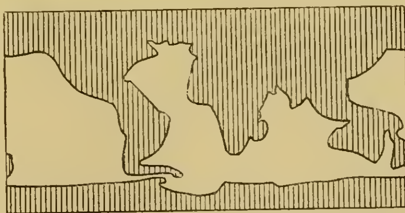

Fig. 2.

line of separation of the continental and oceanic regions. The continental region is shaded. In drawing this map I have omitted a number of small islands, and I have also omitted a few enclosed patches of deep water. Two of these are in the Mediterranean, one in the Arctic Ocean, and others are in the Gulf of Mexico and the Caribbean Sea. The Red Sea, the Mediterranean, and the Arctic Ocean belong to the continental region, and so do the Gulf of Mexico and the Caribbean Sea. At this depth Asia and North America are joined across Behring's Strait, and Europe is joined to North America across the British Isles, Iceland, and Greenland; Australia is joined to Asia through Borneo and New Guinea, and the Australasian continental region nearly reaches the Antarctic region by way of New Zealand. At this depth also South America does not taper to the south, but spreads out, and is separated from the Antarctic region by a very narrow channel. By going down to great depths our problem is very much simplified. We find that the surface of the earth can be divided into continental and oceanic regions of approximately equal area by a curve which approaches a regular geometrical shape. By smoothing away the irregularities we obtain the curve shown in Fig. 3, which exhibits the surface as divided up into a continuous continental region and two oceanic regions—the basin of the Pacific Ocean and the basin of the Atlantic and Indian Oceans. We may take our problem to be this: to account on dynamical grounds for the separation of the surface into a continental region and two oceanic regions which are approximately of this shape.

The key of the problem was put into our hands four years ago by Jeans in his theory of gravitational instability. If there are any differences of density in different parts of a gravitating body, the denser parts attract with a greater force than the rarer parts, and thus more and more of the mass tends to be drawn towards the parts where the density is in excess, and away from the parts where it is in defect. In every gravitating system there is a tendency to instability. In a body of planetary dimensions this tendency, if it were not checked, would result in a concentration of the mass either towards the centre or towards some other part. But concentration of the mass means compression of the material, and it cannot proceed very far without being checked by the resistance which the material offers to compression. There ensues a sort of competition between two agencies: gravitation, making for instability, and the elastic resistance to compression, making for stability. Such competing agencies are familiar in other questions concerning the stability of deformable bodies. A long thin bar set up on end tends to bend under its own weight. A steel knitting-needle a foot long can stand up; a piece of thin paper of the same length would bend over. In order that a body may be stable in an assigned configuration there must be some relation between the forces which make for instability, the size of the body, and the resistance which it offers to changes of size and shape. In the case of a gravitating planet we may inquire how small its resistance to compression must be in order that it may be unstable, and, further, in respect of what types of displacement the instability would manifest itself. If we assign the constitution of the planet, the inquiry becomes a definite mathematical problem. The greatest difficulty in the problem arises from the enormous stresses which are developed within such a body as the earth by the mutual gravitation of its parts. The earth is in a state which is described technically as a state of "initial stress." In the ordinary theory of the mechanics of deformable bodies a body is taken to be strained or deformed when there is any stress in it, and the strain is taken to be porportional to the stress. This method amounts to measuring the strain or deformation from an ideal state of zero stress. If the ideal state is unattainable without rupture or permanent set or overstrain, the body is in a state of initial stress. The commonest example is a golf ball made of india-rubber tightly wound at a high tension. Now the problem of gravitational instability can be solved for a planet of the size of the earth on the suppositions that the density is uniform and the initial stress is hydrostatic pressure. If the resistance to compression is sufficiently small the body is unstable, both as regards concentration of mass towards the centre and as regards displacements by which the density is increased in one hemisphere and diminished in the other. A planetary body of sufficiently small resistance to compression could not exist in the form of a homogeneous sphere. It could exist in a state in which the surface is very nearly spherical, and the mass is arranged in a continuous series of nearly spherical thin sheets, each of constant density; but these sheets would not be concentric. They would be crowded together towards one side and spaced out on the opposite side somewhat in the manner shown in Fig. 4. The effect would be a displacement of the centre of gravity away from the centre of figure towards the side where the sheets are crowded together. How small must the resistance to compression be in order that this state may be assumed by the body instead of a homogeneous state? The answer is that, if the body has the same size and mass as the earth, the material must be as compressible as granite. Granite, as we know it at the earth's surface, is not a typically compressible material. A cube of granite 10 feet every way could be compressed from its volume of 1000 cubic feet to a volume of 999 cubic feet by pressure applied to every part of its surface; but according to the recent measurements of Adams and Coker the pressure would have to be rather more than two tons per square inch. A homogeneous sphere of the same size and mass as the earth, made of a material as nearly incompressible as granite, could not exist; it would be gravitationally unstable. The body would take up some such state of aggregation as that illustrated in Fig. 4, and its centre of gravity would have an eccentric position.

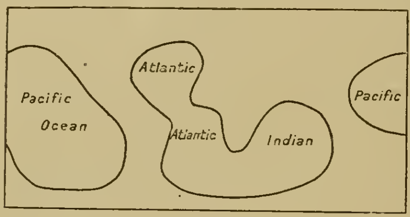

Fig.3

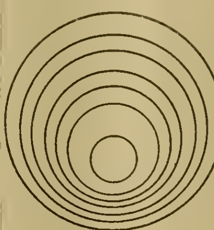

Fig.4.

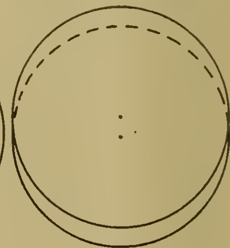

Fig.5.

Now how would an ocean rest on a gravitating sphere of which the centre of gravity does not coincide with the centre of figure? Its surface would be a sphere with its centre at the centre of gravity (Fig. 5). The oceanic region would be on one side of the sphere and the continental region on the other side. It was pointed out many years ago by Pratt that the existence of the Pacific Ocean shows that the centre of gravity of the earth does not coincide with the centre of figure. There is no necessity to invoke some great catastrophe to account for the existence of the Pacific Ocean, or to think of it as a kind of pit or scar on the surface of the earth. The Pacific Ocean resembles nothing so much as a drop of water adhering to a greasy shot. The force that keeps the drop in position is surface tension. The force that keeps the Pacific Ocean on one side of the earth is gravity, directed more towards the centre of gravity than the centre of figure. An adequate cause for the eccentric position of the centre of gravity is found in the necessary state of aggregation which the earth must have had if at one time it was as compressible as granite. The theory of gravitational instability accounts for the existence of the Pacific Ocean.

But we can go much further than this in the direction of accounting for the continental and oceanic regions. We keep in mind the eccentric position of the centre of gravity, and try to discover the effect of rotation upon a planet of which the centre of gravity does not coincide with the centre of figure. The shape of a rotating planet must be nearly an oblate spheroid; but the figure of the ocean would, owing to its greater mobility, be rather more protuberant at the equator than the figure of the planet on which it rests. The primary effect of the rotation of the earth upon the distribution of continent and ocean is to draw the ocean towards the equator, so as to tend to expose the Arctic and Antarctic regions. We have seen that both Arctic and Antarctic are parts of the continental region. But there is an important secondary effect. Under the influence of the rotation the parts of greater density tend to recede further from the axis than the parts of less density. If the density is greater in one hemispheroid than in the other, so that the position of the centre of gravity is eccentric, the effect must be to produce a sort of furrowed surface; and the amount of elevation and depression so produced can be described by an exact mathematical formula. It has been proved that this formula is a sort of expression which mathematicians name a spherical harmonic of the third degree.

The shape of the earth is also influenced by another circumstance. We know that at one time the moon was much nearer to the earth than it is now, and that the two bodies once rotated about their common centre of gravity almost as a single rigid system. The month was nearly as short as the day, and the moon was nearly fixed in the sky. The earth must then have been drawn out towards the moon, so that its surface was more nearly an ellipsoid with three unequal axes than it is now. The primary effect of the ellipsoidal condition upon the distribution of continent and ocean would be to raise the surface above the ocean near the opposite extremities of the greatest diameter of the equator. But, again, owing to the eccentric position of the centre of gravity, there would be an important secondary effect. The gravitational attraction of an ellipsoid differs from that of a sphere, and it may be represented as the attraction of a sphere together with an additional attraction. If the density was greater in one hemi-ellipsoid than in the other, the additional attraction would produce a greater effect in the parts where the density was in excess, and the result, just as in the case of rotation, would be a furrowing of the surface. It has been proved that the formula for this furrowing also is expressed by a spherical harmonic of the third degree.

We are brought to the theory of spherical harmonics and the spherical harmonic analysis. Spherical harmonics are certain quantities which vary in a regular fashion over the surface of a sphere, becoming positive in some parts and negative in others. I spoke just now of making a model of a nearly spherical surface by removing material from some parts and heaping it up on others. Spherical harmonics specify standard patterns of deformation of spheres. For instance, we might remove material over one hemisphere down to the surface of an equal but not concentric sphere (*cf.* Fig. 5) and heap up the material over the other hemisphere. We should produce a sphere equal to the original but in a new position. The formula for the thickness of the material removed or added is a spherical harmonic of the first degree. It specifies the simplest standard pattern of deformation. Again, we might remove material from some parts of our model and heap it up on other parts so as to convert the sphere into an ellipsoid. The formula for the thickness of that which is removed or added is a spherical harmonic of the second degree. Deformation of a sphere into an ellipsoid is the second standard pattern of deformation. The mathematical method of determining the appropriate series of standard patterns is the theory of spherical harmonics. Its importance arises from the result that any pattern whatever can be reached by first making the deformation according to the first pattern, then going on to make the deformation according to the second pattern, and so on. If we begin with a pattern, for instance the shape of the earth, which is not a standard pattern, we can find out how great a deformation of each standard pattern must be made in order to reproduce the prescribed pattern. The method of doing this is the method of spherical harmonic analysis. Except in very simple cases the application of it involves rather tedious computations. With much kind assistance and encouragement from Prof. Turner, I made a rough spherical harmonic analysis of the earth's surface. I divided the surface into 2592 small areas, rather smaller on the average than Great Britain. I gave them the value +1, or one unit of elevation, if they are above the sea, and the value −1, or one unit of depression, if they are below the 1400-fathom line. To the intermediate areas I gave the value 0. The distribution of the numbers over the surface was analysed for spherical harmonics of the first, second, and third degrees.

Any spherical harmonic of the first degree gives us a division of the surface into two hemispheres—one elevated, the other depressed. The spherical harmonic analysis informs us as to the position of the great circle which separates the two hemispheres, and also as to the ratio of the maximum elevation of this pattern to the maximum elevation of any other pattern. The central region of greatest elevation of this pattern is found to be in the neighbourhood of the Crimea, and the region of elevation

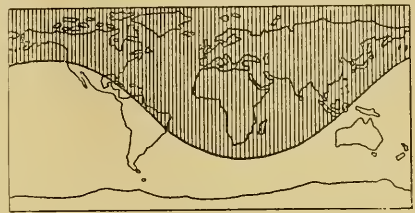

Fig. 6.

contains the Arctic Ocean and the northern and central parts of the Atlantic, Europe, Africa, Asia, most of North America, and a small part of South America. When the surface is mapped on a rectangle in the same way as before, the chart of the harmonic is that shown in Fig 6.[1] The actual disproportion between the amounts of continental area in the northern and southern hemispheres is associated with the result that the central region of elevation, as given by the analysis, is about 45° north of the equator; and the extension of the Pacific Ocean and adjoining Southern Ocean to much higher southern than northern latitudes is associated with the corresponding position of the central region of greatest depression about 45° south of the equator. In regard to harmonics of the second degree, the spherical harmonic analysis informs us as to the ellipticity of the equator and the obliquity of

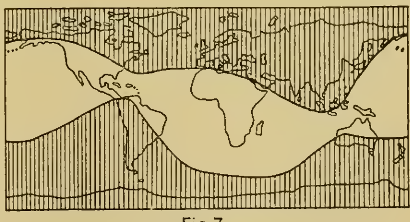

Fig. 7.

the principal planes of that ellipsoid which most nearly represents the elevation of the surface above or its depression below the surface of the ocean, or the geoid. The result is an equatorial region of depression, which spreads north and south unequally in different parts and forms a sort of immense Mediterranean, containing two great basins, and separating a northern region of elevation from a southern. The northern region of elevation occupies the northern part of the Atlantic Ocean and runs down to and across the equator in the neighbourhood of Borneo. The southern region of elevation occupies the southern part of the Pacific Ocean, and it runs up to and across the equator in the neighbourhood of Peru. The chart of the harmonic is shown in Fig. 7. The equatorial regions

[1] In this figure, and in the following figures, regions of elevation are shaded, and regions of depression are left blank.

of elevation given by the analysis are near the ends of a diameter, as we should expect.

It has not been necessary to enter into a minute description of the harmonics of the first and second degrees, because they represent very simple things—a shifting of the surface to one side and a distortion of it into an ellipsoid. The harmonics of the third degree are not so familiar. There are essentially four of them, each specifying a standard pattern of deformation. The first of these, the zonal harmonic, gives us a division of the surface into two polar caps and two zones by means of the equator and the parallels of latitude about 51° north and 51° south. Alternate zones are depressed and elevated, as shown in Fig. 8. The existence of an Antarctic continent and an Arctic Ocean is specially associated with the presence of this harmonic, and the disproportion of the continental areas in the northern and southern hemispheres is also connected with it. The second of the harmonics of the third degree, the tesseral harmonic of rank 1, gives us a division of the surface into six half-zones by means of a complete meridian circle and the parallels of latitude about 27° north and 27° south. Alternate half-zones are depressed and elevated as shown in Fig. 9. The combined effect represented by the zonal harmonic and the tesseral harmonic of rank 1 is a furrowed surface with an Arctic region of depression extending southwards in the direction of the Atlantic, a zone of elevation which runs across the Atlantic, South America, and Africa, and then turns northwards at either end, a zone of depression with the same kind of contour, and an Antarctic region of elevation which extends northwards in the direction of Australasia. These regions are shown in Fig. 10. I have recorded the result

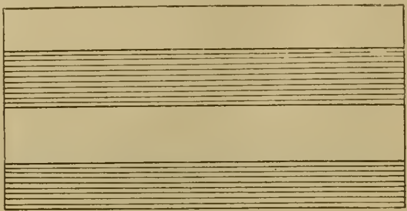

Fig. 8.

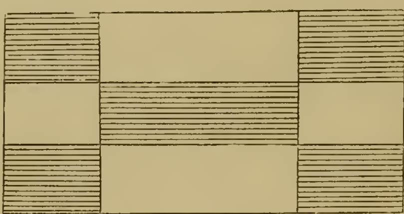

Fig. 9.

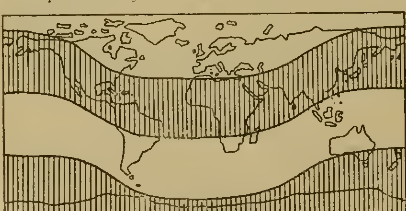

Fig. 10.

of combining these two harmonics because they represent the particular effects that would be produced by the interaction of two causes—the rotation, and the eccentric position of the centre of gravity. The third type of harmonics of the third degree, the tesseral harmonic of rank 2, gives us a division of the surface into octants by means of the equator and two complete meridian circles. Alternate octants are elevated and depressed as shown in Fig. 11. We can name the octants where there is elevation: Asia, Australasia, North America, South America. The harmonic of this type is certainly prominent. It is specially associated with the skew position of South America to the east of North America. The fourth type of harmonics of the third degree, the sectorial harmonic, gives us a division of the surface into six sectors by means of three complete meridian circles. Alternate sectors are depressed and elevated as shown in Fig. 12. The southward tapering of Africa is specially associated with the harmonic of this type. The combined effect of all the harmonics of the third degree is shown in Fig. 13. It represents the sphere deformed into a sort of irregular pear-shaped surface. The stalk of the pear is in the southern part of Australia and contains Australasia and the Antarctic continent. This is surrounded on all sides but one (towards South America) by a zone of depression, the waist of the pear. This, again, is surrounded on all sides but one (towards Japan) by a zone of elevation, the protuberant part of the pear; and finally we find the nose of the pear in the central Atlantic between the Madeiras and the Bermudas. I do not, however, wish to emphasise the resemblance of the surface to a pear or any other fruit, but prefer to describe it as an harmonic spheroid of the third degree. Another

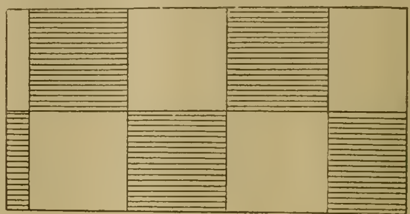

Fig. 11.

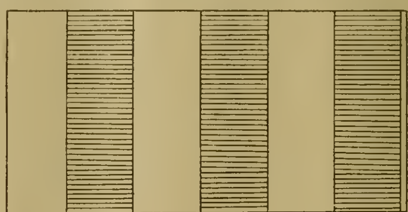

Fig. 12.

Fig. 13.

way of regarding it would be as a surface with ridges and furrows. From a place in the South Atlantic there run three ridges: one north-westwards across America, a second north-eastwards across Africa and Asia, and the third southwards over the Antarctic continent, continuing northwards across Australia nearly to Japan. From the Sea of Okhotsk there run three furrows: one south-westwards across Japan, the Malay Peninsula, and the Indian Ocean; a second south-eastwards across the Pacific; and the third northwards over the Arctic Ocean, continuing southwards by way of the Atlantic. Harmonics of the first and third degrees have in common the character of giving depression at the antipodes of elevation; the harmonics of the second degree give depression at the antipodes of depression and elevation at the antipodes of elevation. The maxima of the harmonics of the first and third degrees are found to be rather greater than the maximum of the harmonic of the second degree. Of three quantities to be added together the two larger ones agree in giving depression at the antipodes of elevation; a result which is in accordance with the fact that most continents have oceanic antipodes.

When we superpose the effects represented by all the various harmonics of the first, second, and third degrees, so as to make, as it were, a composite photograph of all the various elevations and depressions represented by them severally, each in its appropriate amount as determined by the harmonic analysis, we find the curve shown in Fig. 14 as the theoretical curve of separation between regions of elevation and depression which are approximately equal in area. I showed before a smoothed curve (Fig. 3) which I proposed to take as representing the facts to be

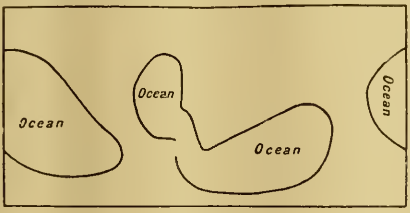

Fig. 14.

accounted for. The resemblance of the two curves seems to be striking. Incidentally it has been noticed how the prominent features of the distribution of continent and ocean are associated with the presence of various harmonics. As regards the contour of the great ocean basins, we seem to be justified in saying that the earth is approximately an oblate spheroid, but more nearly an ellipsoid with three unequal axes, having its surface furrowed according to the formula for a certain spherical harmonic of the third degree, and displaced relatively to the geoid towards the direction of the Crimea.

As regards the amount of elevation and depression in different parts, the agreement of the theory with the facts is not so good. The computed elevation is too small in Southern Africa, Brazil, and the southern part of South America, too great in the Arctic regions, to the south of of Australasia, and in the Mediterranean region. There are many reasons why we could not expect the agreement to be very good. One is the roughness of the method of harmonic analysis that was used. But there is also the fact that many causes must have contributed to the shaping of our actual continents and oceans besides those which have been taken into account in the theory. It appears, however, that the broad general features of the distribution of continent and ocean can be regarded as the consequences of simple causes of a dynamical character: eccentric position of the centre of gravity, arising from a past state of inadequate resistance to compression, an inherited tendency, so to speak, to an ellipsoidal figure, associated with the attraction of the moon in a bygone age, the rotation, and the interactions of these various causes.

In attempting to estimate the bearing of the theory on geological history we must be guided by two considerations. The first is that the earth is not now gravitationally unstable. From observations of the propagation of earthquake shocks to great distances, we can determine the average resistance to compression, and we find that this resistance is now sufficiently great to keep in check any tendency to gravitational instability. The eccentric position of the centre of gravity must be regarded as a survival from a past state in which the resistance to compression was not nearly so great as it is now. The second guiding consideration is that, according to the theory, the inequalities which are expressed by spherical harmonics of the third degree are secondary effects due to the interaction of the causes which give rise to inequalities expressed by harmonics of the first and second degrees. We should expect, therefore, that the inequalities of the third degree would be much smaller than those of the first and second degrees; but the harmonic analysis shows that the three inequalities are entirely comparable. We must conclude that the harmonics of the first and second degrees which we can now discover by the analysis are survivals from a past state, in which such inequalities were relatively more important than they are now. Both these considerations point in the same direction, and they lead us to infer that certain sæcular changes may have taken place in the past, and may still be going on. Sixty-nine years ago Charles Darwin wrote: "The form of the fluid surface of the nucleus of the earth is subject to some change the cause of which is entirely unknown, and the effect of which is slow, intermittent, but irresistible." Forty-two years later Sir George Darwin showed that any ellipsoidal inequality in the figure must be gradually destroyed by an irreversible action of the same nature as internal friction or viscosity. The same may be said of a state in which the centre of gravity does not coincide with the centre of figure when the resistance to compression is great enough to keep in check the tendency to gravitational instability. The state would be changed gradually in such a way as to bring the centre of gravity nearer to the centre of figure. A symptom of such changes might be the occurrence of great subsidences in the neighbourhood of the Crimea, where we found the maximum of the first harmonic. Such subsidences are supposed by geologists to have taken place in rather recent times. Symptoms of the diminution of the inequalities expressed by harmonics of the second degree would be found in the gradual disappearance of seas forming part of the great depression which was described above as a sort of immense Mediterranean (*cf.* Fig. 7), in the destruction and inundation of a continent in the northern Atlantic and in a gradual increase of depth of the Southern Pacific. The disappearance of seas from a vast region surrounding the present Mediterranean basin, and containing the Sahara and Southern Asia as far east as the Himalayas, is one of the best ascertained facts in geological history; and the belief in the destruction of a north Atlantic continent is confidently entertained. In parts of the Southern Pacific a depression represented by harmonics of the third degree is superposed upon an elevation represented by harmonics of the second degree, and we should therefore expect to find the depth of the ocean to be increasing gradually in this region. The region in question is that of the coral reefs and coral islands, such as Funafuti, and the result is in accord with Darwin's theory of the formation of coral reefs. So far as the general distribution of the mass within the earth is concerned, the reduction of the inequalities of the first and second degrees would seem to have already proceeded very far; for we are assured by geodesists that harmonics of the first degree, and those of the second degree which do not represent the effect of the rotation, are far from prominent in the figure of the geoid—much less prominent than we found them to be in the distribution of continent and ocean. We infer that the inequalities of the first and second degrees must have been progressively diminished in comparison with those of the third degree. The general result of such changes would be a gradual diminution of the depths and extents of the oceans which correspond with the harmonics of the first and second degrees, and a compensating increase in the depths and extents of the oceans which correspond with the harmonic of the third degree. To see the character of the changes which would thus be brought about, we may examine a figure which shows the composite elevations and depressions that are represented by harmonics of the first and second degrees, and, separately, those which are represented by harmonics of the third degree. In Fig. 15 the composite elevations of the first and second degrees are shaded vertically, and the elevations of the third degree are shaded horizontally. The deep parts of the Atlantic that border the coasts everywhere from Brazil to Ashanti are regions in which a depression represented by the third harmonic is superposed upon an elevation represented by the other two harmonics, and the same is true of the deep parts of the Indian Ocean which border the shores of Africa and Asia from Madagascar to Burmah. The deep parts of the Pacific that border the western coast of America from Alaska to Chile are regions in which an elevation represented by the third harmonic is superposed upon a depression represented by the other harmonics. These observations suggest that in the greater part of the Atlantic and the northern and western parts of the Indian Ocean the direction of sæcular change may have been that of an advance of the ocean to encroach upon the continental region, while in the Pacific Ocean on the American side the direction of sæcular change may have been that of a retreat of the ocean, permitting an extension of the continental region. This difference would lead us to expect different types of coast in the two regions, and such a difference has been observed. Whereas in the Atlantic region, with few exceptions, the coast cuts across the directions of the mountain chains, in the Pacific region on the American side the coast generally corresponds

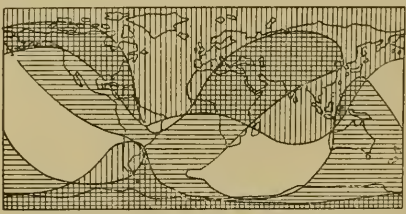

Fig. 15.

in direction with the neighbouring mountain chains of the continent. The deep parts of the Pacific which are nearest to the Asiatic coast from Kamchatka to Siam are regions where a moderate depression represented by the third harmonic is superposed upon a moderate elevation represented by the other harmonics. These shores of the Pacific are distinguished by the wide margin which separates the deep ocean from the coast of the continent. It might perhaps be desirable to recognise in this region a type of coast differing from the two main types associated with the Atlantic and the American side of the Pacific. The analysis does not represent South Africa or the southern parts of South America sufficiently well to warrant us in expecting these regions to exhibit one type rather than the other; but the way in which Australia is represented, as an elevation of the third degree superposed upon a depression of the first, suggests that the coasts of Australia, and especially the eastern coast where the elevation in question is greater, should be of the same type as the American shores of the Pacific; and it is the fact that the mountain chains of Queensland and New South Wales run parallel to the neighbouring coasts. There seems therefore to be much evidence to support the view that the direction of sæcular change has been that of diminishing the prominence of the inequalities of the first and second degrees in comparison with those of the third degree. The process by which such changes would be brought about would be of the nature of relief of strain, expressing itself in occasional fractures of no very great magnitude; and such fractures would be manifested at the surface as earthquakes. Seismic and volcanic activities constitute the mechanism of the process of change. These activities are spasmodic and irregular, but the effect of them is cumulative. For this reason they tend in the course of ages to transform the shape of the earth from one definite type to another. The diminishing speed of the earth's rotation is another cause of change which appears to produce an alternating rather than a cumulative effect. On the one hand it tends to diminish that tendency, which we noted above, to draw the waters of the ocean towards equatorial regions; on the other hand it must result in an actual reduction of the equatorial protuberance of the earth's figure. This reduction can only be effected by seismic activity expressed by subsidences in equatorial regions. The effect which would in this way be produced in the distribution of continent and ocean would appear to be that there would be long periods in which the ocean would tend to advance towards the Arctic and Antarctic regions, interrupted by shorter periods in which it would tend to retreat towards the neighbourhood of the equator.

The theory which I have tried to explain is a tentative one, and further investigation may prove it to be untenable; but it is to its credit that, besides tracing to dynamical causes the existing distribution of continent and ocean, it offers an explanation of the difference between the Atlantic and Pacific types of coast, it gives indications of a possible account of those alternations of sea and land which first led to the study of geology, and it suggests an origin for Charles Darwin's unknown force the operation of which is slow and intermittent, but irresistible.

NOTES.

Next year's meeting of the British Medical Association will be held at Sheffield under the presidency of Mr. Simeon Snell. This year's meeting is at present in progress at Exeter. On Tuesday last the president, Dr. Henry Davy, delivered his address, taking as his subject "Science in its Application to National Health."

The *Nimrod*, in which Mr. E. H. Shackleton's expedition will proceed to the Antarctic regions, sailed from the Thames on July 30 with Lieut. Rupert England in command. Lord Kelvin has presented to the expedition a standard compass and sounding instruments. The Admiralty is lending a compass, chronometers, charts, and sounding apparatus, as well as three Lloyd-Creak Dip instruments for the landing party. Watches are being supplied by the Royal Geographical Society, and, in addition, the vessel will be equipped with a liquid steering compass and a special pole compass. The members of the expedition on board the *Nimrod* are Mr. James Murray, the biologist of the expedition; Mr. W. A. Michell, surgeon and zoologist; and Mr. A. F. Mackay, the junior surgeon of the landing party, who will also engage in zoological work. At Lyttelton, New Zealand, the remaining members of the expedition will join the ship. These include, besides Mr. Shackleton, Mr. E. Marshall, senior surgeon of the shore party and cartographer of the expedition; Lieut. Adams, R.N.R., who will be in charge of the meteorological work; and Sir Philip Brocklehurst, for survey work and field geology. Dr. David, professor of geology in Sydney University, has arranged to accompany the expedition south to King Edward VII. Land.

The weather still continues very cool for the time of year, but on the whole the conditions lately have been somewhat dry. At Greenwich there has been no year since 1888 with so few warm days in July, and the thermometer has not once touched 80°. The total rainfall for the month is less than an inch, whilst the average for the past sixty years in July is 2·40 inches. The aggregate rainfall for the first eight weeks of summer, to July 27, is less than the average in the north-east, east, and south of England, and in the Channel Islands, but in every other district of the United Kingdom it is in excess of the normal. The greatest excess for the summer is 2·42 inches, in the north-west of England, whilst the greatest deficiency is 1·17 inches, in the east of England, the measurements being respectively 7·21 inches and 2·88 inches, and the rainy days respectively forty-one and twenty-six. Both the temperature and the sunshine for the summer have, so far, been below the average.

The experiments which have been in progress in the Congo State for some time past in training the African elephant for domestic work are progressing satisfactorily. During the first three months of the present year, eight young elephants were captured, bringing the stud up to a total of thirty. At first the wild elephants suffer in health on confinement, but this depression soon passes off. Similar experiments are being made in the British territory of Uganda, but so far the results there are uncertain.

As illustrating further the want of sympathy with scientific research shown by the Indian administrative authorities, to which Prof. Ronald Ross, F.R.S., directed attention in an exhaustive article contributed to our issue of June 13, an Indian correspondent writes concerning the rules of the India Office regulating the supply of apparatus to Government colleges. According to these rules, our correspondent states, any piece of apparatus of European manufacture—costing more than 3*l.* 7*s.*—can only be obtained by requisitioning through the Secretary of State. Requisitions are prepared once a year, and, as a rule, eighteen months elapse between writing a demand and the arrival of the apparatus. It is nearly impossible to foresee everything that may be required during the prosecution of a research, and it happens sometimes that a man of science must wait three years for necessary material. The reasonable contention is made that professors in India should be permitted to spend their laboratory funds themselves and to deal with manufacturers direct. It is surely not taking too much for granted to suppose that men in responsible positions, who presumably have been selected for their posts with great care, may be trusted to administer their funds honestly and to the best advantage of the institutions with which they are connected. The system of having to requisition scientific instruments and materials a year or more in advance is not confined to India, and it is both discouraging to scientific work and wasteful in practice.

It is interesting to find that the traditional date assigned to one of the great cycles of national legend is confirmed by independent evidence, and this in the case of the oldest existing literature of any of the peoples who dwelt to the north of the Alps. According to the native annals of Ireland, the Celtic heroes, Conchobar and Cuchulainn, flourished about the beginning of the Christian era, and though some authorities have supposed Cuchulainn to be a degraded Celtic god, there can be no reasonable doubt that he and his uncle lived and fought on earth. This traditional date is supported by the fact, already well recognised by scholars, that, though the poems were at a later date modified by their ecclesiastical transcribers, their spirit is essentially pagan. Prof. Ridgeway, in a paper recently submitted to the British Academy, has approached the problem from the point of view of the archæologist. From an elaborate investigation of the ethnology of this heroic race, their methods of fighting, their use of chariots—unknown to the later Ossianic poems—their arms and armour, and their dress and jewellery, as described in the Cuchulainn Epic, he is able by a comparison of remains of the La Tène period discovered in Ireland to decide that this cycle of culture is here represented; that, as is asserted in the Irish traditions, a tall, fair-haired, grey-eyed race of Celts, like those of Britain and the Continent, invaded Ireland in the centuries immediately before the birth of Christ, and that the poems themselves took shape when the La Tène form of culture was still flourishing in the country, which can hardly have been much later than 100 A.D. The evidence of tradition and archæology thus happily combines to establish the date of this important Saga literature.

According to the report of the Northumberland Sea-fisheries Committee for the past year, the prospects of the fisheries under its supervision are very satisfactory, the marked falling-off in the products of trawling, which has been so noticeable for many years, having at length given place to a distinct upward tendency. It was discovered some time ago that an extensive migration from the south of female crabs takes place during winter, and it is now ascertained that a similar state of affairs exists in the case of flounders, which travel when fully adult into Scotch waters. Means for extending the mussel-beds of the district have been carefully sought, but at present with no great success. The main reasons for the unsatisfactory state of the mussel-supply appear to be the crowded condition of some of the beds, the action of storms on others, and the destruction caused by whelks and starfishes.

Judging from the report for 1906, the Zoological Gardens at Giza, near Cairo, enjoy great popularity among native Egyptians, the number of visitors showing an increase of twenty-five per cent. on the previous year, which was itself a record season. At the close of last year the gardens contained a remarkably fine collection of African big game animals, inclusive of six Sudani elephants, nine beisa oryx, three addax, and three kudu.

The skeleton of a wonderful new horned rodent, *Epigaulus hatcheri*, from the Miocene of Kansas, is described by Mr. J. W. Gidley in the Proceedings of the U.S. National Museum, No. 1554 (pp. 627–636). The total length of the mounted skeleton in a straight line is about 14 inches. From the allied Ceratogaulus, the genus differs by the larger and more backwardly directed horns, the reduced molars, and larger premolars. Although presenting some resemblances to the beavers and squirrels, it appears to be most nearly related to the sewellels (Haplodontidæ). The paper concludes with speculations as to what possible use horns can be to a burrowing animal.

The porcupines of the Malay Peninsula and Archipelago form the subject of a paper by Mr. M. W. Lyon in the Proceedings of the U.S. National Museum, No. 1552 (vol. xxxii., pp. 575–594), in which the generic grouping is revised and several new forms are described. For the large Malay and Java porcupines, commonly known as *Hystrix brachyura* and *H. javanica*, F. Cuvier's genus Acanthion is reinstated. These porcupines differ from the typical Hystrix by the absence of a nuchal crest, the shorter quills, and much shorter nasal bones in the skull, which extend backwards only so far as the line of the lachrymals, instead of to the hind root of the zygomatic arch. A new species from Sumatra is made the type of a separate genus, as *Thecurus sumatrae*, differing from Acanthion by the smaller capsule-like extremities of the tail-bristles, often closed at the end, and the smaller quills, which are replaced on the lower part of the rump by grooved spines like those on the back. The remaining species are referred, as before, to the genera Atherura (or Atherurus) and Trichys.

From Prof. H. F. Osborn we have received copies of a number of papers published in the Bulletin of the American Museum of Natural History, *Science*, &c., from which the following are selected for notice. In vol. xxii., art. 13, of the first-named serial is described the milk-dentition of the hyracoid from the Egyptian Eocene known as Saghatherium, the teeth at that age serving to confirm previous conclusions as to the systematic position of the genus. A restoration of the skeleton and external form of the remarkable Permian reptile Naosaurus forms the subject of vol. xxiii., art. 14. The enormous neural spines of the dorsal vertebræ, armed with transverse spikes, are considered to have supported a sail-like expansion of skin, but no reference is made to the probable object of this structure; the creature measured about 8½ feet in length. A magnificent skeleton of the Columbian mammoth (*Elephas columbi*), discovered in Indiana in 1903, and now mounted in the American Museum of Natural History, is described in art. 12; the tusks are remarkable for their great curvature and the crossing of the tips. The extinct mammals of Patagonia, and American exploration in the vertebrate beds of the Fayum Eocene, form the subjects of two of Prof. Osborn's contributions to *Science*.

IN referring to a scientific expedition sent out by the University of Colorado to study the natural history of the north-eastern part of the State, it is mentioned that, owing to the diversity of climatic conditions, the flora of Colorado is only exceeded in numbers by the flora of the State of California, and possibly of Florida. The object of the expedition was to collect plants, birds, and fossils. Leguminous plants, notably *Psoralea tenuiflora* and species of Astragalus, were prolific in the dry localities. Varieties of Populus known as cotton wood were abundant along the streams. Details appear in vol. iv., No. 3, of the University of Colorado Studies, where Mr. F. Ramaley contributes a second article on the silva of Colorado, treating of the species of Populus.

AN official notice which has been issued by the Inspector-General of Forests in India, intimating that the series of Forest Bulletins initiated in 1905 will be superseded by two publications to be known as the Indian Forest Records and Indian Forest Memoirs, furnishes another proof of the recognition by the Government of India of the importance of the department. Similarly to the Records and Memoirs of the Geological Survey of India, the former, that will be issued as material accumulates, will be devoted to short articles, notes, and preliminary announcements; the latter will contain memoirs or monographs, and will also appear irregularly as occasion arises.

THE report for 1906 of the Director of Agriculture in the Federated Malay States has been received. In connection with rice cultivation, experiments have been instituted to test the value of rotation crops. The position of the rubber industry is reviewed, and the opinion is expressed in favour of pushing the manufacture of block rubber, since it approximates more nearly to the smoke-dried Brazilian product. On the subject of soils and the expense incurred by weeding, Mr. Carruthers recommends the cultivation of a suitable leguminous crop, such as *Mimosa rudica*, the sensitive plant, on rubber lands, that would not only increase the nitrogen in the soil, but would also tend to conserve the surface.

DR. J. C. WILLIS contributes a paper to the Annals of the Royal Botanic Gardens, Peradeniya (vol. iv., part i.), on the occurrence and origin of certain endemic plants on Mt. Ritigala in Ceylon and elsewhere, providing in his opinion strong evidence against the theory of the origin of species by natural selection of infinitesimal variations. Comparing a number of allied species, such as *Coleus elongatus*, an endemic on Mt. Ritigala, with *Coleus barbatus*, a plant widely spread through Ceylon and S. India, Dr. Willis controverts the view that the specific characters of the endemic have developed as adaptations by means of infinitesimal variations, and prefers the mutation theory as affording a more feasible explanation.

FRUIT enters largely into the dietary of Americans, and this wholesome practice has been encouraged by the United States Department of Agriculture by means of bulletins indicating the nutritive value of fruit to the consumer and the economic value as a crop to the farmer. A Farmer's Bulletin, No. 293, compiled by Mr. C. T. Langworthy, provides a rational summary of available data on the composition, food value, and place of fruit in the human diet.

A CATALOGUE of the plants of New Zealand, similar to the London catalogue of the British Isles, has been prepared by Mr. T. F. Cheeseman for the Education Department of that dominion. The arrangement is that of the author's recently issued "Manual of the New Zealand Flora"; the indigenous and naturalised plants are grouped separately, and the distribution is broadly indicated.

IN the Journal of the Royal Society of New South Wales (vol. xl.), Mr. R. H. Mathews gives some details of the organisation of the Kurnu tribe in the north-west of New South Wales, of their rules as to sharing food, of the organisation of the Chauan tribe near the north-east border of Western Australia, and of the language of tribes about Alice Springs; he also gives a Loritcha vocabulary and some details as to avenging parties in Victoria. We learn more as to the "blood" divisions of the Kurnu, of which Mr. Mathews was the discoverer; but an actual genealogy of a small tribe thus organised would be of far more value than many explanations, provided totems, phratries, classes, bloods, and shades were duly noted. It might also enable us to discover whether the present irregularity in marriage regulations is of old standing. The class system of the Chauan tribe seems to be aberrant, so far as the form of the names goes; only two show any close relation to those prevailing among the more easterly eight class tribes; the names are arranged by Mr. Mathews on the supposition that matrilineal descent prevails, but this assumption can only be substantiated by the discovery of phratry names for the two groups of class names, and all the phratry names so far recorded indicate that patrilineal descent is the rule in the north. Mr. Mathews has also published a paper on the Australian tribe in the *Zeitschrift für Ethnologie*, 1906, pp. 939–946. His contributions are now so numerous that he would do well to attempt a general review of the facts he has published, which are otherwise not easy to piece together. It is clear from a paper by Mr. Mathews in vol. xxxvii. of the *Mitteilungen* of the Vienna Anthropological Society that he hardly realises the importance of exhaustiveness or of the localisation of his facts; to take one example, the paper professes to deal with Australian ethnography; the shields described are those of south-east Australia, but there is not a hint that the statements are not true of the whole of the continent.

THE great accuracy which has been attained in the measurement of electric current by the current balance at the National Physical Laboratory will in all probability lead to a more extended use of balances depending on the attraction of co-axial solenoids. A valuable series of papers by E. B. Rosa and L. Cohen dealing with the mutual inductance, and therefore attraction, of such circuits, has appeared in the May Bulletin of the Bureau of Standards at Washington. In one of these the various expressions which have been given for the mutual inductance of co-axial solenoids, from that due to Maxwell to the one Mr. A. Russell gave in the April number of the *Philosophical Magazine*, are compared and tested. Unfortunately, none of them appears to be at the same time accurate and easy of numerical calculation, while in one or two of them the authors have detected small errors.

PUBLICATION No. 62 of the Carnegie Institution of Washington consists of an account by Prof. Carl Barus of the work he has done on the condensation of vapour as induced by nuclei and ions. The condensation is effected in a cylindrical glass fog chamber 6 inches in diameter and 18 inches long, by exhaustion into a vacuum chamber through a stop-cock 4 inches in diameter. The coronas produced in transmitted light by the fog are observed through a goniometer. Different gases have been tried as well as different saturating vapours. In all cases there appear to be three types of condensation nuclei, dust particles, transient bodies which when charged are the ions, and lastly, excessively minute and persistent "colloidal" nuclei, on which condensation only takes place at the higher exhaustions. Prof. Barus has not found any daily period in the number of colloidal nuclei present in the atmosphere which could be ascribed to cosmical radiation. In this respect they differ from the ions, which have been shown by Messrs. A. Wood and A. R. Campbell (NATURE, vol. lxxiii., p. 583) to be present to the maximum extent about 9 a.m. and noon, and to reach a minimum about 3 p.m.

DR. E. GRIMSEHL describes in the *Physikalische Zeitschrift* for July 15 a simple apparatus suitable for demonstrating the principal properties of electric oscillations. Condensers of various sizes are formed by placing two sheets of tinfoil between three sheets of ebonite and vulcanising the whole together, leaving metal ears projecting so that each condenser can be hung on two bare wires which form part of the circuit. Variable inductances are made of solenoids of hard copper wire, one end of each being fixed and the other attached to a slide which can move parallel to the axis of the solenoid, so as to vary the length. The spark gap is formed by two aluminium spheres at the ends of two brass screws which pass through opposite sides of an ebonite box. With this apparatus and, for waves in wires, a simple Hertz generator capable of being tuned, almost all the fundamental experiments on electric oscillations can be performed.

THE curious differences of colour exhibited by the thin films of gold produced on the surface of a glass plate near which a gold wire is slowly disintegrating owing to the passage of an electric current through it, have been explained by M. L. Houllevigue in a communication to the Société Française de Physique at the last meeting (July 15). Films which appear blue in transmitted light are composed of a hydride of gold, stable at ordinary temperatures, but unstable above 130° C., when it loses 7 per cent. to 8 per cent. of its weight. Such a film when heated is converted into the more commonly known form, which appears to be identical with beaten gold leaf, and is green in transmitted light. Several other properties of these films find a simple explanation in M. Houllevigue's discovery.

THE Board of Agriculture has issued the ninth part of the memoir descriptive of the South Wales coalfield (Memoirs of the Geological Survey, price 8*d*.). The volume covers fifty pages, and is an explanation of the new series map, sheet 246, which includes West Gower and the country around Pembrey. The report has been drawn up by Dr. A. Strahan, F.R.S., in part from notes by Messrs. B. S. N. Wilkinson, T. C. Cantrill, and E. E. L. Dixon. The dominant feature in the structure of the district is the anticline which throws up the Old Red Sandstone to form Cefn-y-Bryn. The Old Red Sandstone appears under an aspect that was quite unexpected. The red marls that form the lower half of the formation around most of the coalfield are absent in parts of Gower, whilst the conglomerates at the top attain a remarkable development, and Silurian rocks come to the surface as an inlier. The Carboniferous Limestone is well developed. On the coast between Llanelly and Pembrey, the lower part only of the Pennant series is exposed, but the whole of the Lower Coal series probably exists under the estuary of the Loughor. The probable effect of various anticlines and synclines upon the extent of the Coal-measures under that estuary is taken into consideration and illustrated in a map. The only coal seams hitherto worked are those which are developed in the Pennant series in the western part of the South Wales coalfield, and the value of the concealed and unproved coalfield is lessened by the fact that the strata are likely to be highly inclined and much disturbed. The superficial deposits include the Raised Beach, which is so finely exhibited in East Gower, and glacial deposits, both presenting features of great interest.

WE have received the eleventh of a series of bulletins published by the Engineering Experiment Station of the University of Illinois. It deals with the effect of scale on the transmission of heat through locomotive boiler tubes, and has been drawn up by Prof. E. C. Schmidt and Mr. J. M. Snodgrass. Of late years there has been much discussion on the subject, and statements as to the extent to which deposits of scale affect the conductivity of a tube or sheet have been made from time to time, and have differed widely. The results of the authors' tests lead to the following conclusions:—Considering scale of ordinary thickness, say of thicknesses varying up to $\frac{1}{8}$ inch, the loss in heat transmission due to scale may vary in individual cases from insignificant amounts to as much as 10 per cent. or 12 per cent. The loss increases somewhat with the thickness of the scale. The mechanical structure of the scale is of importance equal to or greater than the thickness in producing this loss. Chemical composition, except in so far as it affects the structure of the scale, has no direct influence on its heat-transmitting qualities.

WE have received from Mr. R. Lavachery, a Belgian engineer residing at Chapultepec, Mexico, drawings of an ingenious appliance invented by him for life-saving at sea. It consists of a rifled cannon from which a projectile is fired; to the projectile are attached a cable, an anchor, and a rocket. The mechanism is very simple, and for humanitarian reasons the inventor has not patented it.

BENJAMIN ROBINS, F.R.S., is remembered as the inventor of the ballistic pendulum and as the founder of the modern science of gunnery. As the details of his life and work are not generally known, opportunity is taken by *Engineering* (July 19), in the year of the 200th anniversary of his birth, to give detailed particulars of his career. Though he only lived to the age of forty-four, yet in that time Robins was in turn mathematical tutor, civil engineer, scientific experimenter, political pamphleteer, editor of "Anson's Voyages," and, at last, engineer-in-chief to the

East India Company. He was among the foremost mathematicians of his day, and had his life been prolonged he would undoubtedly have risen to greater fame.

No. 76 of the Publications of the Carnegie Institution contains an account of a series of researches by Prof. Theodore W. Richards, in conjunction with Messrs. W. N. Stull, F. W. Brink, and F. Bonnet, on the compressibility of a large number of the elements. A very ingenious apparatus was devised for making the measurements, and the results obtained show that the compressibility of an element is a periodic function of the atomic weight, and probably associated with the same causes which determine atomic volume and volatility.

The July number of the *Journal of Hygiene* (vii., No. 3) is devoted to reports on plague investigation in India. Further experimental evidence is detailed of the transference of plague through the intermediary of the flea. It is shown that close and continuous contact of plague-infected animals with healthy animals, if fleas are excluded, does not give rise to an epizootic among the latter, and that when fleas are present the epizootic, if it does start, varies in severity and rate of progress according to the season of the year and the number of fleas present. The season in which epizootics were readily produced experimentally, and spread rapidly, corresponds with that of the plague epidemic.

A second edition of vol. iii. of the "Descriptive and Illustrated Catalogue of the Physiological Series of Comparative Anatomy contained in the Museum of the Royal College of Surgeons of England" has been published. The volume is sold by Messrs. Taylor and Francis. It contains descriptions of the specimens in the section comprising the nerves of vertebrates not dealt with in vol. ii., and also those in the section including the organs of special sense.

The eleventh edition, revised, of Mr. W. T. Lynn's "Celestial Motions" has just been published by Messrs. Samuel Bagster and Sons, Ltd. The price of this handy little book of astronomy is 2s. net.

An interesting article, by Mr. E. V. Heward, upon the physical features of Mars, with particular reference to the habitability of the planet, appears in the August number of the *Fortnightly Review*.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences in August:—

Aug. 1. 4h. Venus and Jupiter in conjunction. Venus 0° 18′ N.
,, Daniel's comet very near Aldebaran.
2. 12h. 6m. Central transit of Saturn's Satellite Titan.
4. 12h. Vesta in conjunction with the Moon. Vesta 0° 52′ S.
,, 15h. 38m. to 16h. 20m. Occultation of χ^1 Orionis (mag. 4·7).
,, Juno very closely S. of ϕ Virginis (mag. 4·9).
10. 14h. Mercury and Jupiter in conjunction. Mercury 2° 6′ S.
10–13. Epoch of August shooting stars, Radiant 45° + 57°.
11. Uranus 1° S of 28 Sagittarii (mag. 5·6).
14. Daniel's comet near γ Geminorum.
17. 16h. 53m. to 20h. 26m. Transit of Jupiter's Sat. III. (Ganymede).
18. 9h. 51m. Central transit of Saturn's Satellite Titan.
20. 12h. 42m. Minimum of Algol (β Persei).
23. 9h. 31m. Minimum of Algol (β Persei).

Daniel's Comet (1907*d*).—Herr Kritzinger's ephemeris for comet 1907*d* is extended to August 19 in No. 4191 (p. 259, July 23) of the *Astronomische Nachrichten*, and a part of it is given below:—

Ephemeris 12h. (M.T. Berlin).

1907	α (true) h. m.	δ (true) ° ′	log *r*	log Δ	Brightness
Aug. 3	4 50·1	+16 37·5	9·9453	9·8812	13·8
,, 5	5 8·9	+16 57·8			
,, 7	5 27·8	+17 12 0	9·9116	9 8878	15·6
,, 9	5 46·5	+17 20·0			
,, 11	6 4·8	+17 22·0	9·8763	9 9021	17·2
,, 13	6 22·8	+17 18·3			
,, 15	6 40·3	+17 9 3	9·8399	9·9234	18·5
,, 17	6 57·3	+16 55·6			
,, 19	7 13·6	+16 38 0	9·8036	9·9499	19·3

An observation made on July 19 gave corrections of +4s. and +1′·9 to the ephemeris, and on that date the magnitude of the whole comet was recorded as 4·0.

Apparent path of Daniel's Comet (1907*d*). August 1–19, 1907.

From the accompanying chart it will be seen that during the period August 1–19 the comet's apparent path lies between α Tauri and λ Geminorum, its declination varying but by a small amount. On the former date the comet will rise about four hours, and on the latter about three hours, before sunrise.

The Heliomicrometer.—For the purpose of determining the heliographic positions of flocculi on spectroheliograms, quickly and accurately, Prof. Hale has devised an apparatus which he calls the heliomicrometer, and of which he gives a preliminary description in No. 5, vol. xxv., of the *Astrophysical Journal* (p. 293, June).

Briefly, it is a modification of an earlier instrument in which the spectroheliogram was projected on to a bright globe divided by meridians of latitude and longitude, the positions of the flocculi being read off directly from the globe. The angular diameter of the latter as seen from the projecting lens was, essentially, equal to the angular diameter of the sun as seen from the earth.

In the present apparatus, images of the photograph and the globe are viewed with two similar telescopes, the two images being brought into the same eye-piece. Immediately in front of the plate to be measured cross-hairs are mounted, and their intersection may be set on the particular flocculus to be measured by the observer operating from the eye-piece; during this process the bright image of the globe is occulted. The image of the properly adjusted globe is then admitted, and, by means of fine motions—again operated from the eye-piece—the intersection of the central meridian and the equator is brought into coincidence with the intersection of the cross-hairs. The amount that the globe has been rotated in each coordinate is then read off from circles fitted with verniers, and thus the latitude and longitude of the flocculus are obtained directly without any computation.

In testing the heliomicrometer method against that of the ordinary measuring machine, it was found that the results were in good agreement, and that the actual operations occupied the same amount of time, thus saving, with the former, the time taken by the computations from the polar coordinates in the latter.

SEARCH-EPHEMERIDES FOR COMET 1894 IV. (E. SWIFT).—Owing to the possibility of its identity with the lost comet of De Vico, Swift's comet of 1894 is of particular interest.

During its return of February, 1901, it was very unfavourably placed for re-discovery, and was not seen, but in the hope that it may be re-discovered during its present return, Prof. Seares publishes two search-ephemerides in Bulletin No. 12 of the Laws Observatory, University of Missouri. The former is based on elements indicating July 9 as the time of perihelion passage, whereas the second takes July 25; both show that the comet will attain its maximum brightness, as seen from the earth, about the beginning of October. It is of interest to note that the present position of this comet is near to that of comet 1907*d* (Daniel), although there is no possibility of the identity of the two objects.

According to the ephemerides, the position of Swift's comet on August 1·5 (Berlin M.T.) will be (1) 2h. 25·7m., $+12° 31'$, or (2) 1h. 51·7m., $+8° 31'$.

A QUICKLY CHANGING VARIABLE STAR.—A star having the position α=9h. 45m. 39·8s., $\delta = +12° 20'·3$ (1900·0), and situated +12·1s. in R.A. and 1'·9 in dec. from B.D. + 12°.2105, has been found by Mr. Metcalf, of Taunton (Mass.), to change its magnitude from 13·5 to 11·5 in four days. The range of variability is confirmed by the Harvard plates of this region, but the exact period has not yet been ascertained. The designation of this object is 66.1907 Leonis. (*Astronomische Nachrichten*, No. 4191, p. 260, July 23).

THE VARIATION OF THE POLE.—The provisory results obtained by the International Latitude Service during the year 1906·0–1907·0 are published by Prof. Th. Albrecht in No. 4187 of the *Astronomische Nachrichten* (p. 177, June 29). The diagram giving the projected path of the pole from 1899·9 to 1907·0 shows that during the year 1906 a further diminution of the amplitude of the variation from the mean pole took place.

UNIVERSITY REFORM.

THE discussion in the House of Lords on July 24 concerning the present state of the Universities of Oxford and Cambridge serves again to bring prominently before the public the importance of well-equipped universities to the nation. The Bishop of Birmingham asked the Government to appoint a Royal Commission "to inquire into the endowment, government, administration, and teaching of the Universities of Oxford and Cambridge and their constituent colleges, in order to secure the best use of their resources for all classes of the community." The Earl of Crewe announced at the end of the discussion that the Government requires time to consider the question, and that for the present a Commission will not be appointed. The Bishop of Birmingham unerringly exposed many of the weak points in the older universities as they are administered to-day. "The system of prize fellowships as it was established by the last Commission is," he remarked, "a mistake—post-graduate endowments should be used to subsidise either those who are to be teachers or those who are engaged in researches such as are worthy of advanced students." There were, of course, many champions to defend the present condition of things, but both sides expressed themselves as appreciative of the value to the community of higher learning in all departments of knowledge.

It was not sufficiently realised, however, that the existence of generously staffed and handsomely housed universities is ultimately a question of funds. In directing attention in these columns to the recent appeals made by both Oxford and Cambridge for funds, it was pointed out that, until as a nation we are prepared to make sacrifices comparable with those undertaken in Germany, the United States, and other countries, our older universities will continue to be a "playground for the sons of the wealthier classes" in order to secure money which is elsewhere provided by the State. There are many inquiries awaiting a Commission when it is appointed, and among them may well be a comparison of the amounts provided by the State for university work in the great countries of the world. The subjoined summary of the *Times* report of the debate in the House of Lords contains the substance of the Bishop of Birmingham's plea for a Royal Commission, the Bishop of Bristol's remarks relating to it, and the reply made by the Earl of Crewe on behalf of the Government.

The Bishop of Birmingham said, in the course of his remarks, that undoubtedly within the last thirty years immense changes had taken place in the higher education of the country—changes so immense that, unless the University was to fall out of the relation which it ought to hold to the whole education of the country, it was inevitable that reforms should be required. To an even greater extent, a fundamental change in the balance of power in the classes which formed the English nation had taken place. It had always been the honour and the pride of the old universities that they trained the governing classes of the country. The term "governing classes of the country" had, however, received a very wide extension. For example, it included now the working classes. There was a very real desire for the diffusion of higher education, and it was hardly possible to exaggerate the need for permeating those classes which were playing, and were destined to play, so increasingly an important part in the government of the country with the best education which we had to offer. Could not the university be brought into more immediate, direct, and effective relations to all those who really desired to be students and to profit by the best education the country could afford?

There could be no reasonable doubt that at present our ancient universities were allowed to become to an extent altogether beyond what ought to be tolerated a playground for the sons of the wealthier classes. As at present constituted, the universities were to a very large extent not in any serious sense places of study at all. There were a vast number of young men who never in any kind of way attained to the position of students—they never acquired the instinct or the power of getting knowledge out of books. The universities should have far more stringent and effective machinery for getting rid of those who had neither the ability nor the intention of becoming students. If those who had no real intention of becoming students were got rid of, the teachers would have more time for study and for the teaching which more properly belonged to a university; and a great deal more teaching power would be liberated for the system of university extension in the real sense—namely, for the purpose of teaching, not popular audiences, but trained and sifted students in different parts of the country, so that the influence of the university might be extended to those who were hungering and thirsting for that sort of knowledge and training which a university was able to supply.

He supposed it would not be denied that a very large part of the endowments of scholars and exhibitioners at the present time went to those who could in any case be at Oxford or Cambridge. It had been calculated recently that two in five of the scholars of the colleges did not, in fact, need the endowment in order to enable them to go there. He did not think it could be denied that the unlimited belief in open competitive examinations which characterised the last Commission had had effects which the reformers of those days never contemplated. Open competition had not really proved to be competition open to all classes; it had given an immense advantage to those whose parents were in a position to supply them with education of the more expensive kind. As a matter of fact, he expected it would be found that the universities did less now than they did generations ago to provide the crown of the educational ladder of the country. If the universities could get rid of the great body of those who had not the slightest intention of using the university as a place of study, there would be room for the employment of the endowments to do what they would all admit was the highest function of a university—namely, to provide a centre for the educational aspirations and desire for knowledge of the whole country. What they wanted was that the universities should be so re-organised and that their endowments should be so used as that, whatever there was of real intellectual aspiration and real desire for knowledge, should find its home and instruction in Oxford and Cambridge; and that, and nothing else, should be the real object which the universities manifestly existed to serve. As to the use of post-graduate endowments, there seemed to be wide agreement that the system of prize fellowships as it was established by the last Commission was a mistake—that post-graduate endowments should be used to subsidise either those who were to be teachers or those who were engaged in researches such as were worthy of advanced students. In order to redress the balance between the wealth of the colleges and the poverty of the university the principle had been established that the colleges should contribute to the needs of the university. But there was a widespread idea that certain colleges had in recent years grown very wealthy, and that the subsidies from the colleges to the university were in a number of cases very inadequate. If another Commission were appointed, it would be part of the duty of that Commission to inquire into the uses made of the college endowments, as well as the university endowments, and, perhaps, carry further the principle established by the last Commission of contribution from the colleges to the university.

The Bishop of Bristol spoke against the proposal, so far as Cambridge was concerned. He endeavoured to show that Cambridge had adapted itself to modern conditions, and he hoped that, as regarded Cambridge, the Government would not trouble the Commissioners with an inquiry. Last year the endowment of the University of Cambridge from its own property, which it could spend as it would, was half as much again as when he left the University, and it had now reached the large sum of 1965*l.* 6*s.* 4*d.* The quarterly payments from members were 14,500*l.*, fees for degrees 28,000*l.*, and oddments 1000*l.*, which, with 30,300*l.* received from the colleges, made a total receipt of 75,000*l.* or 76,000*l.* There were besides trust funds for various professorships, scholarships, studentships, and prizes. The estates of the colleges provided 220,000*l.*, while fees, rent of rooms, &c., amounted to 90,000*l.* The estate management of that 220,000*l.* cost only 7 per cent., but the management, rates, taxes, improvements, and cost of the national monuments came to 130,000*l.* This left a net amount for all purposes of 180,000*l.* Of this, scholarships absorbed 32,000*l.* It was difficult to imagine that Cambridge could have adapted itself more completely to modern conditions. But if a Commission were issued, it would be received, not only respectfully, but willingly; for a Commission could cut some knots which the University could not, or would not, cut for itself. One of these was the question of Greek. Science students ought to be allowed to pass their examinations without a knowledge of Greek. He suggested a small statutory Commission which would be able to make statutes having the force of law. It should be composed of experts who were not faddists and who had full sympathy for the new as well as full respect for the old. The Government might, perhaps, issue two Commissions, one for Oxford and one for Cambridge. Let them give the Bishop of Birmingham all he asked for; but not one-tenth part was necessary for Cambridge. The Government might well, in grateful recognition of the wonderful manner in which Cambridge had adapted itself, in spite of restricted means, to modern conditions, declare that they would secure to the University an additional 75,000*l.* a year.

In replying on behalf of the Government, the Earl of Crewe said:—There is no doubt that for some time what may be called university reform has been in the air. That is due to a variety of causes. The fields of study have been widely expanded in the manner so fully described by the Bishop of Bristol. Then there has been the upspringing of the new provincial universities with all their consequences; and there has within the last few years been impressed upon the public mind the whole question of university extension and the methods by which the endowments of the universities can in some way be applied for the benefit of those poorer citizens of this country for whom, as has been so truly said, they were originally intended.

The appointment of a Commission is urged upon various grounds. We are told that it is important to deal with the problems of the government and constitution of the universities, and to deal with the problems of study, both as regards the nature of the different studies carried on and what I may call the financial side of the question—such matters as scholarships and prize fellowships. Then, again, it is urged that the relations between each university and its colleges, and between college and college—with special relation, of course, to endowments—demand a close inquiry. We are reminded, too, that it is almost thirty years since the last Commission sat, and that even if the universities desired to reform themselves from within, yet it would not be possible for them to do so without the intervention of a Royal Commission. And it is further pointed out that the very work of the last Commission has in some cases proved to be of an actually hampering nature, and that the errors into which as human beings the commissioners in some cases naturally fell could only be set right by legislation founded on the report of a further Commission. Those are the reasons for which we are told that a Commission ought to be appointed. On the other hand, certain objections have been made, both in the course of the debate and outside. Lord Burghclere specially alluded to the requests which have been made by the Chancellors of both universities publicly for those who have been educated at each respectively to come to their aid. They no doubt bear in mind the fact that if such a movement is to succeed it must be to some extent of a national character, because the old universities cannot make those appeals to local patriotism which have been responded to so freely in the case of the newer universities. I have no doubt, also, that they compare the state of things somewhat sadly with what obtains in the United States, where it is estimated that during the last thirty years 48 millions sterling have been privately subscribed for the benefit of the universities of America. And my noble friend argued that, if we were now to accede to the request for the appointment of a Royal Commission, the flow of money which has come in to some extent, and which, it is hoped, will come in to a greater extent, would be, if not stopped altogether, seriously checked. Then, further, it is urged against the appointment of a Royal Commission that, although it is true that there are certain things in the direction of allowing greater flexibility to colleges and universities which the new Commission might do by undoing what has been done by the last one, still you cannot have any guarantee that the Royal Commission would undertake that duty, and that it might not imitate its predecessor in making very distinct and positive suggestions which would have to be carried out, and some of which might prove, as former ones have proved, to be erroneous and unfortunate. And, again, we have been told that really more time is wanted to watch the effect upon our national life and our education generally of the foundation of the new universities. It is urged that it is only after some experience of their work that we can decide what place Oxford and Cambridge really ought to take in our national life. Everyone will, I think, agree that we do not wish these universities to plunge into a competition of science and technology with such universities as those of Leeds and Birmingham, and consequently we are asked to wait in order to see what the next few years at any rate may bring.

Those are the various opposing views which are set before His Majesty's Government. I may remind the House that the Government, as such, has only had the opportunity of considering this matter at all for about ten days, and we certainly do feel that the appointment of a Royal Commission, like other important events in life, is one which is not to be undertaken lightly or inadvisedly. We have, as a matter of fact, only what I may call casual evidence of the feeling which actually exists either at Oxford or Cambridge, such intimations as people have been kind enough to send before this debate began, and we have learned very much from what the various speakers in the course of the discussion itself have said. But it is important for us, before arriving at a final conclusion, to know what the most thoughtful and the most competent opinion at both universities really demands, and we also must either inform ourselves or be informed exactly what the universities cannot do of their own motion and for what purposes legislation would be required on the recommendation of a Commission, and we should also desire to be informed as to whether there does exist at the universities anything like a deadweight of obstruction against reforms which is of the character which could only be removed by statute. Consequently, therefore, we desire time to consider this matter in the light of the best information which we can receive, and we look with confidence for help and suggestions as to the best methods of proceeding from those of both universities who are most competent to give it. In the meantime, I am quite confident that this discussion will of itself have done good and have been useful. This is one of the subjects on which, in Carlyle's famous phrase, "if we differ we differ only in opinion." It is merely a question of honest differences of opinion as to what the best way to proceed is in order to do what we all wish to be done; and certainly it does seem to me that the best minds of those who are either at the universities or who are interested in the universities cannot possibly be applied to a higher object than that of putting these ancient homes of learning, which many of us so deeply venerate, with all their splendid traditions, to the fullest possible use, and, where necessary, of bringing them into closer conformity with the needs of the country and with what, in the opinion of those best qualified to judge, is the truest conception of learning as it should exist to-day.

ARCHÆOLOGICAL EXPLORATIONS IN CHINESE TURKESTAN.

FURTHER news of Dr. M. A. Stein's archæological explorations in Chinese Turkestan has now been received. After leaving Keriya at the beginning of the winter, he proceeded eastwards 1200 miles along the borders of the Taklamakan desert to the Lop-nor region, where he intended to excavate. On the way he made further investigations at the Rawak Stupa, in the Hanguya Tati, and at the Domoko desert site, where he found remains of the Dandan-Uiliq period, the eighth century A.D. At the desert-site north of Niya, where in 1901 he had discovered the remains of a settlement buried in the third century A.D., renewed excavations brought to light more interesting and important antiquities of the same kind as those discovered in 1901, especially noticeable being the wooden tablets inscribed in Kharoshthi. Among the clay seals of these tablets, impressions from Græco-Roman intagli are the commonest.

Dr. Stein passed the scene of his former work at Endere on his way eastwards, and also made further investigations there. Evidence was now found that this site also was originally occupied in the time of the Indian "Kharoshthi"-using kingdom, and had been abandoned and re-occupied by the Chinese in the seventh century, only to be abandoned again after the Tibetan conquest a century later. During the period of their first abandonment, the Endere settlements were seen as ruins by the great Chinese pilgrim Hiuen-Tsang.

Similarly, the oasis of Cherchen, which Dr. Stein reached after leaving Endere, has undergone various vicissitudes of settlement and desolation, having come into being again only a few years ago, when, after the re-conquest of Turkestan, the Chinese made it a penal station for refractory Turkis and Tibetans. Since Marco Polo's day it had been abandoned, but then it was a flourishing province, which had grown up since the time of Hiuen-Tsang, who had seen but the desolate and uninhabited ruins of what had once been a town, where in 519 A.D. a previous Chinese pilgrim had found a hundred families living. The Taklamakan desert now encroaches, now recedes; now there is plenty of water, now little, and so the southern oases wax and wane and wax and wane again.

Dr. Stein's objective being the Lop-nor region, he passed on beyond Cherchen to Charkhalik, in the Tarim basin, finding various Mohammedan remains on the way. From Charkhalik he marched to Abdal, and thence more than a hundred miles northward into the salt desert, to an ancient site discovered by Dr. Sven Hedin in 1900. As it is only in winter that explorations in these deserts can be conveniently carried on, the rigours of the Central Asian winter had to be faced by Dr. Stein now as in the Taklamakan six years before, and 48° F. of frost, coupled with an icy boreal wind, were the usual weather.

On December 17 Dr. Stein reached the site, and pitched his camp at the base of the ruined stupa of the ancient town. This turned out to be very like Niya, and is of the same date (third century A.D.). Not only were masses of Chinese correspondence of that period found, but also, what was really unexpected, large numbers of Kharoshthi documents, which show that the Indian kingdom of Khotan included, not merely Cherchen, but the distant Lop-nor district in its dominion. The whole, then, of the Tarim basin must have been ruled by the Indian maharajas of Khotan in the third century A.D. This is a new contribution to history.

This eastern extension of the Buddhist kingdom of Khotan, which took its origin from that of Gandhara, explains more and more the close original connection between the hellenised art of India and that of China, and shows how the sculpture and painting styles of Gandhara passed, with their Greek character, which they derived from the influence of the Seleuoid kingdom, easily by way of Turkestan to northern Tibet and so to China and Japan.

The Lop-nor settlement was occupied by the Chinese in order to control the road from Turkestan to Kansu; Sha-chau, the nearest Chinese town, lies 300 miles east of the Lop-nor district.

Among the most important and interesting of Dr. Stein's discoveries have been those made at Miran, an ancient site in the Charkhalik district, which throw light on the connection between Græco-Indian and Chinese art. In the débris mounds of a fort and stupa-shrines he has found this time frescoes in which the influence of classical art is reflected with surprising directness.

"The main paintings, which illustrate scenes of Buddhist legend or worship, are remarkable for clever adaptation of classical forms to Indian subjects and ideas. But even more curious are the figures represented in the elaborate fresco dados. They are so thoroughly Western in conception and treatment that one would expect them rather on the walls of some Roman villa than in Buddhist sanctuaries on the very confines of China. One cycle of youthful figures, in a gracefully-designed decorative setting, represents the varied joys of life—a strange contrast to the desolation which now reigns in the desert around the ruins and, in fact, through almost the whole of this region. Kharoshthi inscriptions, painted by the side of the frescoes, and pieces of silk bearing legends in the same script, indicate the third century A.D. as the approximate period when these shrines were deserted."

From this account the importance of Dr. Stein's further archæological discoveries is evident, and both he and his German imitators in the Turfan district, 200 miles north of the Lop-nor, have added by their work a new chapter to history. We cannot doubt that Dr. Stein has added more to our knowledge by his fortunate expeditions to Turkestan than had he, as he tells us his dearest wish was to do, devoted himself to the exploration of Iranian antiquities in northern Persia. We knew much about Persia, nothing about the ancient Indian kingdom in Chinese Turkestan which Dr. Stein has discovered.

Dr. Stein's minor object, the control of a trigonometrical survey of the northern slopes of the Kuen-lun for the Indian Government, has also been carried out with success by Surveyor Rai Ram Singh. The net of the Indian trigonometrical system has been extended from the headwaters of the Keriya River along the mountain slopes above Surghak and along the chain which Continental geographers call the "Russian," with its peak dubbed "Tsar Liberator," right through to the mountains between Cherchen and Charkhalik. This is a great achievement.

Why, by the way, our Continental friends call this range "the Russian chain" is not quite apparent. Russia is still a long way off, and Japan has rendered it improbable that Russian earth-hunger will ever be able to extend the dominion of the White Tsar, as was once hoped by his subjects, to the borders of Tibet. The "Yellow Tsar," the "Bogdo-khan" in Peking, still rules the lands which his ancestors held two thousand years before St. Petersburg was built, and that his subjects are worthy to administer this dominion is evident from what Dr. Stein tells us of the civilised rule of the Chinese, and of the constant friendliness of the Imperial authorities to his mission and their keen interest in his archæological discoveries. The thanks of Western science are due to the Chinese for their ever-ready help to Dr. Stein, without which his discoveries would have been impossible to achieve.

NEW HIGH VACUUM PUMP.

NO laboratory, either chemical or physical, can be carried on to-day without a vacuum pump of some form or other, and in many laboratories it is essential that the pump shall be capable of producing the very

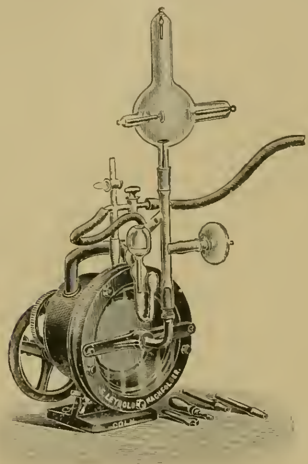

FIG. 1.

highest degree of evacuation. Not only is it necessary to be able to produce a high vacuum, but it is also eminently desirable that it should be possible to produce the state of evacuation as rapidly as possible.

The new high vacuum pump of Dr. Graede, manufactured by E. Leybold's Nachfolger, Cologne, would appear to meet these desiderata. It is claimed that with this pump the highest vacua yet obtainable are secured in a minimum of time. The pump is also simple and compact, and may either be mechanically or hand driven.

The pump which is illustrated in Fig. 1 consists of an iron vessel, half filled with mercury, in which a porcelain drum divided into three chambers rotates. When the drum is rotated the chambers into which it is subdivided are filled alternately with air and mercury. In the first place the chambers suck the air from the receiver, and during further rotation the air is expelled and its place taken by mercury. Fig. 2 shows a section of the pump, one-fourth the actual size. G is the cast-iron casing, which is glazed inside and is cast on to a strong base. The front of the pump consists of a thick plate of glass cemented into the frame P. It is then screwed tightly on to the frame against rubber rings, in order to make an air-tight joint. Three holes are bored into the glass plate, by means of which the two tubes R and R′ and the tap at the bottom are attached. The tube R is connected by means of the glass apparatus, Fig. 3, with the receiver, and R′ with a second pump which serves for preliminary exhaustion. The tap is for introducing mercury into the pump and also for emptying it. The auxiliary pump may be a water injector or any other suitable form of pump which is

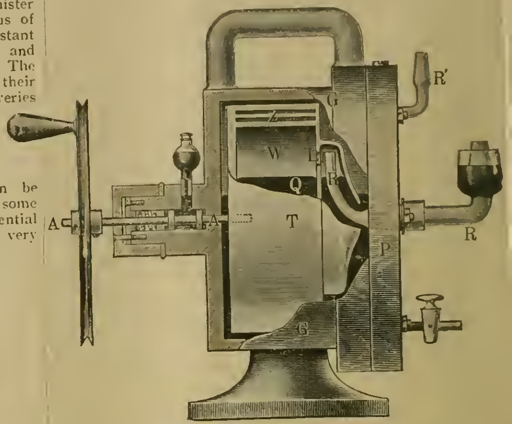

FIG. 2.

capable of giving a vacuum of from 15 to 20 mm. T is the porcelain drum which is attached to the axle A, passing through the casing by means of an air-tight joint, to which is attached the driving wheel.

In using the pump, exhaustion up to 15 to 20 mm.

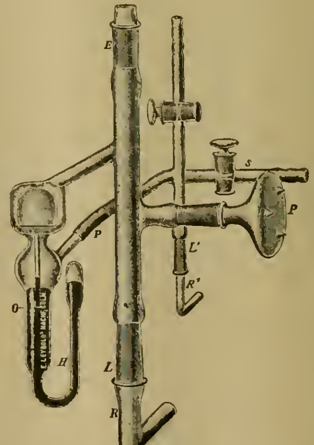

FIG. 3.

is first produced by means of the auxiliary pump; the drum is then slowly rotated in a direction contrary to the hands of a clock. The space W thus increases in size and air is sucked through the opening L. As rotation is continued the opening L passes below the level of the mercury, and the air in the chamber is no longer in connection with the receiver. But as the drum contains three chambers, one of them is always above the mercury; hence the action is continuous. As the chamber revolves W becomes more and more immersed in the mercury, and the air is forced out through the channels Z into the space between the drum and casing, from whence it is removed by the auxiliary pump.

Fig. 3 illustrates the glass attachment, which can be fitted on to the tubes R and R′, Fig. 2, by means of the ground pieces L and L_1. The receiver to be exhausted is attached at E. A manometer H, with a drying chamber P filled with phosphorus pentoxide, is employed to measure the pressure. It also serves as an automatic valve; at atmospheric pressure the orifice O is open; therefore the auxiliary pump connected at S exhausts the receiver fitted at E, directly through the opening O and the connecting tube P. On a vacuum of 20 mm. being attained, the mercury sinks in the right-hand limb, and, rising on the left, closes the opening O as illustrated in the figure; the mercury pump is then started.

Figures are supplied showing the extreme vacuum which can be obtained in a few minutes. Thus in five minutes the MacLeod gauge registered only 0·027 mm., and after fifteen minutes 0·000003 mm. This shows that the pump works extremely rapidly and very efficiently. If it is capable of doing all that is claimed for it, the Gaede pump should prove of great value either for research work or for showing lecture experiments with high vacua.

THE CAUSE OF EARTHQUAKES.

Among the results produced by the San Francisco earthquake of April 18, 1906, must be reckoned a memoir, by Prof. T. J. J. See, covering 140 pages of the Proceedings of the American Philosophical Society (vol. xlv., October–December, 1906), on the cause of earthquakes, mountain formation, and kindred phenomena. The explanation adopted is a development of an old-fashioned idea, and is supported by quotations from the writings of natural philosophers from Aristotle down to Charles Darwin. Earthquakes, with volcanoes and mountain ranges, are all ascribed to the explosive power of steam formed within or just beneath the heated rocks of the earth's crust, chiefly by the leakage of sea water through the ocean beds; the pressure of this steam forces the lava in a lateral direction, and its subsequent condensation leads to the subsidence of the sea bottom often observed after great earthquakes; the lava forced aside may either break out through volcanic vents or may lift the overlying rocks into mountain ranges, and, when the movement is sudden, give rise to faults and fractures which are the result, not the cause, of earthquakes.

It is round these last words, italicised by Prof. See, that criticism naturally centres, and the first consideration which arises is the verbal one of what is an earthquake and what is a cause. An earthquake, as ordinarily understood, is a shaking of the earth, and this shaking is due, wholly in the great majority of cases, and very largely in the remainder, to the molecular movements involved in the transmission of elastic wave motion. In the case of great earthquakes, fractures of the solid rock, accompanied by more or less displacement of the opposite sides of the fissure, are often found, and as the shaking of the earth is greatest near these, and the disturbance is propagated outwards from them, they have been regarded as the cause of earthquakes. In other cases, where no actual fissure is observed at the surface, there is good reason to suppose that the earthquake was caused by an underground fracture, which did not reach the surface, and there can be no doubt that this explanation is adequate in almost, if not quite, every case; but even if the fracture is the immediate cause of the disturbance which is commonly known as an earthquake, the explanation is still incomplete, for we have not reached the cause of the fracture.

It is to this ultimate cause that Prof. See appears to apply the term earthquake, and he is probably right in rejecting the tectonic hypothesis either in the form in which it presents itself to him or in the more ordinary one which regards the fractures as the result of compressional strains, largely due to the secular contraction of the earth, but his explanation fails to account for the remarkable connection between the irregular shifting of the earth's axis and the occurrence of great earthquakes. That these irregular movements of the axis are greatest when large earthquakes are most frequent is a certain, but as yet unexplained, fact; it seems to necessitate displacements of matter in the earth on a far larger scale than is indicated by the differential measurements which alone are open to us. Prof. See's explanation, though it provides for lateral and vertical displacements of matter, necessitates the elevations and depressions being so closely contiguous as practically to neutralise each other's effects, and, therefore, fails as an explanation of the ultimate cause of earthquakes, while it in no way affects the current acceptance of fracture as their immediate cause.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Leeds.—The retirement of Prof. Miall, F.R.S., from the chair of biology, which he has occupied in the Yorkshire College, and subsequently in the University of Leeds, since the year 1876, was recently made the occasion for expressing in a tangible way the esteem and regard in which he is held by his colleagues and friends. A testimonial committee, of which the Vice-Chancellor (Dr. Bodington) was chairman, was formed, and a ready response was obtained to the circular inviting subscriptions for this purpose. Among the testimonials to Prof. Miall which have been thus provided is a portrait by Mr. Frederick Yates, intended to be hung in the hall of the University. The presentation of this portrait was made at a recent meeting in the University library, when a large number of his colleagues and friends were present. The Vice-Chancellor, who presided and made the presentation, spoke in warm and feeling terms of the eminent services which Prof. Miall had rendered to the college and University, as well as to the cause of science, and described him as having been original as a teacher, eminent as a scientific worker, and active as a business colleague. Subsequent speakers included Mr. S. P. Unwin, Dr. Eddison (emeritus professor of the University), and Prof. Smithells. Prof. Miall, in acknowledging the presentation, gave a short historical sketch of the foundation of the Yorkshire College of Science and its development into the Yorkshire College and subsequently into the University of Leeds.

The chair of biology will in future be divided into the professorships of zoology and of botany. To the former has been appointed Dr. Walter Garstang. Prof. Garstang has held research fellowships in zoology at Owens College, Manchester, and subsequently at Lincoln College, Oxford, where he has filled various appointments as lecturer and examiner. He is at present chief naturalist to the Marine Biological Association in charge of the Lowestoft Laboratory.

To the chair of botany Mr. V. H. Blackman has been appointed. Prof. Blackman was sometime fellow of St. John's College; he has held an assistantship in the British Museum, having charge of the collection of fungi, and he is at present engaged in botanical teaching, being a recognised teacher of that subject in the University of London.

In connection with the new department of fuel and metallurgy under Prof. Bone, F.R.S., the Institute of Gas Engineers has established a research fellowship of the value of 100*l.* a year.

The extensions of the University buildings upon which the council is at present engaged comprise:—(1) an extension of the main building in College Road for the better accommodation of biology and of arts teaching; (2) an extension of the civil and mechanical engineering department; (3) the erection of a detached block for the department of electrical engineering; (4) an extension of the cloth finishing department; (5) the completion of the block of buildings for the mining and metallurgical departments. The last-mentioned block will be ready for occupation by the students at the beginning of next session, in October. In addition to these buildings, the University is erecting a new boiler house and lavatories; is proposing to extend the refectory; is adapting a large dwelling house for the purposes of an extension of the geological department, and is uniting the house by means of a bridge at the first-story level with the present geological department of the University; and is adapting other dwelling houses for the use of women students and for seminar work.

THE second International Congress on School Hygiene will be opened on August 5, at the request of the King, by Lord Crewe. The complete success of the meetings seems to be assured. The German Government has not only decided to send delegates to the congress, but, by permission of the Kaiser, Prince Eitel Friedrich has accepted the office of a vice-patron of the congress. While still adhering to its resolution not to issue official invitations to foreign Governments to send delegates, the Board of Education has arranged with the Foreign Office to take such steps as are likely to remove any misunderstanding which might have prevented some foreign delegates from accepting the invitations issued. The meetings will be held at the University of London, and will last until August 10. Sir Lauder Brunton, F.R.S., the president, will deliver the inaugural address on August 5. The sectional meetings will commence on the following day. There are eleven sections in all; their subjects and the name of the president in each case are as follows:—(1) The physiology and psychology of educational methods and work, Sir James Crichton Browne, F.R.S.; (2) medical and hygienic inspection in school, Prof. W. Osler, F.R.S.; (3) the hygiene of the teaching profession, Dr. T. J. Macnamara, M.P.; (4) instruction in hygiene for teachers and scholars, Sir William J. Collins, M.P.; (5) physical education and training in personal hygiene, Sir John W. Byers; (6) out-of-school hygiene, holiday camps and schools: the relation of home and the school, Lord Kinnaird; (7) contagious diseases, ill-health, and other conditions affecting attendance, Sir Shirley F. Murphy; (8) special schools for feeble-minded and exceptional children, Mr. W. H. Dickinson, M.P.; (9) special schools for blind, deaf and dumb children, Lord Crewe; (10) hygiene of residential schools, Dr. Clement Dukes; (11) the school building and its equipment, Mr. T. E. Colcutt. An exhibition of school building and furnishing appliances has been arranged in connection with the congress.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 6.—"On the Two Modes of Condensation of Water Vapour on Glass Surfaces, and on their Analogy with James Thomson's Curve of Transition from Gas to Liquid." By Prof. Fred. T. **Trouton**, F.R.S.

Experiments made with glass wool to determine the amount of water condensed on the surface of glass when in equilibrium with various vapour pressures showed that below a critical pressure, which is about 50 per cent. saturation, there are two distinct modes in which the condensed water can exist.

Thus for the same vapour pressure, if the condensation is in one of these forms, called for convenience the α type, there is much less condensed material present on the surface than in the other form, called the β type; or, to put it in another way, for the same amount of condensed vapour the pressure is greater when the condensation is of the α form than when it is of the β form.

Condensation will take place of the α type if the surface has been thoroughly dried at high temperatures, while of the β type if the drying has only been effected at ordinary temperatures, though in that case also the vapour pressure may be zero.

When the condensation is of the β type the curve, connecting pressure with the amount of condensed water, is found to be very similar to that for wool or cotton, but when the condensation is of the α type the curve is quite different. Thus, starting with the surface very dry, the pressure runs up quickly for relatively little condensation until a critical pressure is reached; after that, on further additions to the surface condensation, the pressure diminishes. This is attributed to a transformation into the β state supervening at this point, when consequently the vapour pressure is in excess of equilibrium, and thus a depletion of the vapour in the surrounding space results, with a corresponding fall in vapour pressure. If moisture be continuously supplied the pressure will, after reaching a maximum, begin to rise, and ultimately pass to saturation.

The analogy with James Thomson's curve of transition from gas to liquid is pointed out. In the one case there is attraction between water-vapour particle and water-vapour particle, in the other between glass and water vapour. The condensation of the α type corresponds to the supersaturated vapour stage in the transition curve, while the β corresponds to its liquid stage.

Where the surface is not completely dry, the fact that the condensation is in the β form, on vapour coming in contact with the surface, is attributed to there being an example of that type already on the surface; but if this is not present, that is, if the surface is desiccated, the condensation is of a type allied to supersaturated vapour rather than to the liquid.

A paradoxical consequence of there being these two modes of condensation is pointed out, namely, that a relatively wet surface is capable of drying one wetter than itself.

As an illustration of the phenomenon a simple experiment is given, in which two dishes of phosphorus pentoxide are placed under a bell jar, with only this difference, that one of the dishes is first made dry by heating. It is then found that the pentoxide which can initially obtain some moisture from contact with the damp dish absorbs the moisture in the bell jar, and ultimately runs liquid, while the other remains dry.

"On the Velocity of Rotation of the Electric Discharge in Gases at Low Pressures in a Radial Magnetic Field." By Prof. H. A. **Wilson**, F.R.S., and G. H. **Martyn**.

The apparatus used in this investigation was a small vacuum tube consisting of two concentric glass tubes cemented into aluminium discs. The discs served as electrodes, and the discharge was passed between them through the annular space between the glass tubes.

An iron bar was fixed along the axis of the vacuum tube, and could be magnetised so as to produce a radial field in the space between the glass tubes.

The discharge was produced by a large secondary battery, and its velocity of rotation round the annular space was measured. The variation of the velocity with the strength of the magnetic field, with the pressure of the gas, and with the current carried by the discharge, was investigated in air, nitrogen, and hydrogen.

The velocity was found to be nearly proportional to the strength of the magnetic field and inversely proportional to the gas pressure. The velocity in hydrogen was about thirteen times the velocity in air or nitrogen.

It is shown that theoretically the velocity should be proportional to the product of the two ionic velocities, and the results obtained, together with previous measurements of the Hall effect, enable the velocities of both the positive and negative ions to be calculated. The negative ions are found to have much higher velocities than the positive ions.

June 13.—"*Miadesmia membranacea*, Bertrand; a New Palæozoic Lycopod with a Seed-like Structure." By Dr. M. **Benson**. Communicated by Dr. D. H. Scott, F.R.S.

The vegetative organs of this interesting new type were discovered by Bertrand in 1894. He found them in sections of a calcite nodule from the Gannister beds of Hough Hill, England. A large quantity of new material has become available, and now not only are more details known as to the vegetative organs, but a fairly complete knowledge of the reproductive organs is possible.

Miadesmia was exceedingly minute, its stem slender and without any trace of skeletal tissue. It is the first Palæozoic Lycopod of herbaceous character known structurally. The megasporophylls, which were identified by Dr. D. H. Scott, F.R.S., in 1901, show a more advanced type of seed habit than has hitherto been met with in Cryptogams. The megasporange gives rise to but one thin-walled spore, which in development and structure resembles an embryo sac and germinates *in situ*. An integument surrounds the sporange, leaving but a small orifice as micropyle. This is surrounded by numerous long processes of the integument, which formed a collecting and incubating apparatus for the microspores. There is no trace of an envelope about the microsporange. The carpellary leaf was shed at maturity, and resembles a winged seed.

Disregarding the structural modifications of the megasporophyll, the nearest affinity of Miadesmia among forms so far known seems to be with the non-specialised species of Selaginella, such as *Selaginella selaginoides*, but the foliage leaves show the archaic leaf-base comparable with that of Lepidodendreæ.

"The Inhibitory Action upon Subsequent Phagocytosis, exerted on Active Normal Serum by Inactive Normal Serum through which Bacilli have been passed." By J. C. G. **Ledingham.** Communicated by Dr. C. J. Martin, F.R.S.

When inactivated normal serum is digested with tubercle bacilli, and finally freed therefrom by the centrifuge, it is found that the supernatant fluid has the property of inhibiting to a great extent the opsonic action of fresh normal serum, not only towards the tubercle bacillus, but also towards the *Staphylococcus pyogenes aureus*. The author interprets the phenomenon thus:—The amboceptors of heated normal serum combine with the tubercle bacilli and also with their free receptors, which remain in the supernatant fluid after removal of the bacilli. When this supernatant fluid containing the "free receptor amboceptor" combination, is added to fresh normal serum, the latter's complement becomes fixed, and consequently in the presence of fresh bacilli, opsonic action is inhibited. The experimental results obtained lend support to the view that the opsonic action of normal serum depends on the cooperation of complement with normal amboceptor.

June 20.—"Preliminary Note on a New Method of Measuring directly the Double Refraction in Strained Glass." By Dr. L. N. G. **Filon.**

If a plane wave of light be passed horizontally through a rectangular slab of glass under flexure in a vertical plane, it is broken up into two components polarised horizontally and vertically.

The light of either component suffers, owing to the stress, an additional retardation proportional to its distance from the "neutral axis," *i.e.* the mid-level of the slab. Thus the wave-front on emergence is no longer vertical, but has suffered a deviation proportional to the bending moment applied. The two components, however, are deviated by different amounts.

If the light be then analysed by a grating, the lines of the spectrum formed will be shifted, in consequence of the change in the angle of incidence. In addition, owing to the different shifts of the two components, each line appears doubled.

Experiment shows that the effect is quite measurable, and provides a new method for measuring directly the doubly refracting effect of stress, giving, not only the difference between the retardations of the two components, but the absolute amounts of each.

With a grating of 14,000 lines to the inch, the maximum separation of the components, for lines in the yellow, was about the distance between the two D-lines.

"On the Origin of the Gases evolved by Mineral Springs." By the Hon. R. J. **Strutt,** F.R.S.

It has long been known that thermal springs, such as those at Bath, give off considerable quantities of gas, which bubbles up with the water, and consists, for the most part, of nitrogen. Of recent years, interest in this subject has been revived by Lord Rayleigh's observation that helium and argon are present along with nitrogen.

It has been found that such gases, when fresh, are rich in radium emanation, and that the deposit thrown down by the water on standing contains a notable quantity of radium. It is natural to connect this observation with the discharge of helium by the springs. The author was formerly inclined to think that the facts were most easily explained by supposing that the supplies of helium and radium were derived from the disintegration of uranium lodes at a great depth by the water, but this view scarcely seems compatible with the universal presence of helium and radium in mineral springs, which has since been brought to light; for uranium lodes are very rare near the earth's surface, and there are fatal objections to supposing that metal to be generally more abundant at greater depths.

The unexpectedly large quantities of radium found in common rocks led the author to suspect that perhaps they might after all be able to supply the helium and radium products, as well as the ordinary gases and saline constituents of the spring. With the view of deciding this question, he has examined the inert portion of the gases given off by several varieties of rock on heating. The subject has attracted some attention from previous experimenters.

The results for two normal rocks were as follows:—

Matopo Granite. Quantity taken, 850 *grams*.

The inert residue consisted of

Nitrogen	11 c.c.
Argon	0·14 c.c.
Helium	0·04 c.c.
Neon	traces

Syenite Rock, Mt. Sorrel, Leicestershire. Quantity taken, 900 *grams*.

Inert residue—

Nitrogen	9 c.c.
Argon	0·026 c.c.
Helium	0·010 c.c.
Neon	traces

In both these cases, the vacuum tube, after removal of argon, gave a brilliant yellow helium glow.

We may compare these analyses with the composition of the Bath gas, as a type of the gases evolved by mineral springs. The total volume of inert gas (mainly nitrogen) is taken as 100.

Gas	Argon Per cent.	Helium Per cent.	Neon
Bath spring	1·5	0·12	traces
Matopo granite	1·27	0·36	traces
Syenite, Mt. Sorrel ...	0·29	0·11	traces

These figures make it fairly clear that there is a general resemblance between the gases of mineral springs and the gases of rocks, so far as nitrogen and the other inert constituents are concerned.

In addition to these constituents, rocks give off hydrogen, carbonic oxide, carbonic acid, and a little methane. The two former are probably secondary products, produced by chemical actions set up on heating. Carbonic acid is represented at the spring by the dissolved carbonates of the mineral water, while methane is present in the evolved gases. The author thinks, therefore, that we may consider that the disintegration and partial solution of ordinary rocks by water at a high temperature accounts for the gaseous, as well as the solid, products, delivered by springs such as those at Bath.

With regard to the primary origin of the argon and neon contained in rocks, the author has no theory to offer. It is natural, however, to associate the helium of rocks with the radium they contain. The relative quantities are quite in accordance with such a view, for the ratio is of the same order as in the strongly radio-active minerals. The author hopes to discuss this subject in detail in a future paper. He has found at least traces of helium in almost all of a considerable collection of ores and other minerals, but hitherto only one case has been found—in certain beryls—where there seems to be sufficient reason to look for any other cause than traces of the radio-active elements to explain its presence. The evidence so far obtained is not favourable to the view that the ionising radiation from ordinary substances is accompanied by production of helium.

June 27.—"On a Standard of Mutual Inductance." By Albert **Campbell.** Communicated by Dr. R. T. Glazebrook, F.R.S.

The author has designed a standard of mutual inductance of such a nature that its value is accurately calculable from the dimensions, and large enough to give good sensitivity in actual use. A high enough value (say 0·01 henry) can be got by having one of the associated circuits a coil of many layers. The objections to such a coil are overcome as follows:—

The primary circuit is a pair of single-layer coils wound on a single marble cylinder; their dimensions can be accurately determined. The secondary is a coil of many layers co-axial with, and midway between, the two primary coils, and of such radius that the mutual inductance is a maximum for change of radius. A series of curves is given from which the proper dimensions were chosen. All round the mean circumference of the secondary coil the magnetic field due to the current in the primary coils is zero, and is very nearly so over the section of the winding, thus allowing accurate calculation. The principle is applicable to other problems involving mutual inductance.

PARIS.

Academy of Sciences, July 22.—M. A. Chauveau in the chair.—A phenomenon resembling the spheroidal state: G. **Lippmann.** A strip of plaster of Paris adhering to a plane surface of glass becomes detached on raising the temperature above 100°, sliding over the surface with the greatest ease.—The effect of oxygen, osmotic pressure, acids, and alkalis in experiments on parthenogenesis: Yves **Delage.** The presence of oxygen is not necessary for the determining of parthenogenesis in starfish—it is even harmful; the presence of divalent ions is not at all essential, a solution of sodium chloride being often sufficient among sea-urchins. The requisite condition of parthenogenesis among certain of the latter consists in the treatment of the eggs by an acid solution, afterwards an alkaline, the first coagulating, the second liquefying certain constituents of the egg protoplasm.—The dielectric cohesion of helium: E. **Bouty.** By repeated purifications, the value of the dielectric constant was found to be reduced from 61·8 to 18·3.—The effect indicated by the electrolytic detector: M. **Tissot.**—A new optical property of magnetic bi-refraction belonging to certain non-colloidal organic liquids: A. **Cotton** and H. **Mouton.** Nitrobenzene shows a magnetic bi-refraction of positive sign, increasing proportionally to the square of the field and the thickness traversed. This property is more or less marked throughout the aromatic series, but not among aliphatic compounds.—The spectrophotography of minerals in different regions of the spectrum; galena and argyrite: A. **de Gramont.**—The coagulation of albumins by the actions of ultra-violet light and radium: Georges **Dreyer** and Olav **Hanssen.** Both serous and egg albumin are coagulated under the action of a prolonged intense light. The serum of the horse is only slightly coagulated by light; a solution of peptone remains clear, though becoming yellow, the same effect being also noticeable with casein. These results are all due to the ultra-violet portion of the light. Radium coagulates vitellin, but apparently no others.—The heats of formation of alkaline protoxides: E. **Rengade.**—A mixed anhydride of sulphuric and nitric acids: Amé **Pictet** and Georges **Karl.** Nitric anhydride dissolves with evolution of heat in freshly distilled liquid sulphuric anhydride. The product distils entirely at 218°–220°, and analysis shows it to have the composition $(SO_3)_4N_2O_5$.—The combination of nickel and cobalt with boron: Binet **du Jassonneix.** Compounds have been obtained of the composition NiBo and CoBo (already described by M. Moissan), Ni_2Bo, Co_2Bo, $NiBo_2$, and $CoBo_2$.—A new silicide of platinum: P. **Lebeau** and A. **Novitzky.** This compound, of the formula SiPt, can be obtained by direct union, is crystallisable, and chemically resembles platinum.—A general method of preparation of anhydrous metallic bromides, with oxides as a starting point: F. **Bourion.** The simultaneous use of sulphur chloride and hydrogen bromide gas provides a convenient means to this end.—The alloys of nickel and tin: Em. **Vigouroux.**—The effect of electric sparking upon a mixture of nitrogen and oxygen at low temperatures: E. **Briner** and E. **Durand.**—Discontinuities observed in the molecular conductivity of dissolved chromium sulphates: Albert **Colson.**—The rotatory power of the proteids extracted from the flour of cereals by aqueous alcohol: M. **Lindet** and L. **Ammann.**—Menthane 1:8-dicarboxylic acid and a new dicyclic ketone: Ph. **Barbier** and V. **Grignard.**—The origin of the deposits of colouring matter in red wine: V. **Martinand.**—Malic acid in wine must, and its destruction in fermentation: W. **Mestrezat.**—The liquefaction by diastase of fecula starch: A. **Fernbach** and J. **Wolff.**—Living reagents and diffusion: Michel **Yégounow.**—A new genus of Sapotaceæ in West Africa, with seeds containing an edible fatty matter: Aug. **Chevalier.** This tree provides a fine red well-veined wood, of density almost equal to unity.—The Pachypodium of Madagascar: MM. **Costantin** and **Bois.**—New researches on the cytology of the seeds of Graminaceæ: A. **Guilliermond.**—The morphological value of the caruncle of *Notopygos labiatus*: A. **Malaquin** and A. **Dehorne.**—The destructive function of the spleen towards trypanosomes: A. **Rodet** and G. **Vallet.** In the case of infection by *Trypanosoma brucei*, the spleen actively destroys the parasites.—The injection of artificial serums: C. **Fleig.** Those containing iron have been used with success in many cases of chlorosis.—The activity of Etna: A. **Riccò.**

CALCUTTA.

Asiatic Society of Bengal, July 3.—Notes on the Pollination of flowers in India. Note No. 4. On cotton in Behar: I. H. **Burkill.** The flowers of *Gossypium neglectum* and *G. intermedium* in Behar are a little visited by insects, chiefly small Hymenoptera of the genera Ceratina and Halictus, which seek honey in vain, and may collect pollen. Longer tongued insects, such as Xylocopa, Anthophora, and a few Lepidoptera only rarely go to the flowers. Plants intermediate between the two species, which are grown mixed, testify to the occurrence of cross-fertilisation; but they are rare, and the very early self-pollination in the flowers shows how much more the cotton crop depends on spontaneous self-fertilisation than on pollination by insects or other external agency.

CONTENTS.

THURSDAY, AUGUST 8, 1907.

RESEARCH IN CHINA.

Research in China. In three volumes and Atlas: vol. i. in 2 parts. Part i. *Descriptive Topography and Geology.* By Bailey Willis, Eliot Blackwelder, and R. H. Sargent. Pp. xiv. + 354 + xvi. (Washington, D.C.; Published by the Carnegie Institution, 1907.)

THE title of this volume recalls the great pioneer work of the illustrious Baron von Richthofen, to whom science is indebted for the first broad and masterly sketch of the physiography and geology of the Celestial Empire. His volumes, unfortunately left still incomplete at the time of his lamented death, form the basis on which all later explorers will build. He indicated some of the great problems which remain to be solved by a more prolonged and minute survey than it was in his own power to achieve. But even where he left questions in doubt, his trained powers of observation sometimes enabled him to see so far into them, and to leave so many pregnant suggestions concerning them, that the paths for subsequent exploration have been indicated by him to his successors.

One of these paths lay in the further investigation of the great series of ancient sedimentary deposits, to which Richthofen gave the name of "Sinisches" (Sinesian or Sinian) system. He collected from what he regarded as the higher parts of this system a number of fossils, which proved the strata containing them to be of Cambrian age. As these sedimentary accumulations appeared to be thousands of feet in thickness, they seemed to offer at least a possibility that, in their lower members, traces might be found of a still older or pre-Cambrian fauna. The great interest which would attach to the discovery of any recognisable remains of that primæval biological period had long drawn the attention of geologists to the desirability of following up the suggestive observations of the German explorer. The opportunity of undertaking this investigation came at last when the Carnegie Institution of Washington was founded in 1902, with ample funds for the purposes of scientific research of every kind in all quarters of the globe. Mr. C. D. Walcott, then the energetic Director of the United States Geological Survey, whose contributions to Cambrian palæontology have given him a worldwide reputation, suggested the sending out of an expedition to China, one of the objects of which should be the further elucidation of the fossil contents of the oldest Palæozoic rocks of the country. He succeeded in planning and organising a scientific mission for the purpose of investigating the stratigraphy, palæontology, structure, and physiography of the regions to be visited. The first grant was made by the Carnegie Institution in the autumn of the year 1902, but it was not until July of the following year that the mission sailed for Europe. The party consisted of two geologists, Mr. Bailey Willis, an active member of the staff of the United States Geological Survey, to whom the chief charge of the expedition was assigned, and Mr. Eliot Blackwelder, of the University of Chicago. They were subsequently joined in China by Mr. R. Harvey Sargent, of the United States Geological Survey, who acted as topographer, and produced the series of maps which forms the Atlas.

The observers reached Pekin late in September, 1903, and spent about two months of the autumn of that year in the geological investigation of certain parts of the province of Shan-tung. The first five and a half months of 1904 were devoted to the exploration of Central China, and the journey of investigation came to an end at I-chang, on the Yangtzi-kiang, on June 9. The time occupied by the research was thus little more than seven months in all. During this brief period the party must have worked hard. Their topographical surveys by graphic plane-table triangulation went on at an average rate of nearly fifty square miles a day, and an area of 2,900 square miles was mapped in fifty-eight days and a half. While the topographer was thus active, the geologists were simultaneously busy with their observations and collections. The results of this combined labour are intended to fill three massive volumes and an atlas of maps. The first part of the first volume which, with the Atlas, has just been issued, forms a bulky quarto of more than 350 pages, with upwards of fifty plates, consisting of photographic views of landscapes, maps, and geological sections. The second part is to include systematic petrography, zoological notes, and a syllabary of Chinese sounds. The second volume is intended "to summarize the detailed presentation of our results, and to combine them with the work of others in a systematic discussion of the geology of south-eastern Asia." The third volume is to be devoted to Palæontology. The Atlas contains some forty sheets of maps, sections, and photographic views, most of the maps being on the scale of 1/125,000, or two miles to the inch, engraved and coloured in the excellent style to which the United States Geological Survey has now accustomed us.

We willingly record our appreciation of the energy, skill, and success with which this expedition has been conducted. But we feel sure that the question will be asked by many not unsympathetic onlookers—were the few months of rapid and necessarily imperfect and incomplete observation sufficient to justify the addition of all these volumes to the ever-growing mass of geological literature? It has long been a characteristic of American geological explorers that they cannot simply describe what they have seen, but must launch out into theoretical disquisitions and systematic discussions, for which there has often been but slender basis in their own work. The various pioneering and other surveys have thus built up a pile of huge quartos, in which the really valuable original observations are often practically buried out of sight. The books are heavy alike for the hand and the head. They take up a large amount of space on library shelves, where they are now, we fear, comparatively seldom consulted.

The volume now before us is a conspicuous illustration of the American habit here referred to. We venture to think that all that was new and important among the results of the expedition might easily have been comprised within the limits of this first single volume. Not content, however, with the space the observers have contrived to fill with the amplification of their notes and discussions of the physiography of the regions which they rapidly traversed, and of which they can have acquired only the most superficial knowledge, Mr. Bailey Willis is yet to inflict upon us another volume of his "detailed presentation of results," besides the other reports that are promised.

If it is asked what have been the chief fruits of this skilfully-planned foray into the Chinese empire, two conspicuous features may be pointed to, on which the explorers deserve to be congratulated. They have materially increased our knowledge of the earliest Palæozoic fauna of China, and they have brought to light a remarkable band of boulder-clay, full of striated stones, lying apparently at the base of the Cambrian system.

The large increase which has thus been made to the known Cambrian fossils of China has been provisionally discussed by Mr. Walcott in a paper published in 1905, in the Proceedings of the United States National Museum, and will be more fully treated in the third volume of the Reports of the Expedition. It appears that at least forty-eight genera and 172 species of organisms are now known to occur in Chinese Cambrian formations, the greater number being assigned by Mr. Walcott to the middle division of the system. The lower division has yielded comparatively few forms, and it does not appear that any trace has been recovered of a fauna older than Cambrian. The trilobitic representation is especially abundant, comprising 118 species, belonging to twenty-five genera. The full details respecting this primæval fauna will be awaited with much interest.

It would appear from the observations of Messrs. Bailey Willis, and Blackwelder that Richthofen perhaps over-estimated the thickness of his "Sinisches System," and that the chances of the recovery of a pre-Cambrian fauna were less than had been hoped for. In Shan-tung the total thickness seems to be little more than 4000 feet, of which only some 1500 or 1600 feet are relegated to the Cambrian system, the overlying strata being referred to the next member of the Geological Record. The lower Cambrian division, consisting of 500 or 600 feet of shales and thin limestones, rests unconformably on a set of gneisses, schists, and granite, with other eruptive rocks. Mr. Blackwelder made a reconnaissance, in the Liau-tung peninsula, nearly along Richthofen's route; but he was unable to add anything of importance to what was noted by the German explorer regarding the Cambrian rocks of that district.

In threading the gorges of the Yang-tzi, the expedition at Nan-t'ou found at the base of the Palæozoic series a remarkable group of sediments resting unconformably on granite-gneiss, and having a total thickness of about 370 feet. Above a conglomerate and a series of red and white sandstones lies a mass of hard green boulder-clay or till, some 200 feet thick, which can be seen to dip under the Ki-sin-ling limestone. No fossils were obtained by the travellers from this boulder-clay, nor after a search for two hours were any found by them in the overlying bands of limestone. But as they disinterred Lower and Middle Cambrian organisms from what they regarded as the same limestone within less than 100 miles from Nan-t'ou, they regard it as highly probable that this ancient boulder-clay is of early Cambrian age.

The stones are subangular, with rounded edges and well-polished and well-striated surfaces. They are of various kinds of rock, and of all sizes up to two feet and a half in length, and they are huddled together without order, as in ordinary boulder-clay. The specimens represented in plate xxxviii. might have been selected as typical examples from any Pleistocene boulder-clay of Europe or America. It is hardly possible to resist the evidence that here is a true glacial deposit which, whether or not intercalated at the very base of the Cambrian system of China, must almost certainly be of early Palæozoic date.

The physiographical discussions in the volume are most unsatisfactory. When one reflects how difficult are the problems of physiographical development, how much patient research is needed into the geological history of a region, how much detailed local topographical knowledge is absolutely essential, and how little, after all, dogmatism on the subject is permissible, one is amazed at the confidence with which the physiography of vast territories is here disposed of. It is not by surveys of fifty square miles a day that these problems are to be solved, and it is matter for regret that such jejune attempts should be made, and should find a place in what ought to be a serious contribution to science.

THE EXPLORATION OF TIBET.

Tibet, the Mysterious. By Sir Thomas Holdich, K.C.M.G., K.C.I.E. Pp. ix+356; illustrated. (London: Alston Rivers, Ltd., 1906.) Price 7s. 6d. net.

"THE public which concerns itself about Tibet is a very small public indeed," says Sir Thomas Holdich in the volume he has compiled for "The Story of Exploration" series, and to this we may add that public interest in that country is not likely to be increased by such unsympathetic treatment as the subject receives in this book. The story of geographical achievement in Tibet, and especially of the attempts to reach the jealously guarded capital of the then closed land, was for many years one of the most fascinating interest, and now in the light of the more precise information that has recently been made available it could well afford re-telling as an instructive record of great daring and tenacity of purpose. In professing to supply such a summary, however, the present account is disappointing in that its information is neither very trustworthy nor up-to-date. The author does not appear to have any personal knowledge of the country, nor has he made himself sufficiently acquainted with what has been written on the subject, with the result that his book betrays frequent inaccuracies, and a lack of clear perspective that is rather bewildering to the reader. The narrative is made up for the most part of quotations from the reports of the more or less illiterate native surveyors, whose accounts, we are here told, although "the best and most important of all the stirring records of that remarkable country, have never yet seen the light"; whereas, as is well known, all those reports which were possessed of sufficient interest, including the best of them, namely, that by A-K, were published many years ago.

The geographical theme is frequently lost sight of altogether under the heaps of irrelevant topics that are dragged in. Indeed, fully one-fifth of the whole book is made up of generous extracts from the pages of Huc, the Lazarist missionary (not "Jesuit"), notwithstanding that our author admits "we do not gain much in the way of geographical information from it"! Relying on such antiquated sources of information, without being careful to check the stories by comparison with the more precise facts of later scientific research, Sir Thomas repeats many of the erroneous statements of the native surveyors as well as the mistaken notions of the older European writers. Thus, to take some instances at random, one would imagine that the author had never heard of the trustworthy work achieved by the British Survey officers of the Lhasa Mission, so generally is it neglected in preference to the less accurate data of the pioneer native surveyors. In this way we have here repeated the gross mistakes of U. G. and Sarat Das in respect to the route from Gyantse onwards to Lhasa. Amongst others, the Yamdok Lake is stated (p. 114) to be 13,900 feet above the sea-level, and at p. 252 to be 13,800 feet instead of the 14,350 feet as given by Major Ryder, while the adjoining Dumo Lake is made to be 500 feet higher than the Yamdok, whereas it is only some three feet higher. Even the elevation of Lhasa is given at 11,600 feet instead of 11,830 feet. So, too, with the map of Lhasa; we are told that A-K's old sketch-map is still "the best map we possess of it"—this is very hard on Major Ryder, who spent several days in the streets of Lhasa surveying and measuring, and plotting out the city in a large detailed map which was published more than two years ago.

The province of Nari, which stands in the extreme north-western corner of Tibet, is strangely enough stated to be in the "*southern* zone" of that country. Darchendo, the great mart for Chinese tea on the eastern border of Tibet, is, he says, "more correctly called 'Ta-chien-lu' in the newer" maps—the fact, however, is rather the other way, as the latter is merely a Chinese corruption of the former, which is the original and current Tibetan name of this important place. In alluding to the Chinese invasion of Nepal, our author goes beyond his authority when he credits Sir Clements Markham with the statement that the Chinese general "Sand Fo" (properly Sund Fô) sacked Kathmandu (which he spells Khatmandu); for Markham does not say that the victorious Chinese even entered the Nepalese capital, from which the battle was fought a day's march distant. So, too, we are informed that Moorcroft (who was really a veterinary surgeon temporarily employed by the East India Company on mule-breeding questions) was "a civilian of the Indian Civil Service."

Elementary facts even as to the position of Lamaism have not been grasped. We read (p. 51) that "Lhasa is the holy of holies, the ark of the covenant to over one-third of the human race." This amusing statement perhaps Sir Thomas did not mean to be taken seriously. For, as pointed out years ago, the Lhasa hierarchy has never been acknowledged by Buddhists outside Tibet, beyond Mongolia and a few of the sparsely populated Himalayan districts. The Buddhists of China, Japan and Corea, Siam, Burma and Ceylon would be astonished were they told that Lhasa, of which few of them have ever heard, was their "holy of holies." That place is sacred only to some five or six million votaries, and not the "400 millions" as here asserted. There are no distinctive page headings, and misspelling is frequent.

It would be pleasant to be able to congratulate the author on the illustrations, but nearly all of these we have seen elsewhere before. They are not very closely connected with the letterpress, nor are the landscapes very characteristic, whilst some of them are not what they profess to be; for out of the ten, at least two are from the Sikkim side of the Himalayas, and not in Tibet at all.

L. A. W.

OUR BOOK SHELF.

An Outline of the Natural History of our Shores. By J. Sinel. Pp. xvi+347; illustrated. (London: Swan Sonnenschein and Co., Ltd., 1906.) Price 7*s.* 6*d.*

THIS book has been written "to help to open some of the volumes of this part of Nature's library" by one who, having spent nearly forty years by the sea-shore, has had excellent opportunities of gaining the necessary knowledge at first hand.

Chapters i.–xiii. are devoted to descriptions, more or less short, of the animals which are to be found between tidemarks and in the maritime zone of Jersey, their habits and where to look for them; some account is also given of the chief characters of the various groups, together with descriptions of the anatomy of a few species, and something about the development of others. The author then deals with the various reasons for colour in marine animals, of which he gives instances, together with examples of "mimetic artifices" among the crabs (others are given in the chapter on Crustacea). In the following chapters we are given lists of apparatus, &c., necessary for shore collecting and tow-netting, with the method of use. A number of useful hints are also given on anæsthetising, preserving, and mounting specimens for the museum and other purposes, and also for imbedding, cutting, and staining sections for the microscope. In the last chapter, dealing with the marine aquarium, the beginner is initiated into the, to most inland people at least, difficult art of keeping and feeding the various marine animals which flourish in captivity, and also of hatching and rearing marine larvæ.

Although on the whole good, the book is marred by several inaccurate statements; among others we may mention the following:—Echinoderms have a heart; *Loligo media* is the young of *L. forbesii*; *Galeomma* is the only bivalve which crawls, whilst the author's explanation of the way in which starfish open oysters is certainly not the correct one. Moreover, we cannot agree that the author has followed the nomenclature most generally in use, especially in Pisces and Echinoderms.

In the outfit of the shore collector, the absence of a crowbar is rather surprising, especially on a rocky coast; whilst half an hour for tow netting, in view of the fact that two or three collections are apparently put into the same bottle, is certainly too long.

The illustrations, 123 in number, are mainly derived from photographs, the majority of which show a considerable lack of skill on the part of the photographer. One or two appear to be out of focus, many are too much of the soot and sawdust type; while in others the background chosen is not calculated to show up the "sitter" to the best advantage. Typographical errors, of which there are a fair number, are almost invariably confined to scientific names, such as *Nephtys* for *Nephthys*, Maidæ for Maiadæ, Spangus for *Spatangus*.

In spite of the above faults, we can, however, recommend the book to all beginners in the fascinating art of shore collecting, although, of course, it does not obviate the necessity of access to monographs on the various groups. R. A. T.

Field Operations of the Bureau of Soils, 1904. (Sixth Report.) Pp. 1151 + a case of 53 maps. (Washington: United States Department of Agriculture, 1905.)

THE United States Survey of Soils continues from year to year its enormous task, under the direction of its chief, Mr. Milton Whitney, and the present sixth report differs in no essential respect from its predecessors. The soil divisions are mapped upon a basis of physical texture, the same name being used right across the continent for soils which are judged to be of the same type, however different the origin or however remote the locality from that of the type originally credited with the name. It is just this classification which has been called in question by the critics of the survey in the United States, who discredit both the methods of identification and analysis which are adopted, and also the rapidity with which the work is pushed along. Certainly when the cost of the survey amounts to less than 10*s.* per square mile, as in the present case, the distribution of soils in the United States must be very different from what we are familiar with in the Old World, or else the maps can be little more than very sketchy first approximations. However, we are too far away to have any means of forming a judgment in this domestic discussion, but what the English reader will always find of value in this survey are the preliminary general accounts of the physiography and agricultural development of each area. There we get sketches of the style of farming and the local conditions which compare, though in a more scientific fashion, with the reports on the counties of England initiated by Arthur Young a little more than a hundred years ago. Doubtless in time these reports will have the same permanent value for America as a detailed picture of the state of the country and the position of its chief industry.

Hypnotism and Spiritism—A Critical and Medical Study. By Dr. Joseph Lapponi; translated by Mrs. Philip Gibbs. Pp. xiv + 268. (London: Chapman and Hall, Ltd., 1906.) Price 5*s.* net.

THE opening chapter deals with the historical data connected with hypnotism and spiritism, and the author points out how spiritism passed through the various stages of spirit rapping up to definite materialisation. Dr. Lapponi then describes what is understood by hypnosis, and it is clear that his views are not in accord with those held by most authorities at the present time. When the reader reaches the chapter on "Details about Spiritism," he will find a most vivid description of a *séance*, as given by "some of the best and most esteemed mediums." The author honestly states that he has not had personal experience of the "truth and reality of the marvellous phenomena" which he describes; nevertheless, he is evidently convinced of its actual existence. Dr. Lapponi gives some interesting accounts of the mystic performances of the Indian fakirs, and also records some instances of telepathy.

In discussing the relationship of hypnotism and spiritism, he endeavours to prove that there is little or no relationship between them, a fact which few would dispute; on the other hand, we do not think that the arguments which he adduces would go far towards convincing the sceptic. The author admits that "illusions and hallucinations explain some isolated cases of spiritism"; he also allows that mediums may have largely had recourse to frauds in order to enhance their reputations, and he is generous enough further to concede that "to the spiritistic frauds done voluntarily may be added others, not only involuntary but unconscious"; but even after allowing all these, he considers that there are phenomena which are well authenticated, and for which neither deception, art, nor science can render an account. This may be true, but because a matter is too subtle to unravel does not justify us in assuming that it is the result of spiritism. The author's attempt to account for the valuelessness of spirit revelation is very feeble, but it is left to the closing chapter to reveal the worthlessness of spiritism, for here we read that "spiritism is always dangerous, harmful, immoral, reprehensive, to be condemned and most severely prohibited without reserve, in all its grades, forms, and possible manifestations," except, maybe, in some rare exceptions. Surely, if there are spirits with whom we can confer, some of them should be able to raise us to higher planes of thought, for the spirit world should belong to a hierarchy which is nearer to the perfect.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Festival of St. Alban.

WITH regard to what is said concerning the date of this festival in the review of the "Life of St. Patrick" in NATURE of July 25 (p. 296), it is to be noted that there is really only one date for the festival. In the time of Bede (H. E., i., 7), as in the pre-Reformation calendars of the English Church, as well as in the Latin Prayer Book of Queen Elizabeth, 1560, the date is June 22. But when the festival reappeared in the English Prayer Book of 1662 it was placed on June 17, an obvious error which is supposed to have arisen from wrongly writing xvii. for xxii. In the Roman calendar the date is, of course, June 22. C. S. TAYLOR.

Banwell Vicarage, July 26.

THE information supplied by the Rev. C. S. Taylor is most welcome. The evidence for regarding the 22nd as an arrested solstitial day, in connection with St. Alban, is now fairly conclusive.

(1) The 22nd was one of the three solstitial days about 303 A.D., the supposed date of Alban's martyrdom.

(2) If closely studied with that fact in view, the legend of his martyrdom, like those of the death of Patrick and Dewi, may reveal a clear midsummer festival setting. That much may be gathered from the statement that Alban was summoned to do sacrifice to the pagan gods. We know from other sources that people were penalised for non-attendance at the great pagan festivals.

(3) There is evidence that St. Alban's festival covered the three solstitial days.

(*a*) One old Welsh calendar fixes the festival on the 23rd.

(b) Though our modern bards call each of the solstitial quarter days an Alban, there is very little authority for such a use of the name. What appears likely is that Alban became a name of the midsummer festival, and that a bardic scribe at first wrongly applied the name to the other quarter days. The Alban of the bards covered three days, and each day is specially named. The first is the Vigil of the Alban, the second is the Alban itself, and the third is the Banquet of the Alban.

(4) Why have the Welsh made so much of the name Alban? The reason may be found in the association of the name with Caerleon-upon-Usk.

(a) There are some ruins near that ancient city still called Mount St. Alban's.

(b) Mr. Wade-Evans has made out a good case for localising Alban's martyrdom at that spot (in "Archæologia Cambrensis," about two years ago).

(c) Geoffrey of Monmouth tells us of a great observatory or school of astronomers in or near that city.

St. Alban's Day being the chief day of the year, and an observatory bearing his name, probably, at Caerleon being apparently the Greenwich of Wales at one time, it is no wonder that the Welsh bards have adopted the name as a solstitial epithet without ever a mention of Alban's martyrdom.

We have in Wales a very modern instance of the same process. In some districts June 22 is observed as Gwyl Barna, the Vigil of Barnabas. St. Barnabas's Day is the 11th, and in the seventeenth century it coincided with the solstice; but since 1752 it has been in those parts associated with the 22nd, and Gwyl Barna is now a name of the solstice. In the neighbourhood of Llandeilo Talybont, Glam., it is the custom of the farm labourers to get together the hay-making implements on the morning of Gwyl Barna, before going to a solstitial fair in the neighbourhood. John Griffith.

Llangynwyd, Glam.

The Sun's Motion with respect to the Æther.

So far as I know, it has not been pointed out that the velocity of light, as deduced from the observed times of occultation of Jupiter's satellites, is affected to the first order by the motion of the earth and Jupiter with respect to the æther. Taking the times best suited to such observations, when the distance between the two planets is very nearly a maximum or a minimum, there will be no appreciable relative velocity in the line of centres, and, to a first approximation, the velocity with which light from Jupiter approaches us is then made up of the true propagation-velocity increased by the common velocity-component of the two planets in the direction earth to Jupiter.

In order to determine the sun's motion with respect to the æther, the values for the apparent velocity of light deducible from the observed times of occultation might be analysed, so as to discover any systematic differences depending on the direction of the line of centres. Only very small corrections would be needed on account of the motion of the planets in their line of centres relatively to the sun. The probable absolute error in the finally deduced velocity of the sun (relatively to the æther) would be of the same order as that affecting the finally deduced velocity of light. The quantity to be determined might perhaps be swamped by the errors of observation, but even so a superior limit could be assigned to the sun's velocity through the æther. Two of the three rectangular components of that velocity being measured in the plane of the ecliptic, the determination of the third component would unfortunately be very badly conditioned. It may be some consolation, however, to reflect that a knowledge of our motion with respect to the æther is not theoretically unattainable.

Again, if the mean æthereal density is either less or greater where atomic matter is present than in free æther, it appears from some results which I have lately obtained in connection with a modified theory of gravitation that motional forces would be experienced (for example) by two bodies moving with uniform translational velocity through the æther. These forces would be proportional to the product of the masses of the two bodies, to the square of the velocity of translation, and inversely to the fourth power of the distance between the bodies. They would be equal in magnitude and opposite in direction, but would not in general act in the same line, so that an elongated body, partaking of the earth's diurnal and orbital motion, would in general be acted on by a couple. This couple would vary as the diurnal motion changed the orientation of the body, and if the variations were measurably great, we should have the means of determining, save for a constant factor and an ambiguity of sign, the velocity of the earth with respect to the æther at any point of its orbit. Observations at three or more points of the orbit would enable us to evaluate the constant factor and to remove the ambiguity of sign, thus determining the velocity of the sun with respect to the æther.

The effects referred to might or might not be detectable, but by means of quite simple apparatus they could be tested for with great delicacy. I hope shortly to publish a fuller account of the analysis on which the above conclusions are based. C. V. Burton.

Cambridge, July 29.

The Dog's Sense of Direction of Sound.

Our dog, Spot, of the intelligence of which an instance has been recorded in Nature, is peculiarly sensitive to sound. The following instance may be worth recording. On Sunday, July 21, a heavy storm of thunder and lightning with rain broke over Wick. I sat in the porch of our house watching—Spot with me. The lightning was frequent, and the thunder played round in all directions—over Bath six miles to the east and Bristol six miles to the south-west.

Spot barked at each clap or rumble and rushed forward, always *towards the direction* from which the thunder appeared to come; the lightning affected him in no way. It was laughable when the thunder appeared to come from no definite direction, but to play round us. For then he ran, barking, over the lawn and round the trees as if angered by a sound he could not locate. I observed carefully what he did for perhaps half an hour, and I think Spot located the directions of sound at least as quickly as I did myself. F. C. Constable.

THE INTERNATIONAL CONGRESS ON SCHOOL HYGIENE.

THE second International Congress on School Hygiene was opened on Monday last at the University of London by Lord Crewe, in the presence of a large gathering, which included delegates from all the countries of Europe, the Colonies, and North and South America, in addition to representatives of administrative bodies in Great Britain. We shall publish at a later date an account of the proceedings of the Congress, but are pleased meanwhile to direct attention to the warm interest taken by the King in the objects for the consideration of which the congress was convened; indeed, but for the King's intervention, the congress would probably have been anything but a success, as will be seen by the opening remarks of the president, Sir Lauder Brunton, F.R.S.

Lord Crewe, Lord President of the Council, in opening the congress, said the first duty he had to perform in connection with the opening ceremony was a very agreeable one. He had a gracious command from the King to express to them the interest with which His Majesty regarded the subjects with which that congress was concerned and his hopes that its discussions might be a great success. His Majesty had further commanded him to express his regret that, owing to his enforced absence from London, he was unable to receive those who were to attend the congress. He was also privileged as a member of the Government to express the same desire on their part that the proceedings of the congress might be crowned with success, and on behalf of the Government to offer them all a hearty welcome. It was not in a strict sense an official conference. It was not subject to official control, it was not run on official lines, and it was not subsidised by official money. That, from many points of view, he took to be a distinct advantage. It lent freedom to the discussions which would take place; but, on the other hand, it must not be supposed that the Government of this country did anything else but take a keen interest in the proceedings of the congress, and they were well aware that the public departments concerned with the subjects for discussion hoped to learn much in the course of the next few days. He hoped that the result of their meeting might have the best possible effects. It must be a good thing for those belonging to different nations and used to different systems to interchange ideas and to engage in a most honourable and friendly rivalry as to which nation and which system could best carry out the objects they all had in view. He hoped, therefore, that their meetings might leave some permanent mark on the subjects, and that their deliberations would do much to advance the knowledge of school hygiene, and to remove what they must all regard as having been a serious blot on the civilisation of the world.

After speeches by Lord Londonderry and Lord Fitzmaurice, Sir Lauder Brunton delivered his presidential address, from which we print the following extracts:—

After welcoming the delegates, he said that he was sure that the first duty which they would wish him to perform as their president was to voice their thanks to the King, patron of the congress, for the gracious welcome which they had received from him through his representative, Lord Crewe. But it was not for words of welcome alone that the congress owed a debt of gratitude to His Majesty. It had also to thank him for most substantial help at a critical time. A fortnight ago things seemed to be going all wrong with the congress; it threatened to be more or less of a failure. At this juncture, through the kind intervention of Mr. Alfred de Rothschild, His Majesty graciously granted him (Sir Lauder Brunton) a personal interview, and asked him to explain the circumstances. He did so, and in a few minutes the King had put everything right, and things, which had been going all wrong before, from that moment went right, and the congress which threatened to be more or less of a fiasco now bid fair to be a brilliant success. Its success would not be due only to the numbers attending it nor to the enthusiasm of its members, but to the work which they trusted it would accomplish, not only during the time of its sitting, but after it was over, for they hoped that arrangements would be made by which its work would become permanent, and would be carried on in the intervals between successive congresses. For his services to the congress the King not only deserved the gratitude of the congress itself, but also of all school children, born and yet unborn, who might owe to its labours health, strength, and happiness.

They were met from every part of the civilised world, throwing aside every subject of disagreement, and were intent only on one common object—the health of the children. Parental affection was one of the strongest and most fundamental instincts, not only in man, but even in the lower animals. They all desired that their children should grow up healthy, strong, and happy; and they were all anxious to take the best means at their disposal to obtain such a desirable end. Amongst these, one of the chief was education. In savage communities, where the chief objects of life were war and hunting, education was comparatively simple, and was thoroughly well adapted to the end in view. But in civilised communities the complexity of conditions sometimes led, and indeed had led, to mistakes in education, and the very meaning of the word had been forgotten, so that, instead of drawing out and developing in every child all its possible powers of body and of mind—so that in its life it should do the very best of which its nature was capable—education had degenerated into a system of cramming and cultivating one or two faculties of the mind, and especially that of memory, to the injury of others, while the condition of the body as the servant of the mind had, to a certain extent, been lost sight of in this country. They were now awakening to the necessity of attending to the body if the mind was to be developed, and many efforts were being made in various countries to secure a system of mental and physical training which would ensure the best development of children. The great advantage of a congress like this was that the systems employed in various places were brought together and compared, so that each country might learn from the others the useful plans they ought to adopt and the errors they ought to avoid.

One of the most important subjects of all in this respect was that of medical inspection in schools, because this was the keystone of physical education. Without it, the defects of eyes, ears, nose, and teeth which affected individual scholars could not be ascertained, and so those children remained backward in their learning, suffering in their bodies and so much damaged in physique that they were unfitted for many occupations, could not enter the Army, and went to swell the numbers of the criminal classes.

The physical training of children during the period of growth was one of the best means of ensuring proper development. In some countries this was carried out more especially by systematic exercise, which developed the muscles, while in this country we depended more upon games. Both of these systems left something to be desired, and the ideal system was to be looked for in a proper combination of both. One of the most difficult, and yet one of the most important, questions of school hygiene was how to combine educational work with physical training, so that both should be productive of benefit, and not of injury, to the child. Proper alternation of mental and physical exercise was one means of preventing this, but attention must also be paid to the nature of the physical exercise.

But all attempts to develop a healthy race would be ineffectual if they took care only of the children who were at school now. They must look a generation ahead, and consider that the children who were at school now fifteen or twenty years hence would be the fathers and mothers of a fresh set of school children whose physique would depend very much upon the way they had been treated and fed in their infancy and childhood. It was, therefore, of the utmost importance that boys and girls should be instructed in the laws of health, the need of cleanliness, the dangers of impure food or water, and the evils of alcoholic abuse. Such instruction should not be given by lectures, which were likely to be misunderstood or forgotten, but by actual demonstration.

In conclusion, the president said that he felt sure that by cooperation they would obtain the object they had in view—namely, the health of the children.

At the conclusion of the meeting the following telegram was sent to the King:—

To His Majesty the King, Royal yacht *Victoria and Albert*, Cowes.—Your Majesty's most gracious message at the opening of the International Congress of School Hygiene by Lord Crewe this afternoon was received with the most humble and most respectful thanks of the delegates from foreign Governments and public authorities and the members of the meeting assembled. Signed, Lauder Brunton, president, James Kerr and E. White Wallis, honorary general secretaries.

And in the evening, at the first general meeting and reception of delegates and members, the following reply from His Majesty was read:—

To Sir Lauder Brunton, 10 Stratford Place, London, W. The King desires me to thank you and the honorary general secretaries for the telegram he has received from you and to express his hope that the ceremony to-day went off well. (Signed) Knollys. Cowes.

THE BRITISH ASSOCIATION AT LEICESTER.

As anticipated, the British Association has been fortunate in its choice of Leicester for this year's annual meeting, and we congratulate the association because of the high character of its proceedings, initiated by the presidential address, and maintained in the special discourses of Mr. Duddell, Prof. Miers, and Dr. Dixey, and the sectional papers, and the town itself because of its genuine and hearty welcome to its many visitors, and the carefully considered arrangements made for the convenience and comfort of all. Many important papers have received consideration at the sectional meetings, and the attendances have shown the interest taken in the subjects covered.

Visitors on arrival found quite artistic street direction cards attached to the lamp-posts and tramway standards, and these, with the capital maps provided on the official ticket and bound with the local programme, gave clear and definite directions for all.

The social side of the meeting has not by any means been neglected, but this has been kept quite subordinate to the real work—the advancement of science. The Mayor's reception and evening *fête*, held at the Abbey Park on the Thursday evening, and attended by nearly 3000 persons, was followed by the garden-party given by Sir Samuel and Lady Faire at Glenfield Frith on the Friday afternoon; both were largely attended and complete successes. Bands have played each afternoon and evening in the pretty loggia erected adjoining the Town Museum, and this central spot has formed a most pleasant rendezvous. A reception by the Leicester Literary and Philosophical Society was held here on Tuesday last.

Saturday, as usual, was given up to excursions. The weather in the morning was anything but propitious, and no doubt deterred many from attending; the day, however, proved bright and clear. Charnwood Forest, Belvoir Castle, Chatsworth, Peterborough, and a trip over the old Swannington Railway proved happy hunting-grounds for scientific pleasure.

The local executive and its chairman, Mr. Colson, must be congratulated on the efforts made by them for the comfort of the members of the association, and the success which attended their endeavours.

The report of the council for the year 1906–7 was adopted at the meeting of the general committee on July 31. The following matters are referred to in the report:—

The council has acted upon the resolution from Section A:—"That, in the opinion of the committee of Section A, it is highly desirable that Sir William Hamilton's memoirs on dynamics, on systems of rays, and other memoirs on pure and applied mathematics, should be republished in accessible form; and that this resolution, if approved by the council, be communicated to the Royal Irish Academy." A subcommittee of Section A is making inquiries for the purpose of promoting the object in view. A resolution from Section H in regard to the appointment of an inspector of ancient monuments has been considered by the council:—"That the council of the British Association be asked to impress upon His Majesty's Government the desirability of appointing an inspector of ancient monuments, fully qualified to perform the duties of his office, with full powers under the Act, and with instructions to report periodically on his work with a view to publication." The council appointed a committee, consisting of Sir John Evans, K.C.B., Sir Edward Brabrook, Mr. Sidney Hartland, Sir Norman Lockyer, K.C.B., and Lord Balcarres, to report on the proposal; and the report of the committee, having been approved by the council, was sent with a covering letter to the Prime Minister on December 10, 1906. Furthermore, the president attached his signature to a memorial upon the same subject drawn up by the council of the Society of Antiquaries. It is understood that, whilst no immediate action will be taken by His Majesty's Government, the matter is receiving careful consideration by the Prime Minister, with the object of placing all ancient monuments in the United Kingdom under adequate protection and more effective supervision.

At the second meeting of the general committee on Friday, August 2, Mr. Francis Darwin, F.R.S., who was nominated by the council to fill the office of president for the year 1907–8, was elected. The Lord Lieutenant, as His Majesty's representative in Ireland, was elected to fill the office of vice-patron for the Dublin meeting next year. The following were elected vice-presidents of the association for the same meeting:—The Lord Mayor of Dublin; the Lord Chancellor of Ireland; H.M. Lieutenant for the County of Dublin (Earl of Meath); Chancellor of the University of Dublin (Earl of Rosse); Chancellor of the Royal University of Ireland (Lord Castletown); Provost of Trinity College, Dublin (Dr. Anthony Traill); president of University College, Dublin (Rev. W. Delany); Viscount Iveagh; president of the Royal Dublin Society; president of the Royal Irish Academy (Mr. F. A. Tarleton); Vice-Chancellor of the University of Dublin (Mr. Justice Madden); Vice-Chancellor of the Royal University of Ireland (Sir Christopher Nixon, Bart.); vice-president of the Department of Agriculture, &c. (Mr. T. W. Russell, M.P.).

The meeting will be held in the first week in September next year, that is, from Wednesday, September 2, to Wednesday, September 9, 1908.

The new members of council elected by the general committee are Dr. Tempest Anderson, Prof. A. R. Forsyth, F.R.S., Mr. D. G. Hogarth, Lieut.-Colonel Prain, F.R.S., and Prof. C. S. Sherrington, F.R.S.

Subjoined is a synopsis of grants of money appropriated for scientific purposes by the general committee at the Leicester meeting:—

Section A.—Mathematical and Physical Science.

	£	s.	d.
Seismological Observations	40	0	0
Further Tabulation of Bessel Functions	15	0	0
Kites Committee	25	0	0
Geodetic Arc in Africa	200	0	0
Meteorological Observations on Ben Nevis	25	0	0

Section B.—Chemistry.

	£	s.	d.
Wave-length Tables of Spectra	10	0	0
Study of Hydro-aromatic Substances	30	0	0
Dynamic Isomerism	40	0	0
Transformation of Aromatic Nitramines	30	0	0

Section C.—Geology.

	£	s.	d.
Fossiliferous Drift Deposits	11	12	9
Fauna and Flora of British Trias	10	0	0
Crystalline Rocks of Anglesey	2	17	2
Faunal Succession in the Carboniferous Limestone in British Isles	10	0	0
Erratic Blocks	17	16	6
Predevonian Rocks	10	0	0
Exact Significance of Local Terms	10	0	0
Palæozoic Rocks	15	0	0
Composition of Charnwood Rocks	10	0	0

Section D.—Zoology.

	£	s.	d.
Index Animalium	75	0	0
Table at the Zoological Station at Naples	100	0	0
Heredity Experiments	10	0	0
Fauna of Lakes of Central Tasmania	40	0	0

Section E.—Geography.

	£	s.	d.
Rainfall and Lake and River Discharge	5	0	0
Investigations in the Indian Ocean	50	0	0
Exploration in Spitsbergen	30	0	0

Section F.—Economic Science and Statistics.

	£	s.	d.
Gold Coinage in Circulation in the United Kingdom	6	0	0

Section G.—Engineering.

	£	s.	d.
Electrical Standards	50	10	8

Section H.—Anthropology.

	£	s.	d.
Glastonbury Lake Village	30	0	0
Excavations on Roman Sites in Britain	15	0	0
Anthropometric Investigations	13	8	8
Age of Stone Circles	53	0	0
Anthropological Photographs	3	3	6
Anthropological Notes and Queries	40	0	0

Section I.—Physiology.

	£	s.	d.
Metabolism of Individual Tissues	40	0	0
The Ductless Glands	30	0	0
Effect of Climate upon Health and Disease ...	35	0	0
Body Metabolism in Cancer	30	0	0
Electrical Phenomena and Metabolism of Arum Spadices	10	0	0
Section K.—Botany.			
Structure of Fossil Plants	15	0	0
Marsh Vegetation	15	0	0
Succession of Plant Remains	45	0	0
Section L.—Educational Science.			
Studies suitable for Elementary Schools ...	10	0	0
Corresponding Societies Committee.			
For Preparation of Report...	25	0	0
Total	1288	9	3

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. A. SMITHELLS, B.Sc., F.R.S., PRESIDENT OF THE SECTION.

THE year which has elapsed since the meeting of our Section at York has been eventful in the most melancholy of ways; the losses sustained by our science have been unparalleled. The passing bell seems to have tolled almost without intermission as one after another of our masters has been taken from us: in Russia, Mendeléeff, Menschutkin, and Beilstein; in France, Berthelot and Moissan; in Holland, Bakhuis-Roozeboom. Whilst in some of these cases we may find consolation in contemplating a length of life and sustained activity beyond what we might have dared to expect, in others our regret is increased by the sense of untimeliness and of vanished hopes. I am tempted to speak of the work of such mighty men as Berthelot and Mendeléeff, to dwell upon the discoveries by which they transformed the whole fabric of chemical science; but this is not the occasion on which to offer an estimate of the labours of those who have passed away. I can only say that in the bond of brotherhood which the pursuit of science establishes among the different nations of the earth we who are Englishmen feel and deplore these losses as our own.

I must not omit to allude also, as I do with deep regret, to the death in our own country of two such ardent and fruitful workers as Cornelius O'Sullivan and Robert Warington.

These words were already in print when again we were called to mourn the loss of one of our greatest men, one who but a year ago was the subject of our special rejoicings, and whose vigour of body and youthfulness of spirit seemed to promise the long continuance of a noble and an extraordinarily fruitful life. We can at least feel thankful that William Henry Perkin lived long enough to learn in what honour and esteem his name was held, not only among his countrymen, but by all the chemists of the world, and by the leaders of those great industries of which he was justly acclaimed the founder. For more than a generation Sir William Perkin had been one of the most familiar figures at the meetings of this Section, and greatly shall we miss his gentle presence, his wise counsel, and his valued contributions.

I can, perhaps, best occupy your time to-day by attempting to give some account of the present state of the scientific subject to which I have paid most attention. The topic of flame, after a long period of repose, has aroused much interest during late years, and I think we may say that some considerable progress has been made in its elucidation, although in this, as in all other subjects of scientific inquiry, the more closely we scrutinise it the more impressed must we be with what still remains unknown.

One of the first questions that meet us in the study of flame is that of the temperature at which in any given case the phenomenon becomes evident. Here, I think, a great clarification of view has taken place. The old idea that there existed a fixed temperature at which inflammation suddenly took place cannot now be maintained, and the term "ignition temperature" has acquired a different meaning. It is now known that in a very great number of cases a mixture of two flame-forming gases, when gradually raised in temperature, will develop luminosity quite gradually, *pari passu*, with the chemical combination that is being induced. This phenomenon is, of course, known universally in connection with phosphorus, but it is not so widely known in connection with other combustible substances. There are some simple facts that seem as if they never could gain admission to text-books, and I do not think I have known more than a single chemical book that is not likely to leave a student under the impression that the phosphorescence of phosphorus is an almost unique phenomenon. I do not know how many times the independent discovery has been made that sulphur, arsenic, carbon disulphide, alcohol, ether, paraffin, and a whole host of other compounds, inorganic and organic, will phosphoresce as truly as phosphorus itself; that, in fact, phosphorescent combustion is the normal phenomenon antecedent to what we ordinarily call flame.

This is, after all, only in harmony with the general truth that chemical combination between two gases does not set in suddenly, but comes into evidence quite gradually as the temperature is raised from a point at which the action, if it occurs at all, is so slow as to be negligible. The increase in the rate of combination is, of course, very rapid as compared with the increase of temperature, a difference of about 10° C. serving to double it. The interval between the beginning of phosphorescence and the production of vigorous flames may therefore be very short. In the case of phosphorus this interval, being from 7° to 60° C., includes ordinary atmospheric temperatures; hence the phosphorescence of phosphorus is a phenomenon that could not well be overlooked. If the prevailing terrestrial temperature were below 7° C., at which, under normal air-pressure, the phosphorescence of phosphorus ceases, it is possible that this element might never have acquired its peculiar reputation; it would not have shone in the dark, and in lighting it with a taper the phosphorescent interval would have been passed over as quickly as is ordinarily the case in the ignition of sulphur, paraffin, and other common combustibles. To make phosphorescence apparent in these last cases it is necessary to take special care to heat up a mixture of the combustible gas and air gently, and to maintain it at a temperature approaching, but not quite reaching, that of ignition. There is no simpler way than that used by Sir William Perkin, who brought the combustible substance near to, or in contact with, a massive metal ball previously heated to the suitable temperature.

The change from phosphorescence to ordinary flame is not sudden, but the appearance of ordinary flame is the end point of a continuous, though rapid, development. This end point is the temperature of ignition. What, then, determines the temperature of ignition? The answer to this question has been given with characteristic conciseness by van 't Hoff as "the temperature at which the initial loss of heat due to conduction, &c., is equal to the heat evolved in the same time by the chemical reaction."

We may obtain a clear idea of the meaning of temperature of ignition by supposing a combustible mixture of gases such as that of air and the vapour of carbon disulphide to issue through an orifice into an indifferent atmosphere. If we surround the orifice by a ring of platinum wire, which is gradually heated up by a current of electricity, a flame will gradually make its appearance. If, as soon as this is observed, the heating of the wire by the current be discontinued, the flame will disappear; it is, in fact, not self-supporting, but depends on the accessory supply of heat through the electrically heated wire. If now we raise the ring to a higher temperature we shall get a brighter flame, owing to an increased rate of chemical action, and at last we shall reach a point where it is possible to cut off the electric current without causing at the same time the extinction of the flame. This is the true temperature of ignition, the temperature at which the reaction proceeds at a rate just sufficient to overbalance the loss of heat by radiation, conduction, and convection from the burning layer of gases, so that the next layer is put in the same state, and steady combustion proceeds.

Phosphorescence has been spoken of as degraded combustion, and, though literally the appellation is correct, I think it is liable to be misunderstood. Again, it is often supposed that phosphorescence is necessarily associated with the formation of incompletely oxidised products. This may be the case in a chemical system which is capable of affording different products at different temperatures, but it is not an essential feature; the phosphorescent combustion of sulphur, for example, affords nothing but sulphur dioxide.

Temperature of ignition is, then, neither a temperature at which combination suddenly begins nor one dependent solely on the nature of the combining gases. It will vary with the proportion in which the gases are mixed and with their pressure and other circumstances. Notwithstanding the simplicity of this conception, it must be admitted that there are many obscure facts connected with the ignition of gases. The inflammability of gaseous mixtures is not necessarily greatest when they are mixed in the proportions theoretically required for complete combination; the influence of foreign gases does not appear to follow any simple law; the presence of a very small quantity of a foreign gas may exercise a profound influence on the ignition temperature as in the case of the addition of ethylene to hydrogen. When a mixture of methane and air is raised to its ignition temperature, a sensible interval (about ten seconds) elapses before inflammation occurs. These facts are cognate to others which have increased upon us so abundantly in connection with the influence of moisture on chemical change. The study of the oxidation of phosphorus in particular brings us among rocks and shoals. Apart from the influence of moisture on the combination we have the limitation of the process by a certain tension of oxygen and by minute quantities of a vast number of chemical substances, among which, in spite of much labour, no other common bond can be found. We do not know what oxide is initially formed in the oxidation, and the existence of the oxides P_4O and P_2O is as confidently disputed as it is affirmed. There is some reason for believing that the phosphorescence connected with phosphorus succeeds the formation of one oxide and accompanies the formation of another. The state of the oxygen, whether atomic, ionic, or molecular, which acts on phosphorus, the induced oxidation of other substances, the ionisation of air accompanying the oxidation—these are all matters concerning which there exists a bewildering literature that hangs over us like a cloud. The whole of my Address would, in fact, not suffice for a summary of the state of our ignorance about the oxidation of phosphorus. The subject, simple as it appears at first sight, is really involved with a vast number of unsolved chemical problems the elucidation of which would throw much light on chemical action in general. I may, perhaps, bequeath the topic to some successor in this Chair as one which may serve to illustrate the advance of knowledge since these present days of darkness.

The structure of flames has always been regarded as dependent upon the chemical changes taking place in the differentiated regions, but until recent times little attention has been given to any question beyond the cause of the bright luminosity of hydrocarbon flames. In a flame such as that of hydrogen or carbon monoxide, where we have some reason to suppose that the same kind of chemical transaction is taking place throughout the region of combustion we should not expect to find a differentiation of structure, and, as a matter of fact, we do not find any. Erroneous ideas have gained currency from the use of impure gases, and hydrogen is still described as burning with a pale blue flame, although Stas long ago stated that if the gas is highly purified, and the air freed from dust, the flame even in a dark-room can only be discovered by feeling for it; a fact consistent with the line spectrum of water lying wholly in the ultra-violet. The presence of a very small quantity of free oxygen in carbon monoxide destroys the perfect simplicity of the single shell of blue flame with which the purified gas burns, and in other flames small quantities of gaseous impurities or of atmospheric dust give rise to features of structure and halos which have been frequently supposed to pertain to the flame of the combining gases. The fringe of a flame in air may be often tinged by the presence of oxides of nitrogen.

No flame better illustrates the relation of structure to chemical processes than that of cyanogen, where the two steps in the oxidation of the carbon are clearly marked out in colour. Apart from hydrocarbon flames, very few others have been carefully explored from this point of view. There is, unfortunately, no gas composed of two combustible gaseous elements; and, though such gases as the hydrides of phosphorus and sulphur do not fall far short of this, the experimental difficulties of an exact exploration of their flames are very great. We are thus prevented from studying the flame of a composite combustible in its simplest form.

The flames of hydrocarbons have naturally been the subject of most frequent investigation. The use of single hydrocarbons instead of the mixtures present in coal-gas and other common combustibles has simplified the study considerably. Two problems stand out prominently: one is to trace the steps in the oxidation of the hydrocarbon, the other to account for the bright patch of yellow luminosity. With regard to the question of the luminosity, I do not think there is any longer doubt about its being due essentially to the separation within the flame of minute solid particles of what is practically carbon. The separation seems to be adequately explained by the high temperature of the blue burning walls of the flame, which decomposes the unburned hydrocarbon within. In a similar way arsenic and sulphur and phosphorus are liberated within flames of their hydrides; but these elements, being volatile, do not appear as solids unless a cold object be placed within the flame. In the case of the hydride of silicon the liberated element at once oxidises to form the solid non-volatile oxide, which gives a bright glow.

The mode in which a hydrocarbon yields carbon by the application of a high temperature has been the subject of experiment and of hypothesis; but neither the view of Berthelot, that the carbon results from a continuous coalescence of hydrocarbon molecules with elimination of hydrogen, nor that of Lewes, according to which the formation and sudden decomposition of acetylene is the essence of the phenomenon, appears to me to be in harmony with the experimental facts; and I am not aware that either view has secured any support from other workers in this field. It is certainly not easy to ascertain experimentally the changes undergone by a single hydrocarbon as its temperature is raised, and at the last it may be objected that the course of events in contact with the solid walls of a containing vessel is not necessarily the same as that within the gaseous envelope of a flame. I am glad to think that there is promise of further light on this subject from the work of Prof. Bone.

The course of oxidation of hydrocarbons has been the subject of very careful and fruitful study. The old view that a selective or preferential oxidation of the hydrogen always took place, that with a restricted supply of oxygen the hydrogen was oxidised and the carbon set free, is, I think, no longer maintained by anyone who has studied the question. The explosion of ethylene with its own volume of oxygen, which leaves us with practically all the carbon oxidised and all the hydrogen free, is fatal to this view. Again, when hydrocarbons are burned in a flame with a restricted supply of air, as is the case in the inner cone of the flame of a well-aërated Bunsen burner, there is clearly no separation of solid carbon, and the products of combustion when withdrawn and analysed disclose the presence of much free hydrogen and no unoxidised carbon. In describing this experimental fact I have spoken of it as the preferential oxidation of carbon. I have always thought it pedantic to quarrel with that expression; for, in speaking of a chemical transaction, we usually include only a description of the initial and final states of combination. I should be sorry, however, to detach the expression from the facts it describes and to exalt it into a general doctrine. That would be quite inadmissible, and, if there is any danger of misunderstanding, it would be better to avoid using the expression.

The admirable researches carried out in the University of Manchester by Prof. Bone and his collaborators have afforded most valuable information as to the oxidation of hydrocarbons at temperatures extending from those of incipient oxidation up to the highest ones that prevail in a flame. According to Prof. Bone, the oxidation of a hydrocarbon involves nothing in the nature of a selective or preferential oxidation of the carbon or the hydrogen: but it occurs in several well-defined stages, during which oxygen enters into and is incorporated with the hydrocarbon molecule, forming oxygenated intermediate products, among which are alcohols and aldehydes. The reaction, just referred to, between ethylene and an equal volume of oxygen is, according to Prof. Bone, to be represented by the scheme:

$$\begin{array}{c} CH_2 \\ \vdots \\ CH_2 \end{array} \rightarrow \begin{array}{c} CH.OH \\ \vdots \\ CH_2 \end{array} \rightarrow \begin{array}{c} CH.OH \\ \vdots \\ CH.OH \end{array} \rightarrow \begin{array}{c} H_2C:O \\ \\ H_2C:O \end{array} \rightarrow \begin{array}{c} H_2+CO \\ \\ H_2+CO \end{array}.$$

There can be no question about the facts on which this scheme is based, and they are a new and important addition to knowledge.

It is a great aid to the study of chemical changes, when we can resolve them into stages, whether or not these stages be realisable under certain experimental conditions. In this way we can get a clear view of the relationship between the action in one set of circumstances to the action in another set; and in this way also we can often establish rational links between reactions which at first sight seem quite disconnected. Intermediate reactions are much used to elucidate cases of contact action, and in the processes of organic chemistry they are almost universally assumed.

I am far from wishing to disparage these practices, but I think it important that we should realise how far we are dealing with convenient devices and how far with ascertained facts. The isolation of an intermediate product in one set of circumstances is in itself no proof that this product is transitorily formed when the reaction is proceeding in another set of circumstances; and if we were to assume generally that because we can represent a chemical transaction as if it were due to a successive construction and destruction of a series of molecular edifices it actually does take such a course, we should, I think, be making the same kind of mistake as to suppose that in the application of two differently directed forces to a body at rest, the body will move successively in the direction of each force instead of moving immediately in the direction of their resultant. I know that I may be considered hypercritical, and perhaps obstinate, in this matter; but I wished to state the reasons that prevent me from accepting entirely the interpretation which Prof. Bone has given to his experimental results, and to direct attention to a question of general importance that has not, I think, received the attention it deserves.

The mode of burning of carbon, whether in the free state or as a constituent of a compound, is not at all easy to determine; and notwithstanding many investigations, among which must be specially mentioned those of Prof. H. B. Dixon and his collaborators, so simple-looking a question as whether carbon forms carbon monoxide by directly uniting with oxygen, or only by reducing carbon dioxide, is still a matter of uncertainty.

Our knowledge concerning the question of flame temperatures has been much improved in recent times, thanks mainly to the admirable work of M. Le Chatelier. The well-known memoir of Mallard and Le Chatelier on the explosion of gases supplied the data which first permitted of a moderately exact calculation of flame temperatures, and the perfection of the thermo-couple by M. Le Chatelier gave us the first instrument that could be used directly for making a satisfactory measurement. The uncertainty connected with this subject may be well illustrated by quoting the temperatures that have at different times been ascribed to the flame of coal-gas when burnt in a Bunsen burner, where we have had values varying from 1230° to 2350° C.

The question of calculating the temperature attained during combustion by reference to calorimetric values, specific heat, dissociation, and other considerations is to form the subject of a joint discussion with Section G during the present meeting, so that I shall not here enlarge upon it.

With regard to the use of thermo-couples, I may remark that the practical difficulties have been successfully met. The chief difficulty is, of course, to secure that the thermo-junction attains as nearly as possible the temperature of the region in which it is immersed. As ordinary flames consist of thin shells of burning gases, on either side of which there is a very rapid fall of temperature, it is necessary to use thin wires, and to dispose them so that there is no appreciable drain of heat from the junction. By using wires of different gauge for the couples it is possible by extrapolation to arrive at a temperature for a couple of infinitely small cross-section, and it is also possible to make a correction for the superior radiating power of the couple as compared with the flame-gases. Without this last correction a maximum temperature of 1770° was obtained for the Bunsen flame by Waggener in Germany, and 1780° by White and Traver in America. Correcting for radiation, Berkenbusch found 1830° as the maximum temperature.

M. Féry, by an ingenious application of his beautiful optical pyrometer to a flame containing sodium, gives 1871° as the highest temperature of the flame of a Bunsen burner burning coal-gas.

The consideration of flame-temperatures has become of increasing importance in the arts owing to the use of the Welsbach mantle as a means of deriving light from coal-gas. The great improvements which have been made in the efficiency of atmospheric burners depend primarily on the fact that the smaller the external surface we can give to a flame consuming gas at a fixed rate the higher must be the average temperature; and since the emission of light from a mantle is proportional to a high power of the absolute temperature, a small increase of temperature is of great effect on luminosity.

The acetylene-oxygen flame in which a temperature of about 3500° prevails, not very different from that of the electric arc, is the hottest of the hydrocarbon flames, and finds some important practical uses.

I have already said something about the luminosity of flames so far as relates to the separation and glow of solid carbon. But there remains the more general question of the luminosity of flames containing nothing but gases. The older explanation of the emission of light from combining gases said no more than that the energy liberated during the reaction and appearing as heat raised the product to incandescence—that is to say, so increased the velocity of its molecules and the violence of their collisions that vibrations were set up the wave-lengths of which lay within the limits of visible radiation. This explanation has long been questioned, and there is now, I think, a very general agreement that it will not suffice. The average temperature, in fact, prevailing in a flame, if attained in the product of combustion by the supply of heat from outside, does not suffice to make that substance luminous. We are therefore thrown back upon the conclusion that the generation of light in a flame is not a consequence, though it is an accompaniment, of the elevation of temperature. The question now is, Can we go any further? To do this we are led to consider individual molecular transactions instead of statistical averages, and the view presents itself that the combining atoms may, in losing their chemical energy, form directly systems of independent vibration where the radiation is such as to fall within the limits of visibility. If we picture such vibrating systems momentarily formed, it is easy to see that by their collision one with another they may acquire in a secondary way increased translational motion, and so lead to a state of things where the greater part of their energy is degraded in the form of heat. The high temperature of a flame would then be a consequence rather than a cause of its light.

This subject of the mechanism of luminosity, however, like so many others, has now become involved with the theory of electrons, and a chemist may be excused if he hesitates to pursue the subject further. Some years ago I called attention to the scantiness of our knowledge of the chemical changes that take place when metallic salts are used in flames for the production of spectra. Though there was general agreement that, for example, the yellow flame produced by common salt was due to the liberation and glow of metallic sodium, there was no agreement as to how the sodium was set free.

Arrhenius, pursuing the analogy which exists between the laws governing matter in the gaseous state and in the state of dilute solution, had previously been led to the view that the electrical conductivity of flames containing salt-vapours was due to ionisation of the salt throughout the volume of the flame. It appeared possible therefore that the luminosity might be ascribed likewise to the metal separated in the ionic state. Experimental investigation undertaken with a view to elicit information on this subject seemed to favour the view that the metal was reduced by chemical processes, and that it glowed in the un-ionised condition. Evidence seemed to point to the conclusion that, for example, when common salt is introduced into the flame of coal-gas the sodium chloride yields sodium by the conjoint action of steam and reducing gases; when liberation of the metal was prevented by adding a large quantity of hydrochloric acid to the flame the glow disappeared, but the conductivity was not always diminished. The fact that sodium salts, including the chloride, impart their characteristic glow to the flame of cyanogen and to other flames in which water is absent leads to some difficulty in finding a chemical explanation, and it must be admitted that a direct thermal dissociation of an alkaline halide or oxide is not out of the question. The interval of detachment of the metallic atom may be exceedingly brief, but it must be remembered that even so short a time as the interval between the molecular encounters in a gas at a high temperature is still sufficient for the emission of thousands of undisturbed characteristic vibrations. The experiments to which I have alluded have been followed up with great industry and success by Prof. H. A. Wilson, who has added much to our knowledge of the electrical condition of the flames containing vaporised salts; but the question of the condition of the luminous gas is still far from being settled. Very interesting and important investigations have been carried out by Lenard, who has shown that the stream of luminous vapour produced from a sodium salt in a Bunsen flame is deflected in an electric field in such a way as to indicate that the vapour is positively charged; but he gives reason for believing that the charged condition is intermittent with the neutral condition. The lines in the spectrum of an alkali metal are divisible, as is well known, into distinct groups or series, in each of which the oscillation frequencies corresponding with the lines are in a definite mathematical relationship. The principal series, which include the lines seen individually as such in ordinary flame spectra, are, according to Lenard, due to the electrically neutral atoms. In a salted spirit flame, and in other flames of low temperature where only lines of the principal series are represented, the stream of luminous gas does not behave in an electric field as if it were charged. In the flame of coal-gas burnt in a Bunsen burner the salt-vapour gives, in addition to the distinct lines of the principal series, diffuse bands of luminosity on the dark background, which, according to Lenard, represent the undeveloped subordinate series; and it is the atoms emitting these series that are deflected in the electric field. It is inferred, therefore, that the light in a salted Bunsen flame comes from different groups of centres of emission—the principal series from the neutral atom, and the lines of the first, second, and third subordinate series from atoms which have lost respectively one, two, and three electrons. Lenard goes further, and shows that the salt-vapour in a Bunsen flame, as in the flame of the electric arc, emits these different kinds of radiation from different structural regions; thus the vapour at the edge of the flame is electrically neutral and gives only the lines of a principal series.

The negative electricity in a salted flame would, according to Lenard, be disembodied, and recent experiments by Gold confirm the view that the negative carrier in flames is a free electron. In connection with this subject I ought to allude to an investigation by Tufts, which seems to throw some doubt on the conclusions which were drawn from the experiments made by Prof. Wilson, Dr. Dawson, and myself; and I must also mention an important contribution to the subject recently made by Prof. Hartley, in which considerable light is thrown upon the chemical changes undergone by compounds of the alkaline earth metals when they are introduced into flames, and upon the relation of these changes to the various spectral features. I am afraid, however, that it would be wearisome if I were to prolong this summary, and I must be content to leave it without doing justice to those who are engaged upon the work. The subject is obviously one of fundamental importance in relation to spectrum analysis, and my own slight connection with it has only strengthened my opinion that there is still a great deal connected with the genesis of spectra that requires the attention of the chemist even more than that of the physicist. Spectrum analysis arose under the joint influence of Bunsen and Kirchhoff, and I think its problems still call for more combined work on the part of chemist and physicist than has latterly been the custom.

Having given a short summary of the present state of knowledge on one particular chemical topic, I may perhaps be permitted to conclude my Address with a few general observations relating to the science as a whole.

The contemplation of such a life as that of Berthelot makes us realise in a vivid way the progress of chemical science. He was a chemist without limitation, his activity extending over the whole range of the science, physical, inorganic, and organic. Whilst we must not forget his exceptional powers, we cannot help feeling how different in its extent was our science when he entered upon his labours from what it was when they ceased, and we cannot help feeling how vain it now is for anyone to hope for so imperial a sway.

Yet it is difficult to believe that the state of chemistry can ever have been more interesting than it is at the present moment, or that anyone who sighs for the good old times can do so from anything but the love of a quieter life. We need not go back more than twenty years to find a sharp contrast. At that time there was indeed no want of activity, but it was that of a band of travellers who had left their frontier adventures far behind, and were marching steadily over a wide and almost uninterrupted plain. To-day we are among the mountains, with new peaks and prospects appearing on every side. Truly a steady head is required; and well may we ask, Whither are we going and where is the path of progress and of safety? I rejoice to live in such times; but I feel no competence to describe them, still less can I pretend to have vision keen and comprehensive enough to let me figure as a guide.

One of the penalties of devotion to a progressive science is the constant feeling of being left behind, and the knowledge that, while we are attending to our personal task, things are happening, near or far, that may, for all we know, be affecting the simplest facts and the most elementary principles on which we have been accustomed to rely. This is a feeling that may well prevail at the present day. At the same time I do not think there is any occasion for panic, and I cannot help regretting the somewhat sensational language that has been used, even within our own circles, in regard to recent discoveries. The revelations attendant upon the investigation of radioactivity do indeed mark a distinct epoch in the history of chemical discovery, but that they entail anything like an unsettlement of our scientific articles of faith is not to be admitted for a moment. They make us realise in perhaps a not unprofitable way that scientific knowledge and scientific theories are necessarily proximate, never ultimate, and that ideas which may have been entertained for a long time without modification, and so have begun to seem perpetual, are, after all, only provisional.

There is certainly some embarrassment on finding that a substance like radium, which according to the conventions would be called a chemical element, breaks up so as to give substances which, according to the same conventions, are likewise called elements. But the confusion is one of terminology and not of ideas. I think it likely that few chemists of my own generation have been in the habit of regarding the conventional elements as the ultimate compositional units of matter. We know that in our own country distinguished men of science like Sir William Crookes and Sir Norman Lockyer have always insisted on the complex nature of the elements, and I suspect there are many among us who might own to having made sober, if unsuccessful, attempts at the resolution of elements before the days of radium.

The perplexities of chemists at the present day do not come, I think, from the novelty of the ideas that are being presented to them, but from the great rapidity with which the whole science is growing, from the invasion of chemistry by mathematics and, in particular, from the sudden appearance of the subject of radio-activity with its new methods, new instruments, and especially with its accompaniment of speculative philosophy. There is an uneasy feeling that developments of great importance to the chemist are being made by experiments on quantities of matter of almost inconceivable minuteness. Spectrum analysis of course took chemistry beyond the limits of the balance, but the new materials which it disclosed could at least be accumulated in palpable quantity. With radio-activity we seem, in relation to the ponderable, almost to be creating a chemistry of phantoms, and this reduction in the amount of experimental materials, associated as it is with an exuberance of mathematical speculation of the most bewildering kind concerning the nature, or perhaps I should say the want of nature, of matter, is calculated to perturb a stolid and earthy philosopher whose business has been hitherto confined to comparatively gross quantities of materials and to a restricted number of crude mechanical ideas. He is tempted to think of Falstaff's reckoning and to exclaim with Prince Henry, "Oh, monstrous! but one halfpennyworth of bread to this intolerable deal of sack!" Experimental science has latterly been spun to greater and greater fineness, until in the region of the *n* rays the objective element seems to have disappeared altogether.

I should, however, gravely abuse the position in which I am allowed to speak for the moment as a representative of chemists if I failed to express profound admiration for the masterly work which has been accomplished by the pioneers of the science of radio-activity. All that I wish to say beyond that, is in explanation of a certain awe or trepidation which chemists of the older school may feel in the presence of such bold explorers; and I am the more tempted to say something on the subject, because in recent times, before the advent of radium, a good deal has happened which has given chemists occasion to ask themselves whether chemistry was not beginning, as it were, to drift away from them.

The most conspicuous development of the science during the past twenty years has been, of course, on the physical side, and abundant have been its fruits; but it has seemed to demand from chemists habits and endowments which they did not normally possess, and which they could not easily acquire. I was much struck by a remark made to me a few years ago by a distinguished chemist, who is, I think, the most perfect manipulator I have ever seen at work, to the effect that he felt himself submerged and perishing in the great tide of physical chemistry which was rolling up into our laboratories. Now, it is precisely such men that must be preserved to chemistry. Though chemistry and physics meet and blend, there is, I believe, an essential difference between the genius of the chemist and the genius of the physicist, and I venture to think that some insistence on the primary functions of a chemist is not untimely. The chemist's first qualification is that he shall be master of a peculiar craft; his greatest merit that he is a consummate workman; his distinctive power a nicety of discrimination in questions affecting the composition and quantity of materials. He is not given to elaborate theories and is usually averse to speculation; nor has he usually an aptitude for mathematics. Such the normal chemist is, or was, and such I hope he always may be—naked perhaps in some respects, but unashamed.

There seems to be a solicitude in some quarters to make a chemist something more than a chemist, a solicitude which, if gratified, will, I believe, make him something less than one. We are told, for example, that a chemist should be a mathematician. I do not admit it for a moment. Some mathematics he must of necessity have—that has always been admitted—but in proportion as chemistry develops on the mathematical side does it become important, not that our chemists should be trained in mathematics, but that they should be more than ever carefully trained in the art of exact experiment: that their methods of work, their powers of observation, and, if possible, their experimental conscience, if I may use the expression, should acquire a finer edge. There is never more cause for anxiety than when we see a mathematical theory awaiting the delivery of the confirmatory facts, and there is nothing more important for chemistry than the continual recruiting of that old guard which will be ever ready to stand to arms on the appearance of an eager theorist.

I do not for a moment wish to disparage the adventurous spirits within or outside our science, still less do I wish to range myself with those who meet new ideas with mere objurgation or raillery. We must be content to see new alliances and new activities on the frontiers that separate us from other sciences; content to see many new kinds of chemistry arise in which we cannot all effectually participate. Chemistry is becoming bewildering in its extent, and it would be a great misfortune if this led to the notion that every chemist must try to enlarge his ambit to its confines and fit himself for every variety of work. Those of us who have responsibilities as teachers cannot, I think, be too careful, lest in the attempt to secure breadth we may encourage shallowness and fail to give our students that peculiar and time-honoured discipline in exactitude of work in chemistry proper, which has characterised the chemists of the past, and which is infinitely more important than superficial dealings with a great variety of processes and appliances. I confess that I have frequent misgivings as to whether our modern courses of instruction may not tend to turn out chemists more learned in the science and less perfect in the art than was the case under the ancient *régime*. There was, after all, great virtue in the system which often detained a student day after day, or perhaps week after week, on a single problem of chemical composition such as is involved in the exact analysis of fahl-ore. It is not easy to meet all requirements, but I think we shall all agree that, whatever is left undone, we must make a chemist a good craftsman. It is of the utmost importance that those whom we send out to work in the newer fields shall take with them the resources that have proved most serviceable in the old, and I think it is by supplying such men for special service, rather than by attempting to shift the centre of gravity of the whole system of chemical education, that we can best serve the newer interests.

Another perturbation within the chemical camp in recent times has come from the region of philosophy. Even before the days of radium we have been accused of clinging too fondly to our atomic theory and of stating our knowledge too exclusively in terms of that theory. We are said to have drifted into a dogmatism as real as any we ourselves have had to attack, and to shut our eyes to the light which will enable us to orient ourselves truly in the wide realm of thought. The answer that most of us would give would be, that we value our hypotheses according to their productiveness in new knowledge, and that it is, on the whole, perhaps better to over-exalt an hypothesis that is fertile than from high considerations of philosophy to allow our ideas to become so fluid that they can afford no rigid framework for thought. I think that the attempts to view chemical phenomena apart from the atomic hypothesis, interesting as they undoubtedly are, have not made us feel that this hypothesis has either misled us in any matter of fact or obscured any pathway that we might have followed with greater profit. The value of the thermo-dynamical treatment of chemical problems is attested by its fruitfulness in promoting fresh discoveries; and here we may welcome a valuable adjunct to the atomic hypothesis. But I do not think we are called upon to acclaim a new method of treating old questions unless it promises some more tangible result than an alleged improvement of our intellectual morals.

If, as I have ventured to hint, mathematics brings with it an element of danger into chemistry, I think that the intrusion of metaphysics would give far greater cause for apprehension. Philosophy always stands with open arms desiring a closer embrace of all the sciences, of which she declares herself to be the fond mother, whilst Science, as we understand the term, has stood reluctant, suggesting, as someone has wittily remarked, that she regards Philosophy rather as a mother-in-law. It may perhaps be desirable, especially in the present state of things, that scientific men should allow themselves to become a little more interested in deep questions affecting all knowledge, and should at least examine with some care the gifts that Philosophy is so anxious to bestow upon us. I have a fear that otherwise in the elaboration of scientific theory we may find ourselves embroiled in an unequal contest with what I cannot but regard as the traditional enemy—I mean the unmitigated metaphysician—and the suggestion that I make is, to tell the truth, not so much from the hope of gain as from the desire for self-defence and the safe preservation of the methods that have served us so well in the past.

I think the accusation that we delude ourselves into the belief that our hypotheses are final truth is not true of any thoughtful chemist; the great men of science have surely possessed that quality of mind which philosophy would most approve. If, as has often been remarked, Faraday was mathematically-minded, though untrained in mathematics, it seems not less true that he stood in the same relation to philosophy. When, for example, he was asked to express his opinions on the atomic theory, he wrote as follows:—

"I do not know that I am unorthodox as respects the atomic hypothesis. I believe in matter and its atoms as freely as most people—at least I think so. As to the little solid particles, which are by some supposed to exist independent of the forces of matter, and which in different substances are imagined to have different amounts of these forces associated with, or conferred upon, them (and which even in the same substance, when in the solid, liquid, and gaseous state, are supposed to have like different proportions of these powers), as I cannot form any idea of them apart from the forces, so I neither admit nor deny them. They do not afford me the least help in my endeavour to form an idea of a particle of matter. On the contrary, they greatly embarrass me; for after taking account of all the properties of matter, and allowing in my consideration for them, then these nuclei remain on the mind, and I cannot tell what to do with them. The notion of a solid nucleus without properties is a natural figure or stepping-stone to the mind at its first entrance on the consideration of natural phenomena; but when it has become instructed, the like notion of a solid nucleus, apart from the repulsion, which gives our only notion of solidity, or the gravity, which gives our notion of weight, is to me too difficult for comprehension; and so the notion becomes to me hypothetical, and, what is more, a very clumsy hypothesis. At that point, then, I reserve my mind as I feel bound to do in hundreds of other cases in natural knowledge."

This is the attitude of mind, I think, of all thoughtful chemists; if they do not exhibit it ostentatiously it is only because it is as disturbing to the proper work of a chemist for him to be constantly dwelling on the inward nature of his hypotheses as it is distracting in ordinary life to have men always talking about their emotions.

Few, I think, will deny that the atomic theory stands to-day as an indispensable instrument for productive chemical work; it has neither had its day nor ceased to be. Physicists have never been quite satisfied with the hard indivisible ball of specific substance and definite mass which has served chemistry so well. They have given it bells, have made a vortex ring of it, and have indeed done much that few chemists can understand to make it meet the exacting requirements of their science. But to us it has always been the same; what we have done to it has been external; we have given it, vaguely perhaps, a charge of electricity, a store of energy; we have attached the hooks or rods of valency, but we have not meddled with its interior. We are now called upon by chemical considerations of change of composition, as well as by other considerations more recondite, to subdivide our atom, to credit it with an unsuspected store of energy, to consider it a congeries of unsubstantial electrons. We should wish, of course, to know that the evidence is good enough, but otherwise there can be no possible objection from our side; it will undo nothing that has been done, and we may have good hopes that it will lead to the doing of many new things in chemistry. The newer theories are in consonance with the old in one most vital point: they afford those mental pictures of phenomena which most of us find indispensable for fruitful work. They do not belong to what Prof. Schuster has characterised as "the evasive school of philosophy." "Those," he says, "who believe in the possibility of a mechanical conception of the universe, and are not willing to abandon the methods which from the time of Galileo and Newton have uniformly and exclusively led to success, must look with the gravest concern on a growing school of scientific thought which rests content with equations correctly representing numerical relationships between different phenomena, even though no precise meaning can be attached to the symbols used." Most of us, I think, will take comfort in this pronouncement and rejoice that if our conception of the atom is to be transformed, it may still be represented as having some kinship with what Sir Henry Roscoe's famous examinee described as the "square blocks of wood invented by Dr. Dalton."

SECTION C.

GEOLOGY.

Opening Address by Prof. J. W. Gregory, D.Sc., F.R.S., President of the Section.

I. *The Geological Society of London.*

1907! This is the centenary year of the Geological Society of London; next month the British geologists will celebrate the event, and their pleasure will be enhanced by the sympathetic presence of a distinguished company of foreign geologists.

With a just feeling of satisfaction may we celebrate this event; for to the Geological Society of London is due the conversion of Geology from a fanciful speculation to an ordered science. Yet so quietly has this society done its work that the debt due to it is inadequately realised. When we consider what the world owes to Geology in respect of its economic guidance—the intellectual stimulus of its conceptions—the reverence it inspires for the venerable and majestic universe—its liberating influence from dogma—we may rightly regard the work of the Geological Society as one of the most valuable British contributions to intellectual progress during the nineteenth century.

A hundred years ago the spirit of the eighteenth century still controlled much of the then orthodox Geology. Jameson's "Elements of Geognosy," of which the preface is dated January 15, 1808, taught, as the certain conclusions of Geology, doctrines that had been reached by applying prejudiced speculation to imaginary facts. It was a manual of pure, *a priori*, Wernerian Geology. The author claimed that to Werner "we owe almost everything that is truly valuable in this important branch of knowledge"; and that it was Werner "who had discovered the general structure of the crust of the globe and pointed out the true mode of examining and ascertaining those great relations which it is one of the principal objects of geognosy to investigate."

But Jameson's book was the death-song of Wernerian Geology in British science. A new Geology was developing; and the Geological Society of London ushered in its birth. No more should observations be made through the distorting medium of preconceived fancies! No more should Geology be inspired by that heedless spirit, which cares not to distinguish between fancy and fact! With youthful vigour the new Geology would have nothing to do with the search for cosmogonies and such like fancy foods; and the Geological Society of London should be nourished on unadulterated facts.

The time was ripe for the change. No less a person than Goethe, once an enthusiastic votary of Geology, was now, in his play of "Faust," holding up its teachers to ridicule. The theories "evolved from the inner consciousness" of Continental Neptunists and Plutonists were to Goethe excellent subjects for caricature. It was then the Englishman, Greenough, founded a society to turn Geology from the pursuit of fleeting fancies and lead her to the study of sober but enduring facts. The members of this society were to abandon the quest of scientific chimæras; they were to leave to later generations the attempt to solve the universe as a whole.

The Geological Society has owed its influence to its bold, original purpose. It was not founded as a drifting social union of men, with a common interest in a single science. Its object was to apply to Geology one particular mode of research. It adopted as its motto this fine passage from Bacon:—

"If any man makes it his delight and care—not so much to cling to and use past discoveries, as to penetrate to what is beyond them—not to conquer Nature by talk, but by toil—in short, not to have elegant and plausible theories, but to gain sure and demonstrable knowledge; let such men (if it shall seem to them right), as true children of knowledge, unite themselves with us."

The methods of the society were as practical as its ideals. London, with characteristic unconventionality and originality, has used its scientific societies as its university for post-graduate teaching. Informally the Geological Society enrolled every British master of Geology on its staff of unpaid professors, then set each of them to teach the branch of Geology which he knew best. And these professors were no carpet knights; they were knights errant who derived their knowledge, not from books alone, but from their wanderings over hills and dales, in mines and quarries, by ice-polished rocks and water-worn valleys. At its meetings the leaders of the society announced what they had discovered, gave sure and demonstrable proofs of their discoveries, and showed in what direction the geological forces should be directed for the conquest of Nature. The goodly fellowship of the Geological Society has always encamped on the ever-advancing frontier of geological knowledge, where the well-surveyed tracks pass out into the bright, alluring realms of the unknown.

The actual founders of the Geological Society were apparently men of less showy intellect than the great Werner, whose teaching had intoxicated many of the most gifted of his enthusiastic pupils. They were men, like Horner and Greenough, who had a practical insight that enabled them to give a permanent help to the progress of science. They had that supreme gift, the power to see things as they are. It would not be fair to claim for them that they were the originators of accurate methods in Geology; such methods had been used before their day—by William Smith in England, by Lehman in Germany, and by Desmarest in France. But these men, acting singly, had not been able to save Geology from the eighteenth-century spirit of adventurous speculation, nor had they lifted from Geology the burden of those quaint theories, that made this science the butt of Voltaire's luminous ridicule.

The great achievement of the Geological Society has been this: as a corporate body it has been able to spread its influence very widely; its clear-sighted pursuit of a practical ideal has been adopted in other countries; its resolute rejection of the temptation to wander in dreamland has affected geological students all over the world. In this way has been laid a broad foundation of positive knowledge upon which modern Geology has been built.

The fine self-restraint, which induced the founders of the Geological Society to restrict its work for a while to observing the surface of the earth, has had its reward. The methods this society was founded to employ have been so widely used, that we now have geological maps of a wider area than was known to geographers of a century ago. The general distribution of all the rocks on the earth's surface has been discovered; most settled countries have been surveyed in some detail; the main outlines of the history of life on the earth have been written and carried back almost as far as palæontologists are likely to go. There are doubtless fossiliferous areas still undiscovered in the "back blocks" of the world; but, though negative predictions are proverbially reckless, it seems probable that Palæontology will not carry geological history materially farther back. Fossils have been discovered in the præ-Cambrian rocks; the best known is the fauna described by Walcot from Montana; but his Beltina, the oldest well-characterised fossil, is still of Palæozoic type. It may be that the poverty of carbonate of lime, which is so characteristic a feature of most Cambrian and præ-Cambrian sediments, indicates that the bulk of the contemporary organisms had chitinous shells or were soft-bodied. Palæontology begins with the appearance of hard-bodied organisms; it can only reveal to us the dawn of skeletons, not the dawn of life. We are dependent for knowledge of the climate and geography of Eozoic time to the evidence of the sediments, of which there are great thicknesses beneath the fossiliferous rocks in most parts of the world.[1]

II. *The Geology of the Inner Earth.*

Now that this geological survey of the earth is in rapid progress; while the history of life has been written at least in outline; the chief fossils, minerals, and rocks have been described and generously endowed with names; and the manifold activity of water and air in moulding the surface is duly appreciated, it is not surprising to find that the centre of geological interest is shifting to the deeper regions of the earth's crust and to the problems of applied Geology. The secrets of these deeper regions are both of scientific and economic interest. They are of scientific importance, for it is now generally recognised that the main plan of the earth's geography and the essential characters of the successive geological systems are the result of internal movements. The relative importance of those restless external agents that we can watch, denuding here and depositing there, has been exaggerated; probably they do little more than soften the outlines due to the silent heavings produced by the colossal energies of the inner earth.

The study of the deeper layers of the crust is of economic interest, for, with keener competition between increasing populations and with the exhaustion of the most easily used resources of field and mine, there is growing need for the better utilisation of soils and waters, and for the pursuit of deeper deposits of ore.

If a shaft be sunk at any point on the earth's surface, a formation of Archæan schists and gneisses would probably always be reached; and, working backward, geological methods always fail at last—in primæval, Archæan darkness. The Archæan rocks still hide from us the earlier period of the earth's history, including that of all rocks which now lie beneath them. But already there are indications that the mystery of the "beyond" is not so impenetrable as it seemed.

(1) *The Nebular and Meteoritic Hypotheses.*—The eighteenth century explained the history of the earth by the nebular hypothesis of Laplace. Geologists respectfully adopted this idea from the astronomers; they accepted it as one of those essential facts of the universe with which geological philosophy must harmonise. The resulting theory represented the earth as originally a glowing cloud of incandescent gas, which slowly cooled, until an irregular crust of rock formed around a gaseous or molten core; as the surface grew cooler, the depressions in the crust were filled with water from the condensing vapour, forming oceans which became habitable as the temperature further fell. The whole earth was thought to have had a long period with a universal tropical climate, under which coral reefs grew where flow our polar seas, and palms flourished on what are now the Arctic shores. Still further cooling had established our climatic zones; and it was predicted that in time the polar cold would creep outward, driving all living beings toward the equator, until at length the whole earth, like the moon, would become lifeless through cold, as it had once been uninhabitable through heat. This theory has permanently impressed itself on geological terminology; and its corollaries, secular refrigeration and the contortion of the shrinking crust, once dominated discussions concerning climatic history and the formation of mountain chains. This nebular hypothesis, however, we are now told, is mathematically improbable, or even impossible; and it is only consistent with the facts of Geology on the assumption that, in proportion to the age of the world, the whole of geological time is so insignificant that the secular refrigeration during it is quite inappreciable; hence Geology can no more confirm or correct the theory than a stockbreeder could refute evolution by failing to breed kangaroos into cows in a single lifetime.

The theory of the gaseous nebula has been probably of

[1] Such are the Algonkian sediments represented by the Huronian and Algonkians of America, the Algonkians of Scandinavia, the Karelian of Finland, the Briovarian of North-West France, the Heathcotian of Australia, the Transvaal and Swaziland systems of South Africa, the Dharwar and Bijawar systems of India, the Itacolumnite series of Brazil, &c.

more hindrance than help to geologists; its successors, the meteoritic hypothesis of Lockyer and the planetismal theory of Chamberlin, are of far more practical use to us, and they give a history of the world consistent with the actual records of Geology. According to Sir Norman Lockyer's meteoritic hypothesis, nebulæ, comets, and many so-called stars consist of swarms of meteorites which, though normally cold and dark, are heated by repeated collisions, and so become luminous. They may even be volatilised into glowing meteoric vapour; but in time this heat is dissipated, and the force of gravity condenses a meteoritic swarm into a single globe. Some of the swarms are, says Lockyer, "truly members of the solar system," and some of them travel around the sun in nearly circular orbits, like planets. They may be regarded as infinitesimal planets, and so Chamberlin calls them planetismals.

The planetismal theory is a development of the meteoritic theory, and presents it in an especially attractive guise. It regards meteorites as very sparsely distributed through space, and gravity as powerless to collect them into dense groups. So it assigns the parentage of the solar system to a spiral nebula composed of planetismals, and the planets as formed from knots in the nebula, where many planetismals had been concentrated near the intersections of their orbits. These groups of meteorites, already as solid as a swarm of bees, were then packed closer by the influence of gravity, and the contracting mass was heated by the pressure, even above the normal melting-point of the material, which was kept rigid by the weight of the overlying layers.

This theory has the recommendation of being consistent with the history of the earth as interpreted by Geology. For whereas the nebular hypothesis represents the earth as having been originally intensely hot, and having persistently cooled, yet geological records show that an extensive low-level glaciation occurred in Cambrian times in low latitudes in South Australia;[1] indeed, it seems probable that, in spite of many great local variations, the average climate of the whole world has remained fairly constant throughout geological time. Whereas it has often been represented, in accordance with the nebular theory, that volcanic action has steadily waned, owing to the lowering of the earth's internal fires and the constant thickening of its crust, yet epochs of intense volcanic action have recurred throughout the world's history, separated by periods of comparative quiescence. Whereas it has been assumed, as a corollary to the nebular theory, that the force which uplifted mountain chains was the crumpling of the crust owing to the contraction of the internal mass, yet observation reveals that the crust has been corrugated, and fold mountains formed by contraction to an extent far greater than secular cooling can explain.

(2) *The Materials of the Inner Earth.*—This planetismal hypothesis is not only consistent with geological records, but also with the known facts as to the internal composition of the earth and the structure of extra-terrestrial bodies as revealed by meteorites. Meteorites are of two main kinds—the meteoric irons, which consist of nickel iron, and stony meteorites, which are composed of basic minerals. Some of the stony meteorites have been shattered into fault breccias, showing that they are fragments of larger bodies which were subject to internal movements, like those that have formed crush conglomerates in the crust of the earth. Those stony meteorites, therefore, both in composition and structure resemble the rocks in the comparatively shallow fracture zone of the earth's crust. The nickel-iron meteorites, on the other hand, represent the barysphere beneath the crust.

The earth appears to consist of material similar to that of the two types of meteorites; but whether the proportions of the two materials in the earth represent their proportions in other bodies and in meteoric swarms is problematical. There appear to be no satisfactory data for an estimate of the relative abundance in space of the iron and stony meteoric material. Stony meteorites have been seen to fall far more frequently than iron meteorites; but the largest known meteorites are of the nickel-iron group, although this material, in moist climates, very soon decays. The most trustworthy indication as to the relative amounts of the stony and nickel-iron meteorites is given by a comparison of the weight of the two types of material in meteorites of which the fall was seen. According to Mr. Fletcher's list of the meteorites in the British Museum up to 1904, the collection included 319 specimens of which the fall is recorded: of them 305 specimens were stony meteorites of an average weight of 2·63 lb., 9 were iron meteorites of an average weight of 2·31 lb., and 5 were siderolites (or meteorites containing a large proportion of both silicates and nickel iron) of an average weight of 54 lb.[1] Therefore, according to this test, the stony materials would appear to be the more abundant. But if all known meteorites are considered, the iron group far outweighs the other; for the iron meteorites in the British Museum collection weighed 11,873 lb., as against a total weight of only 865 lb. of stony meteorites. The available evidence suggests that the stony meteorites fall the more frequently on the earth, but the meteoric irons come in such large masses that they outbalance the showers of the smaller stones.

We might have expected help from another source in examining what lies below the Archæan rocks. Cannot the relative proportions of the stony and metallic constituents in the earth help us? Unfortunately, this proportion is as uncertain as that of stony and iron meteoritic material. The best-established fact about the interior of the earth is that its materials are much heavier than those of its crust. The specific gravity of the earth as a whole is about 5·67; the specific gravity of the materials of the crust may be taken as about 2·5, while that of the heavier basic rocks is only about 3·0. Hence the earth as a whole weighs about twice as much as it would do, if it were built of materials having the same density as those which form the crust.

Two explanations of the greater internal weight of the earth have been given. According to one, the earth is composed throughout of the same material, and the internal mass is only heavier because it is compressed by the weight of the overlying crust. Laplace estimated that the material would gradually increase in density from the surface to the centre, where its specific gravity would be 10·74, and the calculations of Schlichter show that condensation due to compression may be adequate to account for the greater internal weight.

According to the alternative or segregation theory, the difference in density is explained as due to a difference in composition; the interior of the earth is thought to be heavier owing to the concentration of metals within it. The probability of this metallic interior has been advanced from several lines of evidence; and the assumed metallic mass has received from Posepny the name of the "barysphere," or heavy sphere. According to this view the earth is essentially a huge ball of iron, which, like modern projectiles, is hardened with nickel; and it is covered by a stony crust, the materials of which were primarily separated from the metallic mass, like the slag formed on a ball of solidifying iron in a puddling furnace.

It has been objected that the weight of the earth is not great enough for much of it to be composed of metallic iron or of meteoritic material. The specific gravity of iron under the pressure at the earth's surface is about 7·7, and it would be even greater when compressed in the interior. But the barysphere is doubtless impregnated with much stony material that would lessen its weight. An estimate by Farrington (1897) of the average specific gravity of the meteorites of which the fall had been recorded is only 3·69. According to the Rev. E. Hill (1885) the mean specific gravity of all the meteorites in the British Museum was 4·5; and, though Mr. Hill duly considered the effect of compression, he concluded that "the density of the earth is perfectly consistent with its being an aggregation of meteoric materials." Moreover, within the metallic barysphere there may be a core of lighter material; for earthquake waves travel more slowly in the central core of the earth than in the intermediate zone, or are even suppressed altogether there; hence the centre of the earth may be occupied by matter less compact than that of the shell around it; and, according

[1] As shown by the work of Prof. Howchin, of Adelaide.

[1] The weights are given in pounds avoirdupois. For the calculation I am indebted to Mr. W. R. Wiseman, of the Geological Department of Glasgow University.

to Oldham's calculations, the light central core occupies two-fifths of the diameter of the earth.

The evidence of density alone, therefore, gives no convincing evidence of the nature of the earth's interior; and geologists have been left with no conclusive reason for choosing between the condensation and segregation theories. Radio-activity has, however, unexpectedly come to our aid, and has disclosed a further striking resemblance between the internal mass of the earth and the iron meteorites. It has supplied direct evidence about the constituents of the earth at depths which have hitherto been far beyond the range of observation. Mr. Strutt has shown that radium is probably limited within the earth to the depth of 45 miles; that the deeper-lying material is free from radium; and that this substance is not found in iron meteorites.

The agreement in radio-active properties between the iron meteorites and the interior of the earth is an additional and weighty argument in favour of the view that the earth is largely composed of nickel iron.

(3) *Physical Conditions and Temperatures.*—The physical condition in which the material exists is now of secondary interest. The old controversy as to whether the earth has a molten interior inclosed within a solid shell has lost its importance, because it has become a mere matter of definition of terms. The facts which led geologists to believe that the interior of the earth is fluid are consistent with those which prove that the earth is more rigid than a globe of steel. For under the immense pressure within the earth the materials can transmit vibrations and resist compression like a solid; but they can change their shape as easily as a fluid. They are fluid just as lead is when it is forced to flow from a hydraulic press. Not only are geologists now justified in their belief that the deeper layers of the earth's crust are in a state of fluxion, but, according to Arrhenius (1900), the earth is solid only to the depth of 25 miles, below which is a liquid zone extending to the depth of 190 miles; and below that level, he tells us, "the temperature must, without doubt, exceed the critical temperature of all known substances, and at this depth the liquid magma passes gradually to a gaseous magma." This distinguished physicist gives a description of the earth's interior which reminds us of the views of the early geologists. Arrhenius's theory rests, however, on the existence within the earth of exalted temperatures; and this assumption a geologist may now hesitate to accept with less risk of getting into disgrace than he would have run a few years ago. It is improbable that the rapid increase of heat with depth which is observed near the surface should continue below the lithosphere; for, if the earth consists in the main of iron, even although it be arranged as a mesh containing silicates in the interspaces, the heat conductivity might be sufficient to keep the whole metallic sphere at a nearly equal temperature. Here, again, Mr. Strutt's work on radio-activity is in full agreement with the requirements of geologists, for he estimates that below a crust 45 miles thick the earth has a uniform temperature of only 1500° C. Whether the further conclusion, that this heat is due to the action of the radium in the crust, be established or not, it is gratifying to hear a physicist arguing in favour of a moderate and uniform internal temperature.

All that the actual observations prove and that geological theories require is that the material within the earth be intensely hot, and that it lie under such overwhelming pressure that it would as readily change its form and as quickly fill up an accessible cavity as any liquid would do. Whether such a condition is to be described as solid, liquid, or gaseous is of little concern to geologists.

III. *The Deep-seated Control over the Earth's Surface.*

The modern view of the structure of the earth adds greatly to the interest of its study, for it recognises the world as an individual entity of which both the geological structure and the history have to be considered as a whole. Once the earth was regarded as a mere lifeless, inert mass which has been spun by the force of gravity, that hurls it on its course into the shape of a simple oblate spheroid. Corresponding with this astronomical teaching as to the shape of the world was the geological doctrine, that all its topography is the work of local geographical agents, the control of which over the surface of the earth is as absolute as that of the sculptor's chisel over a block of marble.

Both these conceptions are now only of historic interest. The irregular individual shape of the earth is expressed by its description as a geoid. The processes which have produced its varying shape have also controlled its geological history and evolution, for they cause disturbances of the crust, which affect the whole earth simultaneously; and so the geographical agents are given similar work and powers at the same time in different places.

Hence there is a remarkable world-wide uniformity in the general characters of the sedimentary deposits of each of the geological systems. The last pre-Cambrian system includes thick masses of felspathic sandstones alike in the Torridonian of Scotland, the sparagmite of Scandinavia, the Keweenawan Sandstones of the United States, and perhaps also the quartzites of the Rand. The Cambrian has its greywackes and coarse slates and its numerous phosphatic limestones; the Ordovician its prevalent shales and slates; the Silurian its episodal limestones and shales. The Devonian has its wide areas of Old Red Sandstones as a continental type, while its marine representatives show the prevalence of coarse grits and sandstones in the lower series, of limestones and slates in the middle series, and the recurrence of sandstones in the upper series; and this sequence occurs alike in North-Western Europe, in America, and Australia. The Carboniferous contains the first regional beds of thick limestone and the first important Coal Measures. The Trias is as characterised by rocks indicating arid continental conditions in America and Australia and South Africa, as Prof. Watts has shown then prevailed in the neighbourhood of Leicester. In the Mesozoic era we owe to Suess the demonstration of the world-wide influence of those marine encroachments or "transgressions" whereby the great continents of the Trias were gradually submerged by the rising sea.

Speaking generally, there is a remarkable lithological resemblance between contemporary formations in all parts of the world. This fact had been often remarked, but was usually dismissed as due to a number of local isolated coincidences of no special significance. But the coincidences are too numerous and too striking to be thus lightly dismissed. They are among the indications that the main earth-changes have been due to world-wide causes, which led to the predominance of the same types of sedimentary rocks during the same period in many regions of the world.

The conditions that govern the geological evolution and general geography of the earth are probably due to the interaction between the earth's crust and the contracting interior; they may take place as slow changes in the form of the earth, causing the slow rising or lowering of the sea surface, or the slow uplift or depression of regions of the earth's crust; or they may give rise to periods of violent volcanic action in many parts of the earth, between which may be long periods of quiescence. The geographical effects of changes in the earth's quivering mass affect distant regions at the same time. Therefore the landmarks of physical geology will probably be found to give more precise evidence as to geological synchronism than those of Palæontology, on which we have hitherto had to rely.

IV. *Plutonists and Ore-formation.*

Belief in the earth's internal fires was most faithfully held amongst geologists by the Plutonists of the eighteenth century, and repudiated with equal thoroughness by the Neptunists, who refused to concede that volcanic action was due to deep-seated cosmic causes. Thus Jameson in 1807 stoutly maintained that volcanoes were superficial phenomena due to the combustion of beds of coal beneath fusible rocks, such as basalt, and that the explosions were due to the sudden expansion of sea-water into steam by contact with the burning coal. Volcanoes, according to this view, were correctly described as burning mountains, giving forth fire, flame, and smoke. The extreme Neptunist and Plutonist schools have long since been extinct, but the controversy is not quite closed. The battlefield is now practically restricted to economic geology, and the issue is the origin of some important ores.

Ore deposits present so many perplexing features that deep-seated igneous agencies were naturally invoked to explain them, and some of the most thorough-going champions of the igneous origin of ores make claims that remind us of the eighteenth-century Plutonists. The question is to some extent a matter of terms. Many of the ores which Vogt, for example, describes as of igneous origin he attributes, not to the direct consolidation of material from a molten state, but to eruptive after-actions due to the hot solutions and heated gases given off from cooling igneous rocks. Igneous rocks probably play a notable part in the genesis of most primary ore deposits; for the entrance of the hot ore-bearing solutions is rendered possible by the heat of the igneous intrusions, as Prof. Kemp has well shown in his paper on "The *Rôle* of Igneous Rocks in the Formation of Metallic Veins." Prof. Kemp limits the term "igneous" to materials formed by the direct consolidation of molten material; and this decision seems to me to be most convenient. For example, the quartzite that is so often found beneath a bed of basalt is due to hot alkaline water from the lava cementing the loose grains of sand; the process is an eruptive after-action, but it would be unusual to call such a quartzite an igneous rock.

(1) *Igneous Ores.*—That there are ores which are the products of direct igneous origin is now almost universally admitted. The mineral magnetite is a most valuable source of iron, and it is a constituent of most basic igneous rocks. If iron were a high-priced metal, such as tin or copper, of which ores containing one or three per cent. are profitably worked, then basalt would be an ore of igneous origin. Under present commercial conditions, however, basalt cannot be regarded as an iron ore. But if the magnetite in a basic rock had been segregated into clots or masses large enough and pure enough to pay for mining, then they would be iron ores formed by igneous action. There are cases of such segregations large enough to be mined. The most famous is Taberg, a mountain in Småland, near the southern end of Lake Wetter, in Sweden. It is a locality of historic interest; a view of it, as a mountain of iron, was published by Peter Ascanius[1] in the Philosophical Transactions in 1755, and Sefström discovered the element vanadium in its ore in 1830.

Taberg consists of an intrusive mass of rock composed of magnetite, olivine, labradorite, and pyroxene. Many theories of its formation have been advanced. The view generally adopted is that of Törnebohm, who described the rock as a variety of hyperite in which there has been a central segregation of magnetite to such an extent that some of it contains 31 per cent. of iron. Törnebohm claims to have traced a gradual passage from normal hyperite to a variety poor in felspar, then to one without felspar, and finally to a granular intergrowth of magnetite and olivine. This Taberg ore was mined and smelted for iron in the eighteenth century, when transport was more costly and commercial competition less keen than it is to-day. The ore has been worked at intervals as late as 1870; and as the hill is estimated to contain 100 million tons of ore above the level of the adjacent railway, it is not surprising that efforts are being again made to utilise the deposit, in spite of its low grade and high percentage of titanium. The Taberg rock has almost reached the line which divides magnetite-bearing rocks from useful iron ores. Its igneous origin, however, has not been universally accepted. The theory has been rejected by so eminent an authority as Posepny, according to whom the ore occurs in solid veins as well as in grains; and he holds that, like other Scandinavian iron ores, it was due to secondary deposition. During a visit to the mountain, I failed to see any secondary veins, except of insignificant value. The microscopic sections of the ore show that it is a granular aggregate of olivine, generally with labradorite and pyroxene. Hence I have no hesitation in accepting the view of the Swedish geologists and regard Taberg as a magmatic segregation. Posepny[2] has in this case carried his Neptunist theory of the genesis of ores too far.

[1] vol. xlix. pp. 30–34, pl. ii.
[2] F. Posepny. "The Genesis of Ore Deposits," Trans. Amer. Inst. Min. Eng., 1893, p. 323.

At Routivaara, in Swedish Lapland, there is a still larger mass of magnetite, which is claimed, in accordance with the descriptions of Petersson and Sjögren, to be due to segregation from the magma of the surrounding gabbro. This mass of magnetite is of colossal size, but it is of no present economic value, owing to its high percentage of titanium and its remote position.

An igneous origin is claimed by Prof. Högbom for some small masses of titaniferous magnetite in the island of Alnö, opposite Sundsvall, on the eastern coast of Sweden. This case is of interest, as the surrounding rock is not basic: it is a nepheline syenite, containing only 2 per cent. of magnetite, which, however, has been concentrated in places, until some specimens (according to an analysis quoted by Prof. Högbom) contain as much as 64 per cent. of magnetite, 9 per cent. of ferrous oxide, and 12 per cent. of titanic oxide.

The Alnö magnetites, again, are of no practical value, as they are too low in grade and too refractory in nature. I understand that about 500 tons of the material have been smelted, but with unprofitable results, and the rest of the material quarried has been left on the shore. We may therefore accept the iron-bearing masses of Alnö and Routivaara, as well as that at Taberg, as due to magmatic segregation, without having conceded much as to the igneous formation of ores. The process in this case has formed rocks, rich in titaniferous magnetite, from which iron could be obtained, but rocks which no ironmaster is at present willing to buy as iron ore. Whether a basic igneous rock is to be regarded as an iron ore, or as only useful for road metal, depends on cost of treatment. The definition of the term "ore" is very elastic. Petrographers speak of the minute grains of magnetite or chromite in a rock as its ores; but that is a special use of the term "ore." Usually ore means a material which can be profitably worked as a source of metals under existing or practicable industrial conditions.[1] According to this definition, the Swedish deposits of titaniferous magnetite are at present doubtfully within the category of iron ores.

The famous iron mines of Middle Sweden at Dannemorra, Norrberg, Grängesberg, and Persberg occur under different geological conditions; they work lenticles or bands of ores in metamorphic rocks, of which some are altered sediments; and the view has therefore been held by de Launay and Vogt that the ores also are altered sediments.

That ores are formed by igneous segregation of sufficient size and purity to be of economic importance is a theory which rests on two chief cases—the nickel ores of Sudbury in Canada and the iron ores of Swedish Lapland.

(2) *The Sudbury Nickel Ores.*—The nickel ores of Sudbury are the most important historically. They have been repeatedly claimed as of direct igneous origin by Bell (1891), von Foullon (1892), Vogt (1893), Barlow (1903), and by other geologists; and his view was advocated before the Association at the Johannesburg meeting by Prof. Coleman. The theory was stoutly opposed by Posepny in 1893, and Prof. Beck in 1901 described some of the brecciated ore, and showed that its metallic minerals are sharply separated from the barren rock. He held that such ore must have been formed, not only after the consolidation of the rock, but even after or during its subsequent metamorphism. The views of Posepny and Beck seem to have been established by additional microscopic study of the ores by C. W. Dickson (1903). He has shown that the sulphides are separated from the barren rock by sharp boundaries, and without any indication of a passage between them; that the fragments of ore in the rock have short corners, whereas, had they grown in a molten magma, the angles would have been rounded, and the faces corroded. Most of the ore, moreover, occurs as a cement filling interspaces between broken fragments of barren rock and along planes of shearing. The Sudbury ores, therefore, appear to have been deposited from solution during or after the brecciation of the rocks in which they occur, and long after their first consolidation.

[1] The Oxford Dictionary adopts a still more restricted definition: according to it an ore is "a native mineral containing a precious or useful metal in such quantity and in such chemical combination as to make its extraction profitable."

If Dickson's facts be right, the Sudbury ores are necessarily aqueous and not igneous in origin.

(3) *Scandinavian Iron Ores.*—The other important mining field of which the ores are claimed as of igneous origin is Swedish Lapland. Its ores are rich and the ore bodies colossal. One mine, Kirunavaara, yielded more than one and a half million tons of ore in 1906, and according to a recent agreement with the Swedish Government the annual output of ore from that mine may be raised to three million tons by 1913.

The chief mining fields of Lapland, although situated to the north of the Arctic Circle, have long been known; for some of them contain veins of copper which were worked, for example, at Svappavaara in the seventeenth century. The iron ores, however, could not be used until a railway had been laid through the swamps of Lapland to carry the ores cheaply to the coast. In 1862 an ill-fated English company began a railway to the Gellivara mines, and thirty years later this was completed across Scandinavia, from the head of the Gulf of Bothnia at Lulea to an ice-free port at Narvik, on the Norwegian coast.

This railway, the most northern in the world, passes the two great mining fields of Gellivara and Kiruna. The mining field of Kiruna is the larger and at present of the greater geological interest, as its structure is simpler and its rocks less altered.

The ore body at Kiruna outcrops along the crest of a ridge two miles long, and it is continued beneath Lake Luossajarvi to the smaller but still immense ore body of Luossavaara. At Kiruna the ore rises to the height of 816 feet above the surface of the lake, and it varies in thickness from 30 to 500 feet, with an average thickness of about 230 feet. According to the report by Prof. Walfrid Petersson,[1] submitted this year to the Swedish Parliament, Kirunavaara contains 200 million tons of ore above lake-level, and Luossavaara another 22½ million tons. The ore is high-grade. According to Lundbohm 60 per cent. of the trial pits showed a yield varying from 67 to 71 per cent. of iron, and 21 per cent. of them showed a yield of from 60 to 67 per cent. of iron. The average of nineteen analyses published in Prof. Petersson's recent report gives the contents of iron as 64·15 per cent. Unlike the Taberg and Routivaara ores, the percentage of titanium is very low; thus in nineteen analyses given by Petersson the average of titanic acid is only 0·23 per cent., and it varies in the specimens from 0·04 to 0·8 per cent.

The ore lies between two series of acid rocks, which have been very differently interpreted, but will no doubt be fully explained by the researches now in progress under the direction of Mr. Lundbohm. The rocks were first called halleflinta, as by Fredholm, and regarded as of sedimentary origin. They are now accepted as an igneous series, associated with some conglomerates, slates, and quartzites. The ore body itself is bounded on both sides by porphyrites, of which that on the lower or western side is more basic than that overlying the ore to the east. The basic western porphyrite is in contact with a soda-augite syenite of which the relations are still uncertain. Interbedded with the overlying eastern porphyrite are rocks that appear to be volcanic tuffs, and both in the tuffs and in the upper porphyrite are fragments of the Kiruna ore.

Three main theories of the genesis of the Kiruna ores have been proposed. Their sedimentary origin was urged on the ground that they occur regularly interstratified in a series of altered sediments, and that the ores, therefore, are also sedimentary. This view may be promptly dismissed, since the adjacent rocks are igneous.

The second theory has been advanced independently by Prof. de Launay and Dr. Helge Bäckström: according to them the porphyrites above and below the iron ores are lava flows, and the ore was a superficial formation deposited in an interval between the volcanic eruptions. According to de Launay the iron was raised to the surface as emanations of iron chloride and iron sulphide; the iron was deposited as oxide, and most of it subsequently reduced to magnetite during the metamorphism of the district.

The third theory—that the ores are of direct igneous origin—has been maintained by Löfstrand, Högbom, and Stutzer; according to them the ores are segregations of magnetite from the acid igneous rocks in which they occur. The segregation theory has been opposed, amongst others, by de Launay and Vogt. Thus, de Launay maintains that the segregation would have been impossible in such fluid lavas as the Kiruna porphyrites, and is improbable, since there is no transition between the ore and the barren rock.

The segregation theory has serious difficulties, and is faced by several obvious improbabilities. The ore occurs as a band nearly forty times as long as it is broad. It has the aspect, therefore, of a bed or a lode. The ore has not the granular, crystalline structure of an igneous rock like the hyperite of Taberg, but the aspect of a material deposited from solution or formed metasomatically. It is almost free from titanium, the undesirable constituent so abundant in the ores of Taberg and Routivaara.

The igneous theory cannot, however, be lightly dismissed, as it is supported by the high authority of Prof. Högbom, and therefore demands careful consideration.

It has been advanced in two main forms, the one considering the ore to have been deposited at the time when the igneous rocks are consolidating, the other considering it was deposited at a later period. According to Prof. Högbom, the ore was syngenetic, being a true magmatic segregation from a syenite. But, according to Dr. Stutzer (1906), the segregation was later than the consolidation of the syenite. He describes the lode as an intrusive banded dyke, of which the chief constituents are magnetite and apatite; and the injection of this dyke pneumatolytically affected the rocks beside it, producing an intermediate zone, impregnated with ore, which he compares to contact deposits.[1]

In spite of the high authority of Prof. Högbom, I am bound to confess that the Kiruna ores do not impress me as of igneous formation. Their bed-like form, microscopic structure, and poverty in titanium are features in which they differ from those admittedly due to direct magmatic segregation. The microscopic sections that I have examined suggest that both the magnetite and apatite were deposited from solution and later than the consolidation of the underlying porphyrite, which the ore in part replaces. An examination of the field evidence supports the conclusions of de Launay and Bäckström as to the ore being a bedded deposit overlying a lava flow, but enlarged by secondary deposition.

V. *Future Supply of Iron Ores.*

This conclusion is perhaps economically disappointing. The possible existence of such vast segregations of iron in the acid igneous rocks has an important economic bearing. There is only too good reason to fear that the chief iron ores are comparatively limited in depth; for most of them have been formed by water containing oxygen and carbonic acid in solution, which has percolated downward from the surface. Ores thus formed are therefore restricted to the comparatively limited depths to which water can carry down these gases. On the theory, however, that these ores are primary segregations from deep-seated igneous rocks there need be no limit to their depth. They would rather tend to increase in size downward, while maintaining, or even improving, in the richness of their metallic contents. For these bodies may be regarded as fragments of the metallic barysphere which have broken away from it and revolve around it like satellites floating in the rocky crust. On this conception these ore bodies would be of as great interest to the student of the earth's structure, as their existence would be reassuring to the ironmaster, haunted as he is by constant predictions of an iron famine at no distant date. It is no doubt true that many of the richest, most accessible, most cheaply mined, and most easily smelted iron ores have been exhausted.

[1] *Bihang till Rikd. Prot.*, 1907, 1 Saml., 1 Afd., 84 Häft, No. 107, pp. 213, 217.

[1] In a later paper, of which only a short abstract has been issued, Dr. Stutzer, however, explains that "the intrusion of the ore dyke was at relatively the same time as the formation of the syenite, and that the ores were formed by magmatic separations *in situ*, or as peregrinating magmatic separations (magmatic veins and bedded streams)." He adds that "pneumatolysis plays no inconsiderable *rôle* in the formation of these veins." Dr. Stutzer's position may be summarised as regarding the ores as collected by segregation, but deposited in their present position by eruptive after-actions.

The black-band ironstone and the clay iron ores of the coalfields, which gave the British iron industry its early supremacy, now yield but a small proportion of the ores smelted in our furnaces. The Mesozoic beds of the English Midlands and of Yorkshire still supply large quantities of ore. Nevertheless the British iron industry is becoming increasingly dependent on foreign ores. So it would be pleasant to find that the Scandinavian iron mines are not subject to the usual limits in depth. I fear the typical iron deposits of Middle Sweden and of Gellivara will follow the general rule; but Kiruna may be an exception, and its ores may continue far downward along the surface of its sheet of porphyrite. The uncertainty in this case lies in the extent of the subsequent enrichment and enlargement of the bed; if most of the ore is due to secondary deposition, then it may be restricted to the comparatively shallow depths at which this process can act; and though that limit will be of no practical effect for a century or more to come, the ore deposit may be shallow as compared with gold mines.

The geological evidence may convince us that all the economically important iron ores are limited to shallower depths than lodes of gold, copper, and tin; but this conclusion shall not enroll me among the pessimists as to the future of the iron supply. Twenty years ago a paper on the gold supplies of the world was read to the Association at the request of the Section of Economics. About the time that the report was issued, there were sixty-eight mining companies with a nominal capital of 73,000,000*l.* at work upon the Rand. Nevertheless, the author, accepting the view that "the future of South African gold-mining depends upon quartz veins," concluded: "There is as yet no evidence that the yield will be sufficient in amount to materially influence the world's production. As regards India, the prospect is still less hopeful."

That quotation may be excused, as it is not only a warning of the danger of negative predictions, but of the unfortunate consequences that happen when geologists are unduly influenced in geological questions by the opinions of those who are not geologists. In economic Geology, as in theoretical Geology, we should have greater confidence in the value of geological evidence. Negative predictions are especially rash in regard to iron, it being the most abundant and widely distributed of all the metals. The geologist who knows the amount of iron in most basic rocks finds it difficult to realise the possibility of an iron famine; he can hardly picture to himself some future ironmaster complaining of "iron, iron everywhere, and not a ton to smelt." There are reserves of low grade and refractory materials which the fastidious ironmaster cannot now use, since competition restricts him to ores of exceptional richness and purity. When the latter fail, an unlimited quantity could be made available by concentration processes. The vast quantities of iron ores suitable for present methods of smelting in Australia, Africa, and India show that the practical question is that of supplies to existing iron-working localities, and not of the universal failure of iron ores.

VI. *Mining Geology and Education.*

The genesis of ores and the extent of future ore supplies are intimately connected questions, and the recognition of this fact has led to the remarkable growth of interest in economic Geology. This wider appreciation of the practical value of academic Geology should, I venture to urge, be recognised among teachers by giving a more honoured place to economic Geology.

It was inevitable that until the principles of Geology had been firmly established, the detailed study of their application should have been postponed. Now, however, last century's work on academic Geology enables the difficult problems connected with the genesis of metalliferous ores to be investigated with illuminating and practically useful results.

British interest in mining education has therefore been revived. Its history has been sadly fitful. Lyell,[1] in 1832, deplored the superiority of the Continent in this respect, as "the art of mining has long been taught in France, Germany, and Hungary in scientific institutions established for that purpose," whereas, he continues (quoting from the prospectus of a School of Mines in Cornwall, issued in 1825), "our miners have been left to themselves, almost without the assistance of scientific works in the English language, and without any 'School of Mines,' to blunder their own way into a certain degree of practical skill. The inconvenience of this want of system in a country where so much capital is expended, and often wasted, in mining adventures, has been well exposed by an eminent practical miner."

[1] C. Lyell, "Principles of Geology," vol. i., ed. 2 (1832), p. 63.

Though the chief British School of Mines made a late start, the brilliant originality of its professors soon carried it into the front rank; but in an evil day for the Mining School it was united with a Normal School for the Training of Teachers, now the Royal College of Science, and that school by its great success overwhelmed its older ally. Those interested in economic Geology therefore welcome the recent decision to separate the technical from the educational and other courses, while leaving the Schools of Mines and Science sufficiently connected for successful cooperation. This policy should give such opportunities for the teaching of mining research that we may not always have to confess, as at present, that British contributions to mining Geology do not rank as high as those made to other branches of our science.

Regrets are sometimes expressed, and perhaps still more often felt, at the tendency in scientific teaching to become more technical; but I, for one, do not fear evil from any such change. It is possible that the educational conflict of the future will be between academic science and technical science, on grounds in some respects analogous to those between classics and science during the last century. The advocates of the educational value of technical science are not inspired by mere impatience with the apparently useless, for they accept the principle that the essence of education is method, not matter. Therefore they claim that the methods and principles of science can be better taught by subjects which are being used on a large scale in modern industries than by subjects of which the interest is still purely theoretical. Those who fear that academic science will be neglected if technical science be used in education may be encouraged by the brilliant revival of classical research since classics lost its educational monopoly. Academic science is even less likely to be neglected. It will always have its fascination for those intellectual hermits—shall I not say those saints of science?—who prefer to work for love of knowledge, free from the worrying intrusion of the mixed problems and fickle conditions of the industrial world; and the greater the progress of applied science the more urgent will be its demands for help from pure science, and, as a necessary consequence, the wider will be the appreciation and the more generous the endowment of scientific research.

Technical education must be as rigorous as that in academic education, and its connection with the fundamental principles must be as intimate. When so taught, economic problems provide at least as good a mental training as those branches of science which are purely theoretical. If the new Imperial College of Science and Technology carry on the mission for which the Geological Society was founded a century ago, if it inspire its students to have their delight in using past discoveries on the open surface of the earth, so that they may penetrate to what is within, then they will gain that sure knowledge of the formation and distribution of ores, which is of ever-growing national importance.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY GEORGE G. CHISHOLM, M.A., B.SC., PRESIDENT OF THE SECTION.

Geography and Commerce.

THE subject which I have chosen for this Address is one that is very apt to raise questions that might lead to keen and even warm controversy. For the raising of such questions no occasion could be less suitable, and it will therefore be my endeavour to handle the subject in such a manner that burning questions may be altogether avoided. For that reason I propose to consider the relations of geography and commerce from an historical point of view, which at least gives one the opportunity of confining oneself to less debatable ground than is entered on when one ventures on prophecy, that "most gratuitous form of error," as it is styled by George Eliot. That I shall be able to keep wholly free from debatable matter is more than I can hope, but it is my intention to try to avoid it as much as possible by illustrating my subject chiefly by reference to the broad, familiar facts of commerce considered in the light of geographical and other implications that may be described as obvious—obvious, and yet perhaps not unimportant and not unworthy of having attention specially called to them; for, after all, the obvious is obvious only to those who are looking in the right direction and with the proper focus, not to those who are looking another way or far beyond what is immediately before them.

As the first of these obvious considerations I may point out that unquestionably the foundation of commerce is the mutual advantage to be derived from the exchange of commodities produced in different places. Geographical relations are therefore of necessity implied in commerce. But those who carry on commerce have always aimed at the greatest possible advantage to themselves, and the commerce that has always attracted the greatest attention is that which has resulted in the greatest additions to their wealth. Peculiar importance therefore belongs to the geographical relations between regions which in any given circumstances lead to the most profitable exchanges.

But before applying this consideration there is another point which must detain us a little. In speaking of wealth as I have just done I am aware that I have made use of a term which economists recognise as one requiring a great deal of exposition to prevent misunderstanding, and there is not the slightest doubt that in the history of commerce it has led to great misunderstanding, and therefore it is necessary, without entering upon an economic disquisition on the subject, to consider the meaning of the term "wealth" sufficiently to indicate the way in which that misunderstanding has arisen. For this purpose it will be most convenient not to give one of the highly abstract definitions of wealth which a modern political economist will give us, but to go back to the more concrete considerations set forth by Adam Smith, who tells us that "the wealth of a country consists not in its gold and silver only, but in its lands, houses, and consumable goods of all different kinds."[1] Now no definition of wealth is given by economists which excludes this last form of wealth, but the misunderstanding to which I refer arises from the fact that this form of wealth is apt to be overlooked. It may happen that a country or region produces a great abundance of consumable goods in proportion to its population, and hence from this point of view be entitled to be regarded as wealthy, and yet may not be a country or region that attracts much attention by its wealth. What has always attracted attention to wealth, and what has caused wealth to have an important effect in directing the main streams of commerce, and commerce to have an important effect, direct or indirect, on history, has been the accumulation of much wealth in few hands, so that a comparatively small number of people in a community have enjoyed, directly or indirectly, the command of a great deal of labour, have had the means of providing themselves with commodious and luxurious houses, with a variety of other comforts, luxuries, and splendours, and over and above that the means of so directing labour as to add still further to their wealth. Such conditions may exist where the great bulk of the population are extremely poor.

Now, it happens that wherever a great abundance of consumable commodities is produced on a relatively small area there is always in that area a greater or smaller number of individuals in whose hands much wealth is concentrated. It is for economists to explain how this comes about, or has come about, but it is a fact of the utmost importance for geographers to bear in mind in considering the relations of commerce and geography.

The existence of a relatively dense population may be due to different causes, such as a great abundance of agricultural products, the carrying on of mining or manufacturing industries, the concentration of the administration of a great dominion, or the pursuit of commerce itself. Where it is due to any cause but the production of great quantities of the necessaries of life foodstuffs must be imported in large quantities, and where the pursuit of manufactures is the cause, or one of the chief causes, then the importing of raw materials is entailed. Where these are most advantageously found there also much wealth is likely to be accumulated in few hands.

Further it is to be noted that where a comparatively small number have the command of much wealth there is sure to be a demand for things of such value that they can be bought only by the wealthy, things that are more or less rare, such as precious metals, jewels, gems, ivory, fine woods, ornamental skins and feathers, manufactured goods of rare materials or of fine quality, as well as, in many places and in most periods of history, slaves. Such trade is necessarily limited in amount, but puts great profits in the hands of those who carry it on with success, and for that reason attracts attention.

With this class of goods may be associated certain others that may be regarded as intermediate in position between those which are bought only by the wealthy and those which are not merely generally consumed but also very widely produced. Amongst these may be mentioned salt, the consumption of which is universal, but the production of which, away from the seaboards of the warmer latitudes, though in a sense widespread, is strictly confined to scattered spots. A more interesting example is that of spices, one of which, pepper, has from a remote period been very generally consumed, but in still smaller quantity than salt, and for that reason has been able to bear still higher transport costs. For ages these costs were very high, for various reasons, amongst which were risks both numerous and great, but the profits of those who were successful in the trade were proportionately high.

Peculiar importance in commercial geography is thereby given to the relations between the regions that yield or yielded spices and those in which they were consumed at a great distance from the place of origin, and one of the most important facts in human history is that for many hundreds of years an extremely valuable trade in these commodities was carried on between India and the Mediterranean. Spices no doubt were less talked about, less prominent as symbols of wealth, than gems and jewels, fine woods and ivory, but they formed the basis of a larger trade, which was in the aggregate probably more profitable than that in the still more costly wares.

The geographical relations between India and the Mediterranean necessarily determined the routes followed by this traffic. These routes were singularly few. They were practically confined for the most part to minor variations in two main routes, one by way of the Red Sea, the other by the Persian Gulf. At more than one period of history, in very early times in the days of the splendour of Assyria and Babylonia, and again in the flourishing days of the Caliphs of Baghdad, the Persian Gulf route had a peculiar advantage in the existence of the large and rich populations that afforded an intermediate market; and another important fact in the relations of geography and commerce, one that has had vast effects on human history, is that the physical conditions of the area between the head of the Persian Gulf and the Mediterranean are and throughout human history have been such as to make the most convenient outlet of that route some point or points on that seaboard which in ancient times was known as Phœnicia. Between that seaboard and the Euphrates the desert is sufficiently narrowed to be most easily crossed. The most favoured outlets on this seaboard were not always the same. They varied in different circumstances, which gave a different geographical value now to one point, now to another. But on these variations, interesting and instructive as they are from a geographical point of view, there is no time to enter on this occasion, and it will be enough to call attention to a very interesting paper by the late Elisée Reclus entitled "La Phénicie et les Phéniciens," dealing with this and other matters connected with the geographical basis of Phœnician commerce and industry, a paper too that is apt to be overlooked, inasmuch as it was con-

[1] "Wealth of Nations," book iv., ch. i.

tributed by him with a generosity characteristic of one of the least self-seeking natures with which the world was ever blessed to a rather out-of-the-way publication, the *Bull. de la Soc. Neuchâteloise de Géol.* (vol. xii., 1900). But while I do not desire to enter into details regarding the Phœnicians it is necessary to point out how naturally and indeed inevitably this position of the Phœnician cities between the Mediterranean on the one hand and Mesopotamia and the Persian Gulf route to India on the other hand brought other sources of wealth in its train. Conveniences for the distribution of manufactured goods have always been one of the most important advantages for the development of manufacturing industry, and the wealthier the community forming the market for the products of such industry the more valuable are the manufactures likely to be. Hence the Phœnician manufactures of fine linens and woollens richly dyed, glass and metal wares, for which other parts of the Mediterranean and its seaboard furnished the raw materials, slaves to do the manual labour, and food for that population which the narrow strip of Phœnicia could not adequately supply. Food is indeed a bulky commodity, but even bulky commodities could be transported by sea at a relatively small cost, and in connection with this traffic we must note the indirect effect which the wealth of Phœnicia must have had in promoting the settlement of districts favourably situated for supplying food, and especially of such districts where the opportunities for producing food were great, but not fully turned to account, where the supply therefore could easily be made superabundant in proportion to the wants of the population. This shows that from the very nature of commerce its benefits are not confined to one side. Although the geographical conditions for a long period of time led to a special accumulation of the wealth due to commerce on Phœnicia, Phœnician trade promoted the growth of wealth and civilisation elsewhere. The Greeks of the Ægean distinctly recognised what they owed to the Phœnicians, and they in their turn derived much wealth from Eastern trade, even though not so directly as the Phœnicians, and they in their turn derived some of the food for a commercial population from the far west —from Syracuse, Sybaris, and even the distant Kume. But the far east had a peculiar fascination. As the articles from which much of the wealth of commerce was derived originally came from India, it was natural that the idea should arise that India was a wealthy country, a country well worth possessing. I am not aware whether India ever was in historical times a wealthy country in the sense of producing a great abundance of the necessaries and ordinary conveniences and comforts of life in proportion to the population, but if it was not rich itself it was at least the means of making others rich. There can hardly be a doubt that the desire of possessing this country of real or imagined wealth was prominent among the motives that led Alexander the Great to embark on that enterprise which had such surprisingly—one might almost say miraculously—widespread, profound, and lasting effects on the history of the Near East. If we may accept as historical the speech in which Quintus Curtius represents Alexander as having addressed his troops after his victory over Porus, in order to encourage them to advance further into India, that speech affords fairly strong evidence of what has just been stated. "What now remained for them," said Alexander, "was a noble spoil. The much-rumoured riches of the East abounded in those very regions to which their steps were now bent. The spoils accordingly which they had taken from the Persians had now become cheap and common. They were going to fill with pearls, precious stones, gold, and ivory not only their private abodes, but all Macedonia and Greece." Alexander was no merchant. Pepper was beneath his notice. His symbols of wealth are those which have always most powerfully affected the imagination. Later on, however, we shall meet with a king who was a merchant, and who understood perhaps better than Alexander wherein consisted the value of Indian trade.

At the outset of his career Alexander had destroyed Tyre, thinking, no doubt, that he had thereby wiped away the claims of one rival for a share of the wealth of the East; but it is a noteworthy fact that he did not thereby destroy the value of the site of Tyre under the conditions which then subsisted. Tyre revived and again obtained wealth from its trade with the East, as it did again and again in subsequent history. A heavier blow to Tyre than its mere destruction was the ultimate accomplishment of Alexander's idea for founding a great seat of commerce on the harbour which he saw could be created in the neighbourhood of the Nile delta. The foundation of Alexandria and the successful efforts of the successors of Alexander in Egypt to divert a large part of the trade in spices and other Oriental goods to the Red Sea route for the Mediterranean did more than a single act of war to deprive Tyre and other Phœnician cities of the peculiar preeminence which they had long enjoyed in the trade in those wealth-bringing commodities.

But perhaps the history of Venice shows even more clearly than that of Tyre the importance of this eastern trade in connection with certain inevitable geographical relations. The foundation of the future commercial glory of Venice may be said to have been laid when Rome planted her colonies north of the Po. The gradual clearing of forests gained for agriculture to a greater and greater extent one of the most favoured agricultural areas in Europe. There resulted a superfluity of agricultural products, which begot a trade by sea. The great outlet of this plain in Roman times was Aquileia, which in the beginning of the fifth century, when no one of discernment could imagine that there would ever be other than Roman times, was described by a Roman man of affairs and minor poet as one of the nine great cities of the world. But before that century was out Aquileia was destroyed, never to recover. The value of its site was replaced, and that in a strange way, which no man of discernment could ever have foreseen. The time that saw the destruction of Aquileia and the times that immediately followed were such as made safety a prime consideration, and especially for all who possessed or desired to possess wealth. Refugees from Aquileia, and afterwards from other Italian cities, thought at first of nothing but safety. Many of them found it on a few muddy and sandy islands near the muddy shores of the lagoon in which Venice now lies. But here they found the means of trade. The sea could be made to furnish both fish and salt, and the rivers that flowed into the lagoon enabled them to exchange these commodities for provisions of other kinds which the adjoining land could supply. Gradually this commerce grew, until in the eighth century we find the Venetians trading with Syria and Africa, Constantinople, and the ports of the Black Sea.

Throughout the period of growth the policy of this trading republic, both by land and sea, is very significant. Venice early realised the force of Bacon's maxim "that he that commands the sea is at great liberty, and may take as much and as little of war as he will." Power at sea was necessary to provide security for her commerce. In early times she generally owned allegiance to the Eastern Roman Empire, a suzerainty which could do her little harm and could and did do her much good. To that allegiance she adhered until she was strong enough to turn against and reap advantage from the overthrow of her suzerain. At an earlier date, before the close of the tenth century, she had conquered Dalmatia, and thereby destroyed the hordes of pirates who had found refuge in the innumerable harbours of that coast and constantly harassed the commerce of the Adriatic. At every opportunity she secured establishments and acquired possessions in the Levant.

On the land side, however, dominion would have added more to her risks than her advantages, and that dominion was not sought. For more than eight hundred years after the first flight to the islands of the lagoon, more than six hundred after the election of the first Doge (697), Venice possessed no territory on the mainland beyond a mere narrow ribbon on the edge of the lagoon. The nature of the situation made her indispensable to the trade of the land immediately behind. An incident belonging to the close of the ninth century illustrates the force of this observation. A keen dispute had arisen between the Patriarch of Aquileia and the Patriarch of Grado. Venice supported the Patriarch of Grado, and war seemed to be threatened. But so necessary had the commerce of Venice become to the inhabitants of the territory acknowledging the authority of Aquileia that in order to bring about the submission of the Patriarch of Aquileia it was enough to close or blockade the port of Pilo, on the mainland opposite the *lidi*. The subjects of Aquileia then forced the patriarch to sue for peace.[1] On another occasion, in a dispute with the Bishops of Belluno and Treviso, the matter was again partly settled through the efficacy of the measures taken by the Doge Orseolo II., with the consent of the people, to stop commerce with the territory of the bishops, by which the inhabitants found themselves without supplies of salt, and without the means of exchanging their leather and meat for Venetian wares or selling the abundant timber of their forests for the building of Venetian ships.[2] In holding the outlets for maritime commerce Venice felt herself to be in the possession of "the keys of trade," to use the expression employed by Sir William Petty in speaking of the analogous position of Holland in later times at the mouths of the Rhine, Meuse, and Scheldt.

But while possession on the mainland was not necessary to Venice she always recognised and sought the advantage of good relations with the occupants of the plains behind her, whoever these occupants might be, and on every occasion endeavoured to turn to her own benefit the vicissitudes of those plains. In her early days she is found now in alliance with the Greeks, now with the Pope, now with the archbishops of Ravenna, and now with the Lombards, just as it happened to suit her interests, and in any case taking every opportunity of obtaining direct and indirect advantages from trade with the most profitable customers in the plains. When famine pursued the steps of the Lombard invaders of Italy in the sixth century "the Venetians in their pacific retreat," says Mutinelli,[3] "could send their ships to the ports of Apulia and elsewhere to obtain victuals and corn for the famished barbarians," and in consequence the Lombards took them under their protection and granted them security and favours throughout the Lombard kingdom. When Charlemagne, at the invitation of the Pope, invaded Italy to deliver the Church from its subjection to the Lombards, Venetian traders promptly appeared in the camp of the Franks at Pavia and sold to the Frankish chiefs all the riches of the East—Tyrian purples, the plumage of gay birds, silks, and other ornaments, pranked in which the purchasers stalked about in their pride, feeling, no doubt, that now at last they had conquered a land the wealth of which would reward all their labours and hardships.[4] Charlemagne, it is true, was inclined to look with little favour on the Venetians, whom he regarded as supporters of the Greeks, but an attack by his son Pepin in 809 on the islands of the lagoon only served to establish the strength and security of their position, at least on the inner islands of the lagoon. By closing the passages of the canals, removing the navigation beacons, and fortifying and barring the chief entrances to the land they succeeded in holding out during a siege of six months, until the heats of summer began to decimate the troops of Pepin, who, on hearing also of the approach of a Greek fleet, came to terms with the Venetians on conditions similar to those which had been maintained with the Lombards. The Venetians agreed to a tribute, but solely for the narrow strip of territory held on the mainland and in return for commercial privileges in the Frankish dominion, not for any recognition of the existence of the State. The tribute was afterwards paid or withheld according to the power which the Emperors showed of enforcing it; but one permanent result of this incident was that the Venetians, perceiving the smaller security belonging to the islands nearer the mainland, of their own choice made the Rialto the capital of their little State[5] (810).

As a last illustration of the nature of the relations of Venice to the North Italian plains we may refer to some of the points mentioned in a celebrated and often quoted address delivered to the principal senators of Venice by the Doge Mocenigo just before his death (1423), at the time at which Venetian trade was at the very height of its prosperity. At that time Venice was in possession of a considerable tract of adjacent territory on the mainland, and there was a party favourable to further action on the part of Venice against the growing power of Milan. The aged and sagacious Doge feared that this party was going to gain the upper hand and elect as his successor Francesco Foscari, who, he thought, would involve them in dangerous and disastrous as well as useless enterprises. The immediate occasion of the conflict of views in the Venetian Senate was a request of the Florentines for support against alleged designs of the Duke of Milan. Mocenigo, however, not only warned the senators in the most earnest and urgent language against Foscari personally, but also advised them against the particular enterprise, maintaining that it was of no consequence even if the Duke of Milan made himself master of Florence, since the artisans of Milan would continue to send their manufactures to Venice, and the Venetians would be enriched to the loss of the Florentines. He then went on to give particulars of the trade of Venice at that time, dwelling specially on the value of that with Lombardy. To Lombardy alone, it appears, Venice sold every year cloths to the value of 400,000 ducats, *tele* (? linens) to the value of 10,000 ducats: wools of France and Spain to the value of 240,000 ducats, cotton to the value of 250,000 ducats, wine to the value of 30,000 ducats, cloth of gold and silk to the value of 250,000 ducats, soap to the same value, spices and sugar to the value of 539,000 ducats, dye-woods to the value of 120,000 ducats, other articles 110,000 ducats: in all, goods to the value of more than 2,500,000 ducats, the profit amounting to quite half a million ducats. With the exaggeration that comes natural to a lover of his country Mocenigo goes on to say rather grandiloquently that to the Venetians alone land and sea were equally open; to them only belonged the carriage of all riches, they were the providers of the entire world.

All this trade, as well as that of Genoa and other Italian ports which shared with others in the spice trade must have had a remarkably fructifying effect in North Italy generally. Agriculture and manufactures would be alike promoted, and in consequence of that the growth of population; and when war, with its attendant scourges, led to a diminution both of industry and population, this commerce could not fail to assist in bringing about a speedy recovery. It has already been hinted that in manufactures both Milan and Florence took a prominent place in the time of Mocenigo. In truth, manufactures in both cities are of much older date, and it may be interesting to mention here that even in the thirteenth century English wool was a commodity sufficiently valuable to bear the cost of transport to Florence. A letter has come down to us,[1] dated London, January 6, 1284, from the representative of a Florentine house, giving particulars as to purchases that he had made, in many cases for several years in advance, of all or a portion of the wool of many English monasteries from Netley and Titchfield, in Hants. and Robertsbridge, in Sussex, to Grimsby, in Lincolnshire, and Sawley, on the Ribble, in the county of York (one of these monasteries, you may be interested to learn, as near Leicester as Monks Kirby, about midway between Rugby and Nuneaton); and from the work in which this letter is published we also get particulars[2] as to the cost of conveying wool from London by way of Libourne to the Mediterranean port of Aigues Mortes in the same or

[1] Romanin, "Storia documentata di Venezia," vol. i., pp. 197–8.
[2] *Ibid.*, pp. 270–1.
[3] "Del Commercio dei Veneziani," p. 12.
[4] "De rebus bellicis Caroli Magni," L. iii., quoted by Romanin, as above, vol. i., p. 130.
[5] Romanin, as above, vol. i., pp. 144–9.

[1] Published (1765) in a work having no author's name, but stated in the British Museum Catalogue to be by G. F. Pagnini della Ventura, and bearing the title "Della Decima e delle altre Gravezze della Moneta, e della Mercatura de' Fiorentini fino al secolo XVI.," the third volume of which contains "La Pratica della Mercatura" of Balducci Pegolotti (ascribed to the first half of the fourteenth century), under whose name the work is entered in the British Museum Catalogue. The date of the letter is given on p. 94 of vol. ii., and the letter itself on pp. 324–7 of the same volume. For the identification of the names of monasteries in their much disguised Italian forms and spelling I am indebted to my friend Mr. A. B. Hinds, M.A., editor of the last issued volume of the "Calendar of State Papers (Venice)." Most of them, however, are entered and identified in the list given from Pegolotti on pp. 629–41 of Cunningham's "Growth of English Industry and Commerce, Early and Middle Ages," 4th edition (1905).
[2] *Ibid.*, vol. iii., pp. 261–3.

the following century. Florence, indeed, depended on England, Spain, and Portugal for wools of fine quality, its own and other wools of Italy being of very inferior value, so that when four bales of English wool were worth in Florence 240 gold florins the same quantity of wool of Garfagna dell' Aquila was worth only 40 florins.[1] The author of this work adds that he has found no indication of the prices of the wools of Spain and Portugal in Florence. Besides manufacturing cloths from the raw material "Florence carried on a large trade in dressing and finishing woollens manufactured in Flanders and Brabant, and brought to Florence either by way of Paris and the Saône-Rhône valley or by way of Germany and across the Alps. In the time of Mocenigo many of these products of Florentine industry came to Venice for export. In the address already referred to Florence is said to have sent to Venice every year 16,000 pieces of cloth, which were sold to Aquila, Sicily, Syria, Candia, the Morea, and Istria.

It will be noticed that in the address above quoted Mocenigo lays no special stress on the spice trade, but there is not the slightest doubt that spices were amongst the most important commodities with which the Venetians provided a large part of the western world. Just as nowadays the large trade of Britain in bulky goods makes of this country a great entrepôt for the more valuable and less bulky, so in Venetian times the exceptionally large population behind Venice receiving and supplying the bulky goods thus fed the shipping which brought to Venice a much larger proportion of the more valuable goods of the East than was brought to other ports. But there is plenty of direct evidence of the importance of Indian trade to Italy in the Middle Ages. It is to be remembered that of necessity this trade enriched other countries before it reached Venice, and in proof of its importance in the Mediterranean generally one may call attention to the investigations of the Venetian Marin Sanuto Torcello about the end of the thirteenth century, who, we are told, saw with indignation that the defeats of the Christians in Palestine were specially due to the power of the Soldans of Egypt, and perceiving that their great power derived its nourishment from the commerce with the Indies, based on that observation the projects which he urged on Christendom for the overthrow of that power. It is further significant that a sea way to India should have been sought by Genoese as early as 1291,[2] and even more significant that a century later Venice should have found it worth while to maintain a consul in Siam.[3]

But the clearest evidence of the supreme importance of the Indian trade to the Italian cities is to be found in the results of the discovery which finally diverted from Venice and the Mediterranean the great bulk of the Indian trade until that trade had lost all the special significance which it had retained for thousands of years. It need hardly be said that I refer to the discovery of the sea way to India by the Portuguese in 1497–9. Of the feeling aroused in Venice by this discovery Romanin has reproduced,[4] from the "Diarii" of Priuli, an interesting contemporary record, written with reference to a despatch to the Doge probably from Pietro Pasqualigo, a Venetian envoy at Lisbon at the time of the return of the second Portuguese voyage to India under Cabral. The letter is stated to have reached Venice on July 24, 1501. After giving the letter, in which we are told, among other things, how the Portuguese had charged their ships at Cochin with spices at a price which the writer feared to mention, Priuli adds: "On the arrival of this news at Venice all the city was deeply moved and remained stupefied, and the wisest held it for the worst news that could reach them. For, it being recognised that Venice had risen to so high a degree of renown and wealth solely by the commerce of the sea and by navigation, by means of which every year a great quantity of spices was brought thither, which foreigners then flocked together to acquire, and that by their presence and the traffic they obtained immense advantages, now by this new voyage the spices would be brought from the Indies to Lisbon, where Hungarians, Germans, Flemings, and French[1] would seek to acquire them, being able to get them there cheaply; and that because the spices that came to Venice passed through the whole of Syria and the countries of the Soldan, paying in every place exorbitant duties, so that at their arrival at Venice they were so weighted that what at first was of the value of a single ducat was raised in the end to sixty and even a hundred ducats; from which vexations, the voyage by sea being exempt, it resulted that Portugal could give them at a much lower price." So said the wisest, but it is interesting also to note what was said by the less wise. Priuli goes on: "And while the wisest saw that, others refused to believe the story [these, I presume, were the least wise], and others again said that the King of Portugal would not be able to continue this navigation to Calicut, since of thirteen caravels only six had returned safe, the loss would be greater than the advantage, and that it would not be so easy to find men who would consent to risk their lives in so long and perilous a navigation; that the Sultan of Alexandria, seeing the loss of so fine a profit as that obtained by the passage of the spices through his lands, would see to that."

But in this case it happened that the wisest were right. The effects of this discovery were not long in making themselves felt in the notable diminution in the sales of spices at Venice. Under the date February, 1504, Priuli enters in his diary, "The galleys of Alexandria have entered into harbour empty: a thing never before seen." In the following month the same thing happened in the case of the galleys from Beirut.[2] Under August, 1506, it is stated that the Germans at the fair of the preceding month had bought very little. Various remedies for these evils were thought of, and among these it is interesting to note that in 1504 the Council of Ten seriously discussed a proposal to empower an envoy to the Sultan of Egypt to come to an agreement with him, if possible, for the cutting of a canal through the Isthmus of Suez.[3] But the proposal was not adopted. Other efforts to avert the results of the great achievement of the Portuguese were vain. Other disasters befell the republic about the same time. Not only was commerce taking another direction, but, says Romanin, "the wars of Italy were emptying the treasury, the Turkish power was despoiling the republic step by step of its possessions beyond the sea, and Venice was beginning to descend that incline which was to reduce it to a subordinate position among the powers of Europe."[4] North Italy generally suffered at the same time. The withdrawal of the greater part of the spice trade, by diminishing the growth of wealth among the inhabitants, made that part of the world a less important market for manufactured goods. Countries outside of Italy, where rival manufactures had already started, were increasing their wealth more rapidly, and thus imparting an increasing stimulus to their manufactures, and these increased while those of Italy declined. In 1338 the number of woollen factories in Florence is given at 200, making in all 70,000 to 80,000 pieces of cloth in the year; in 1472 the number of shops or factories had risen to 270, but no estimate is given of the quantity of the product; in 1529, however, the number of shops is said to have sunk to 150, and the quantity of cloth manufactured to 23,000 pieces per annum, and in the time of the editor of Balducci Pegolotti the quantity was only about 3000 pieces annually.[5]

Before going further, however, there is one point in the comments on the discovery of the sea way to India quoted above from the "Diarii" of Priuli which calls for notice. Hungarians, Germans, Flemings, and French, he observes, will in future go to Lisbon to get the spices of India more cheaply than at Venice. This remark illustrates the difficulty of shifting the geographical point of view according to circumstances, a difficulty of which at all times abundant illustrations can be offered. The

1 *Ibid.*, vol. ii., p. 95.
2 See the account of this attempt and its results so far as they are known in G. H. Pertz, "Der älteste Versuch zur Entdeckung des Seeweges nach Ostindien" (Berlin, 1859).
3 Romanin, as above, vol. iii., p. 335, note (5).
4 As above, vol. iv., p. 461.

1 We must recognise, with due humility, that the English are of little account in Venetian eyes in 1501.
2 G. Coen, "Le Grandi Strade del Commercio Internazionale proposte fino dal Sec. XVI" (Leghorn, 1888), p. 71.
3 Coen, as above, pp. 82–3.
4 As above, vol. iv., p. 466.
5 "Della Decima," as above, vol. ii., pp. 64, 105.

purchasers of spices who come first into the mind of Priuli are Hungarians and Germans. It was inevitable that they should be among the leading customers of Venice. The Hungarians were supplied from the Dalmatian ports which belonged to Venice. The Germans came by way of the Rhine and the Elbe, and then across the Alps, to get supplies for central, north-western, and northern Europe. But it was neither Hungarians nor Germans who came in greatest numbers to Lisbon to buy the spices which Portuguese ships brought from the East. In any case Lisbon had no advantages like those of Venice for supplying by land a large and rich population immediately behind it. The valley of the Tagus was small and poor, and had not the capacity for expansion in wealth and population which the Lombard plains had when the commerce of Venice began to grow. The bulk of the spices brought to Lisbon had therefore to reach their final markets by routes that did not pass through Lisbon into the interior. To supply the most important of those markets it was the Dutch, the people who held "the keys of trade" for the important valleys of the Rhine, Meuse, and Scheldt, who came to Lisbon in greatest numbers to buy spices of the Portuguese. And here it has to be added that, in spite of the discovery of the sea way to India, the Venetians continued to retain great advantages in the spice trade with Hungary and parts of Germany, as well as, of course, the northern plains of Italy. Things did not remain always as bad as recorded in the years 1504 and 1506. The Portuguese, while maintaining successfully for a hundred years the monopoly of the trade in spices at the place of origin in the East, found their advantage in dividing the trade with Europe between the sea way and the Persian Gulf route, of which latter route they held the key since the final capture of Ormuz in 1515. The trade by way of the Tigris through Baghdad (the so-called Babylon of those days) and the Euphrates to the old Phœnician seaboard was again revived, and was maintained as long as Portugal held command of the trade. It was by this route that the first English commercial expedition to India, that of Newberie, Leedes, Story, and Fitch, went out in 1583, and by which Ralph Fitch, the sole survivor of that expedition, returned in 1591. By this route Venice got back some of her spice trade; not perhaps with the same profit to herself as formerly, but still a trade of no slight importance not only to Venice, but also to Augsburg, Nuremberg, and some of the other cities of South Germany.

But beyond doubt the bulk of the trade was now carried on by the sea route, and we are thereby enabled to get a better idea both of the amount and the nature of the trade. On both points we get information from the "Narrative" of the above-named Ralph Fitch, who tells us that "the Fleete which commeth every yeere from Portugal, which be foure, five, or sixe great shippes, commeth first hither [to Goa]. And they come for the most part in September, and remaine there fortie or fiftie dayes; and then go to Cochin, where they lade their Pepper for Portugall."[1] Now in 1583 a ship of 500 tons would certainly be called a great ship. In 1572 the largest vessel sailing from the port of London was of 240 tons,[2] and the largest of the first fleet of the East India Company was one of 600 tons. I could give more definite information as to the capacity of these fleets at that time if I knew exactly what a *salma* was, for in a report on Portuguese trade sent to the Grand Duke Ferdinand I. of Tuscany (1587–1608) we are told that the fleet consisted of four or five carracks of the capacity of 5000 or 6000 *salme*.[3] But a *salma* is a term for which one sometimes gets a very indefinite meaning, at other times definite but very diverse meanings, sometimes a weight of 25 lb., which is obviously too little, and again a weight of 1000 lb., which is probably too much. The large dictionary of Tommaseo gives this latter weight with an example stating the capacity of a ship; but if that were the meaning then the carracks would be of a burden of from 2250 to 2700 tons, a much heavier tonnage than is elsewhere indicated, so far as I am aware, for vessels of the period. Probably 3000 tons would be the outside limit of the aggregate cargoes annually brought to Portugal, for in any case much room in the ships was required for the large crews of those days with their armaments, for then the idea of carrying on commerce by sea without being in a position to defend your ship was out of the question.

Of the commodities sent home from India, Fitch mentions in this place only pepper, and the correspondence of Albuquerque with the King of Portugal soon after the discovery of the sea way to India clearly reveals how all-important the pepper trade was; but it may be worth while to give the complete list of the commodities which Ralph Fitch enumerates at the end of his "Narrative" as coming from India and the country further eastward. The list is not a long one. It comprises pepper, ginger, cloves, nutmegs and maces, camphora ("a precious thing among the Indians . . . solde dearer then golde"), lignum aloes, long pepper, muske, amber, rubies, saphires, and spinels, diamants, pearles, spodium, and many other kindes of drugs from Cambaia—all of them, it will be observed, having the character of being of high value in proportion to their bulk, so that a very great value of such goods might be carried in ships of small capacity.

Fitch does not tell us what was sent in return, but information as to that is to be had from other sources and presents one or two points of interest. In 1513 Albuquerque, after a long course of fighting, concluded a peace with the Zamorin of Calicut, in which it was agreed, among other things, that the Zamorin should supply the Portuguese with all the "spices and drugs" his land produced, and that "coral, silk stuffs, quicksilver, vermilion, copper, lead, saffron, alum, and all other merchandise from Portugal" should be sold at Calicut as heretofore.[1] Coral comes first in this enumeration. To us at the present day this does not seem a very important article of commerce, but it was otherwise then. One Mafio di Priuli, writing from India in 1537 to the Magnifico M. Constantino di Priuli, says, "At a great fair which is called that of Tremel I have seen buttons of coral sold for their weight in silver."[2] That is the point of view of a European in India, but a native of the East Indies in Europe at the same date would no doubt have spoken with astonishment of the amount of silver that could be got in Europe for a few grains of pepper. Our letter-writer says in his cheerful, hopeful, gossiping way, "The gains of these parts are other than those of Damascus, Aleppo, and Alexandria: for if one does not gain cent. per cent. from Portugal here, and from here back again, one thinks that one gains nothing. And three or four years would be quite enough."[3] But, while he indicates how these immense gains are made, he also indicates clearly enough how they continue to be made—that is, how they are so counterbalanced by losses that if these great gains were not made on occasion commerce would cease. It was all very well to exchange your coral for spices, but the great matter was to get your coral out and your spices home in safety. The writer of this letter had entrusted to a friend who had left on a ship for Ormuz jewels of the value of 4000 Venetian ducats, but the jewels were lost. He believed that his friend was murdered. "But such losses," he adds, "will occur." Another time he lost more than 6000 ducats gold in Portuguese vessels going to Ormuz, and on another occasion he suffered great loss when Pegu was sacked by the King of Burma.

These notes may serve to illustrate the conditions of trade in the glorious days for Portugal when fine fortunes were heaped up in Lisbon through trade, but the great bulk of humanity got very little at least directly through that trade; but we have not exhausted the interest connected with the nature of the outgoing commodities for India, and to that it will be well to return. Another of the stipulations of the treaty of 1513 above referred to was that while duties were to be paid in coin "the Portuguese were to pay for all the pepper and other

[1] Horton Ryley, "Ralph Fitch," p. 61.
[2] *Ibid.*, p. 17.
[3] Angelo de Gubernatis, "Memoria intorno di viaggiatori Italiani nelle Indie Orientali dal secolo XIII a tutto il XVI," p. 149.

[1] Danvers, "The Portuguese in India," vol. i., p. 283.
[2] P. 34 of the letter referred to as published at Venice in 1824.
[3] *Ibid.*, p. 29.

merchandise they might purchase in kind," and, as the peace led among other things to a dearth of prizes, Albuquerque "was constrained to send an urgent request home for large quantities of merchandise to be sent out to make up for this deficiency."[1] How long this stipulation remained in force I cannot say, but things were certainly different a hundred years later. In the report to the Grand Duke of Florence above cited we are told that what the Portuguese carry to India for exchange is above all "silver in reals, and besides silver wine, oil, and some other sort of merchandise, such as coral, glass, and the like, of little importance"; and as to the silver he adds that "the reals bring a gain of more than 50 per cent. as soon as they have reached India, for the real of eight, which in Lisbon is worth 320 reis, in India is sold and spent at the rate of 480 to 484 reis of that money, and with it one buys all sorts of spices and drugs which are sold there, except pepper, which is the monopoly of the King of Portugal and those to whom he gives a lease of that trade." The importance of silver among the outgoing commodities for India has continued from that time down to the present day, latterly, however, in diminishing proportion. For a long time after the date at which we have now arrived it was as predominant as a means of exchange with India as it was in the first century of the Christian era, when the drain of silver from the Roman Empire to the East was bewailed by the writers of that time. In the voyages of the English East India Company of the four years 1620–3 inclusive the value of the bullion (chiefly silver) sent out to India was 205,710*l.*, as against only 58,806*l.* worth of merchandise.[2]

Now, what is the meaning of the change in the position of silver in Indian trade which seems to have taken place between 1513 and the end of the sixteenth century? No doubt we may see there the result of another change in geographical relations brought about by a discovery nearly contemporaneous with that of the sea way to India—namely, that of the New World. The first result of that discovery of importance to commerce was the pouring into Europe of large quantities of the precious metals, and the quantity was enormously enhanced after the silver mines of Potosi, in Upper Peru (as it was then called), were discovered in 1545. It was probably this discovery that brought it about that of all commodities of such small bulk in proportion to their value as to stand the costs of transport to the East this was the one which could be sent out for the most part with the greatest advantage. And this discovery no doubt also helps to explain why that of the sea way to India had so little effect for a very long time in lowering the prices of spices in Europe, why prices even rose. At the time of the return of Vasco da Gama from the first voyage to India the price of pepper at Lisbon is estimated by Danvers[3] to have been about 1*s.* 5*d.* per lb., and we all know that the immediate occasion of the foundation of the English East India Company about a hundred years later was that the Dutch suddenly raised the price of pepper against the English from 3*s.* to 6*s.* and 8*s.* per lb.

But the particular commodity which made up the principal portion of the outward trade to India is, after all, a matter of detail, though not unimportant detail. The main point on which I want to insist is that, whatever the commodities were, whether carried out or home, the nature of the trade with the East was little if at all altered by the discovery of the direct route to India by sea. The trade still continued to be one concerned in a moderate number of articles of small bulk but high value. It was merely a change of route that the Portuguese effected, and for more than a hundred years they remained in sole command of this route. After that, however, they were ousted from the greater part of this trade, and that the more valuable part, chiefly by the Dutch, and from a geographical point of view it is very interesting to note how the Dutch did it. They did not trouble themselves much about India proper. They left the Portuguese alone at Goa, and from that port as a base allowed them to pick up as much trade as they could at Calicut and Cochin, which, said Albuquerque, "were capable of supplying the Portuguese fleets until the Day of Judgment." But Malacca, on the straits of that name, gave command of the route to the further East, whence came in the end even larger quantities of pepper than could be got from India, whence came too ginger, cloves, and nutmegs, as well as the products of China. The importance of this place Albuquerque had accordingly recognised, and in 1511, the year after he took Goa, he took it also by the right that always belongs to the lion as against the jackal. This place was taken by the Dutch (1641), who had previously established themselves on Java and the Spice Islands, where they maintained an absolute monopoly. Ceylon, again, was (and is) almost the only place from which the true cinnamon was to be obtained, so the Dutch took that island also from the Portuguese (1656). As long as the Portuguese were the sole Europeans in the East, Calicut and Cochin not merely furnished the Portuguese with Indian wares, but were important entrepôts for the spices, perfumes, drugs, and jewels of the Further East as well as of Chinese silks and porcelains; but the trade in these commodities could be wholly or largely diverted to places in the possession of the Dutch. Even before the capture of Malacca and Ceylon a Portuguese viceroy had reported (1638) that the Dutch had a monopoly of trade from the Bay of Cochin China to the point of Sunda.

But this change also was little more than a change of route. The general character of the Eastern trade remained the same. The English East India Company, the operations of which, through the hostility of the Dutch, came to be restricted to India proper, there founded a trade that gave much more opportunity for expansion under modern conditions than that of the Dutch, but for a long time it retained the same character. All the commodities enumerated by Colquhoun as brought back by the voyages of 1620–3 in exchange for the bullion and merchandise sent out were pepper, cloves, mace, nutmegs, Chinese and Persian raw silk, besides calicoes, the sole manufactured article, and one of course that had relatively a much higher value than now, when the direction of the trade in that commodity is reversed.

A similar character for a long time belonged to the trans-Atlantic trade, even though the costs of transport in that case were less, and favoured the development of a trade in somewhat bulkier commodities. Furs from the Far North, tobacco from Virginia, sugar and afterwards coffee and cotton from the West Indies, were by far the most prominent imports. It was the tobacco trade of Virginia that first enabled Glasgow, which at the time of the union of the English and Scottish Parliaments was an insignificant town with less than 13,000 inhabitants, to convert itself into a seaport, and thus lay the foundations of its subsequent prosperity. Now tobacco makes up less than 1 per cent. of the value of the goods imported at Glasgow, and, though that may be partly due to a diminution in the actual quantity of tobacco imported at Glasgow, this result has chiefly been brought about by changes in relative values. A hundred years ago the value of the imports into Great Britain and Ireland from the British West Indies was about one-fourth of the total value of the imports from all parts; now it is less than 1 per cent. of that value.

What has brought about such changes, what makes the essential difference between recent and all previous commerce, is the series of enormous improvements in the means of communication which followed so closely on the invention of textile machinery and the improvement of the steam-engine in this country. These improvements have had two important effects on commerce. First, they have facilitated the maintenance of order and security both by land and sea, and thus enormously reduced the risks of commerce. Secondly, they have directly lowered the cost of transport for different goods in different degrees. Bulky goods of little value could now for the first time be profitably conveyed many hundreds of miles by land to a seaport, and there load ever larger ships for distant shores, thus opening up markets with vast undeveloped resources in the heart of great continents. Along with these bulkier goods the more valuable goods are carried at a cost far

[1] Danvers, vol. i., pp. 284, 286.

[2] I take these figures from p. 6 of the appendix to P. Colquhoun's "Treatise on the Wealth, Power, and Resources of the British Empire," 2nd ed., London, 1815.

[3] As above, vol. i., p. 64.

below that of former times, so that for such commodities as pepper the mere freight is almost a negligible item.

At the present day there can be no doubt that in point of quantity the spice trade is much larger than it ever was. If Venice could get the whole of that trade into her hands, a thing which she never had, notwithstanding the patriotic boast of Doge Mocenigo, the trade would not now bring her a tithe of the wealth which it brought in the days of her grandeur. Much has been said of the sudden "fall" of the Portuguese and Dutch in turn, and that fall has often been explained by mistakes in method. "The fall of the Dutch colonial empire resulted," says Sir William Hunter, "from its short-sighted commercial policy. It was deliberately based upon a monopoly of the trade in spices, and remained from first to last destitute of sound economical principles."[1] But one may well ask, Did the Dutch ever fail in a manner for which they were in any way responsible? It is true that the Dutch East India Company did not supply as many people as they could with the spices of which they held the monopoly. But that was not their aim. It is true that they did not build up a great empire like that of the English East India Company. But neither was that their aim. Their aim was to declare dividends, and dividends they declared. The profits of the company down to 1720 averaged 20 per cent. per annum, never sinking below 15 per cent., and sometimes rising to 50 per cent. If spices ceased to enable them to declare such dividends that was not their fault. It was James Watt, George Stephenson, William Symington, and Robert Fulton, who, without intending it, and without being able to foresee what in this respect they were destined to do, sucked the value out of pepper, and that in a manner which neither the strength of armies nor the subtlety of statesmen could have done anything to prevent.

Now the countries that offer the most attractive markets for the greatest quantities of goods of all kinds are no longer those which look to the spice trade or to trade in any specially valuable commodities for their enrichment, but those which abound in coal so placed as to develop a great amount of manufacturing industry, an industry engaged for the most part in working for the million, not merely in producing the luxuries of the rich. The commodities of very small bulk in proportion to their value now have a comparatively insignificant place in commerce. The precious metals and precious stones still indeed retain a good deal of their former importance. But very few vegetable or animal products can be put in the same category. Rubber, indeed, may be reckoned as one, and very handsome profits are reaped from some rubber estates. But everyone knows that such exceptional profits can be reaped only for a short time. Of animal products ornamental feathers are the most valuable in proportion to their bulk. Egrets' feathers, I believe, are seldom worth less and often worth a good deal more than twice their weight in gold, but ornamental feathers altogether make up less than a third of 1 per cent. of the total value of British imports.

Perhaps the greatest feature of modern commerce is the unparalleled manner in which it has promoted the increase of population nearly all the world over. Rendering it possible for manufacturing and commercial peoples to depend in a very large measure for their very means of subsistence on supplies brought from the ends of the earth, it is rapidly pushing the settlement of vacant land to the base of the mountains and the edge of the desert. Fifteen years ago Prof. Bryce said, "We may conjecture that within the lifetime of persons now living the outflow from Europe to North America will have practically stopped."[2] We are at least nearing the time when the "new lands" of this earth in the temperate zone will all have been allotted. The results of such a check to expansion after a long period of stimulation to expansion must be momentous, but what the nature of these results will be I for one confess that I am unable to foresee. I am, however, convinced that, if we are to be enabled to make any probable forecast as to the course of future development, one of the most important aids to that result must consist in the study of the relations of geography and history from the point of view which I have endeavoured to indicate. To study these relations merely with reference to the immediate causes and effects of wars and treaties gives little real insight into the working of geographical influences in history. As in the study of the human body medical men have recognised the necessity of ascertaining with the aid of the microscope the normal functions of the cells of which the body is composed, the pathological states that interfere with their normal working, and the effects on one part of the body of minute disturbances of function in another part, so in tracing the course of history it is becoming more and more recognised that the minute gradual silent changes must be inquired into and taken into account, not merely in relation to the regions in which they take place, but in relation, it may be, to regions far distant. Such studies, it is true, are not confined to the geographer. In them, indeed, the geographer must seek the aid of workers in other fields: but there can hardly be a doubt that it must help greatly towards arriving at a sound solution of the problems presented to keep steadily before one the geographical point of view. The field for such studies is of course immense, the material perhaps not all that could be wished; but I can imagine no task more delightful for those who have the opportunity to engage in it than that of seeking out and examining from that point of view such material as actually exists.

1 "Imperial Gazetteer of India," 2nd ed., vol. vi., p. 262.
2 "The Migrations of the Races of Men considered Historically," in the *Scottish Geographical Magazine*, 1892, p. 419.

NOTES.

THE death is announced, at the age of fifty-one years, of Prof. Emil Petersen, professor of chemistry in the University of Copenhagen. Prof. Petersen was a pupil of and collaborator with Prof. Jörgensen, and was well known for his researches in physical and analytical chemistry.

WE regret to see by the *Scientific American* that Prof. Angelo Heilprin died on July 17 at the age of fifty-four years.

THE sum of 900*l*. has been given by Mr. W. H. Crocker, of San Francisco, to the University of California for the purpose of defraying the expenses of an expedition to observe the total solar eclipse of January 3 next, which will be visible on the Pacific coast.

THE Board of Trade is about to constitute a special temporary branch (under the direction of Colonel Sir Herbert Jekyll, K.C.M.G.) for the purpose of dealing with matters relating to London traffic so far as they come within the scope of the Board.

MR. H. C. PLUMMER, assistant in the Oxford University Observatory, has been appointed to a fellowship at the University of California in connection with the Lick Observatory on Mount Hamilton.

IN reply to a question put to him in the House of Commons on Thursday last by Mr. McCrae, the member for Edinburgh, East, as to whether he was in a position to say if he was able to accede to the request of the Scottish members of Parliament for a grant to the Scottish Meteorological Society for the purpose of reopening and maintaining the Ben Nevis observatories, the Chancellor of the Exchequer said the only scheme which had up to the present been placed before him was one under which the whole cost of the re-equipment and maintenance of the observatories would be thrown upon public funds, and to this he did not feel justified in assenting. He was, however, quite prepared to consider the question of renewing the Government grant, which was for many years given to these institutions through the Meteorological Council, provided that an adequate contribution towards their re-establishment and maintenance were forthcoming from other sources.

A party of observers, consisting of Dr. T. A. Jaggar, jun., head of the department of geology, Massachusetts Institute of Technology; Dr. H. S. Eakle, University of California; Prof. H. V. Gummery, professor of mathematics, Drexel Institute, Philadelphia, who will have charge of the magnetic observations; Dr. Van Dyke, who will study the botany and entomology of the islands; and Prof. F. T. Colby, who will investigate the natural history of the region, recently sailed from Seattle, Washington, to study the geological formation of the Aleutian group of islands and other scientific features of the archipelago. The investigators will, according to the *Scientific American*, pay particular attention to Perry Island, which suddenly rose from the sea more than a year ago. The party will begin working westward from Attu Island, and will devote several months to their researches.

Dr. Charcot has furnished the *Geographical Journal* with further particulars of the plans for his new Antarctic expedition. The choice of the same field of exploration as on the former expedition was made, after due consideration of the plans of other expeditions now being organised or projected, for the following reasons:—(1) the importance of gaining further knowledge of the almost unknown Alexander I. Land; (2) the possibility of the existence in that region of an ice-barrier similar to that of Ross, over the surface of which an advance could be made; (3) the advantages of continuing the scientific work begun by the former expedition, and utilising the experience gained by it; (4) the support to be expected from the Argentine Republic in view of the excellent relations entered upon on the former occasion. The building of a special ship will, it is hoped, soon be begun. While large enough to permit the carrying out of scientific work under suitable conditions, the vessel will be small enough to enable it to navigate in safety along the coasts and to seek shelter in small coves. In addition to ordinary sledges, it is proposed to take motor-sledges for possible use on the surface of an ice barrier. Wandel Island is to be the final base of operations, and from this the coast of Alexander I. Land will be explored as far as possible, also the unknown area, scientific work being at the same time carried on at the base. During the second summer an attempt will be made to navigate westward as far as possible in the direction of King Edward VII. Land.

Information is given in the August number of the *Geographical Journal* respecting a new scientific expedition to the extreme south of South America which is being organised by Mr. Carl Skottsberg, one of the members of the recent Swedish Antarctic Expedition. The expedition, which will leave Gottenberg next month, will consist of Messrs. Skottsberg, P. Quesnel, and T. Halle. It will not sail in a ship of its own, but will make use of the ordinary mail steamers and coasting vessels for transport to the scene of operations, and will be equipped for botanical, geological, zoological, and meteorological work. Proceeding *via* Buenos Aires and Montevideo to the Falklands, the leader and Mr. Halle will there spend the summer of 1907–8 for the purpose of continuing the researches begun by the Swedish Antarctic Expedition, Quesnel meanwhile going to Punta Arenas, where he hopes to make an excursion to the Cerro Payne region. On re-uniting at Punta Arenas, the party will, if time permits, make an expedition to the northwards along the Cordillera and round Otway and Skyring waters, before winter sets in. This will be spent in the rainy region of the western channels, and in the spring an attempt will be made to reach Lago Fagnano, the party then moving its headquarters to the region of Beagle channel. It is proposed to conclude the summer's work with a trip to Tekeenika Bay, returning to Sweden in April or May, 1909.

Mr. Charles Hawksley has commemorated the centenary of the birth of his late father by offering the sum of 1000*l*. to the council of the Institution of Mechanical Engineers for the foundation of a scholarship or premium. The offer has been accepted by the institution, and the terms on which the gift is to be held are under consideration.

Two sums, each of 250*l*., have been received by the Institution of Mechanical Engineers from the Metropolitan Water Board and the chairman of the Court of Arbitration (under the Metropolitan Water Act, 1902), which the donors desire to be used for some engineering purpose connected with the institution. The council have invested the amount—500*l*.—in a trustee security, the income from which they have decided, after consultation with Sir Edward Fry, shall be offered biennially for a paper submitted in accordance with prescribed conditions. It has been further decided that the prize shall be known as the "Water Arbitration Prize," and shall be offered for a paper on an engineering subject to be announced by the council one year before the time for sending in the papers. The prize, which will have a value of approximately 30*l*., will take any form which the council may from time to time decide upon, and will be accompanied by a certificate bearing the seal of the institution. If, in the opinion of the council, no paper of sufficient merit be received in reply to any particular offer of the prize, the amount available for that award will be added to the capital of the fund. The conditions for the first award, to be made in 1908, are that:—(1) The award will be made to the author of the selected paper dealing with the filtration and purification of water for public supply. (2) Members, associate members, associates, and graduates of the institution may compete. (3) Papers must be sent in to the secretary of the Institution of Mechanical Engineers, and must reach him not later than January 3, 1908. (4) Each paper must be clearly written, or typewritten, on one side only of foolscap paper, with a margin, and must be accompanied by an outline or synopsis of its contents of not more than six hundred words; any illustrations submitted with the paper must be properly drawn to scale. (5) Papers submitted for competition will become the property of the institution, and, at the discretion of the council, may be either read and discussed at a general meeting or printed in the Proceedings without having been so read and discussed. Each paper must consist of original matter written by the competitor himself, and the council will require a written statement to that effect. Any paper not accepted for printing in the Proceedings will be returned to the author. No paper which has been previously published will be accepted for competition.

A special committee, with M. V. V. Podvysotsk, director of the Institute of Experimental Medicine, as president, has been appointed by the Medical Council of the Russian Ministry of the Interior to study the question of establishing a committee for the investigation of cancer.

According to the *Lancet*, the late Prof. Grancher, of Paris, has left to the society founded by himself, the object of which is the protection of children from tuberculosis, a sum sufficient to provide an annual income of 20,000 francs. Dr. Roux, director of the Pasteur Institute, has accepted the position of president of the society.

At the first meeting of the medical section of the Royal Society of Medicine, which is to take place on October 22, Dr. Hector Mackenzie will open a discussion on the complications and sequelæ of pneumonia and the treatment of pneumococcal infections by serum or vaccine. The section is now fully constituted, and is open to receive papers for reading and discussion during the winter session.

The fourteenth International Congress of Hygiene and Demography will meet in Berlin from September 23 to September 29. A strong international committee has been constituted for the organisation of the meeting, which promises to be a very successful and interesting one. Of the British section, Sir Shirley Murphy is the chairman, Prof. Nuttall, F.R.S., and Mr. Paul Moline are the secretaries, and Mr. Cutler is the treasurer. The congress is divided into eight sections, and a number of interesting subjects have been selected for discussion. Anyone engaged scientifically or practically in hygiene or demography is eligible as a member, the subscription being 1*l.*, which entitles him to a copy of the transactions. Those not eligible for membership (*e.g.* the relatives of members) will be admitted to the sectional meetings, &c., on payment of a subscription of 10*s.* Some of the subjects selected for discussion are the ætiology of tuberculosis, pathogenic protozoa, alcoholism, care of infants, overwork in schools, caisson disease, uniform methods of testing disinfectants, preventive inoculation, housing of the working classes, artificial ventilation, sleeping sickness, and control of milk.

The eighth session of the Australasian Medical Congress is to take place in Melbourne in October of next year. The president will be Prof. H. B. Allen, of the University of Melbourne. The eleven sections into which the congress is to be divided will be presided over respectively by Dr. G. E. Rennie, medicine; Dr. B. Poulton, surgery; Mr. E. T. Thring, obstetrics and gynæcology; Dr. J. T. Wilson, anatomy and physiology; Dr. F. Tidswell, pathology; Dr. J. M. Mason, public health and State medicine; Dr. J. Lockhart Gibson, diseases of the eye, ear, and throat; Dr. F. Truby King, neurology and psychiatry; Dr. A. Jefferis Turner, diseases of children; Surgeon-General W. D. C. Williams, naval and military surgery and medicine; Dr. W. McMurray, skin diseases, &c.

An electrical exhibition lasting a fortnight is to be held in Montreal, commencing on September 2, and from September 11 to 13 the Canadian Electrical Association is also to meet in the same city, when the following papers, among others, will be read:—How to increase the load factor; some of the difficulties encountered in operating alternating current systems; new and old type incandescent lamps; the Nernst lamp; and electric heating and cooking appliances.

In the Scottish National Exhibition to be held in Edinburgh in 1908 there will be sections devoted to fine arts, education and history, arts and crafts, mining, engineering and metallurgy, transportation and motive power, shipbuilding and waterways construction, chemistry and scientific appliances, lighting, heating and ventilation, agriculture, horticulture and sylviculture, domestic economy, sports and pastimes, botany and zoology, artisans' work, women's section, urban and rural improvements.

A recently issued report from the British Consul at Copenhagen states that the Danish Government has allocated the sum of 4276*l.*, to be used during the next three years, for the purpose of the extermination of rats, on the understanding, however, that the sum of 1666*l.* be expended over a like period by an organisation which is in existence for the destruction of rats. It is stated that a Danish patent rat destroyer has been invented, which, when eaten by rats, causes disease of the bladder, which kills them; whereas it may be swallowed by human beings, dogs, and poultry without danger.

In connection with the international investigations of the upper air, conducted from July 22 to 27, several kite ascents have been made under the auspices of the Meteorological Office. A number of registering balloons (*ballons sondes*) have also been sent up, six at Manchester and three at Ross (Herefordshire), for the joint committee of the Royal Meteorological Society and the British Association; six at Petersfield by Mr. C. J. P. Cave; five at Crinan and four at Pyrton Hill, Oxon, for the Meteorological Office. The recording instruments for nearly all the ascents have been supplied by the Meteorological Office. Up to Monday, July 29, nine had been recovered, and one has been reported since. One balloon sent up at Ross, Herefordshire, on July 23, is reported to have reached the height of probably 60,000 feet, or about eleven miles. It is too early yet for any detailed results to be given.

As the annual presidential address to the Philosophical Society of Washington on December 8, 1906, Prof. C. Abbe read a most interesting and instructive paper on the progress of science as illustrated by the development of meteorology. The author pointed out that while some portions of this subject are already as exact as our knowledge of other sciences can make them, the path of progress is strewn with the wrecks of popular errors. Since the establishment of the Meteorological Society of the Palatinate at Mannheim in 1780, the advance made has been entirely in the direction of the line of work that it laid out, viz. to collect data from all parts of the globe for the purpose of compiling synoptic daily weather maps for the study of the atmosphere as a whole. At the present time the investigation of the upper air is being made throughout the world, and each national weather bureau is extending its field of observation horizontally, while each is now alive to the fact that satisfactory advance in practical meteorology requires corresponding progress in our knowledge of the sciences involved in the motions of the atmosphere. Another step in advance is due to the investigation of the interaction of the continental and oceanic hemispheres, to our knowledge of which subject the researches of Sir Norman and Dr. Lockyer, among others, have greatly contributed. This principle is already recognised by the directors of the Indian Meteorological Service in their forecasts of the approaching monsoons.

At the annual meeting of the National Association of Colliery Managers at Chesterfield on July 25, Mr. J. P. Houfton delivered the presidential address. He dwelt upon the increasing difficulty and complexity of the problems connected with mining as the shallower seams were exhausted, and urged the necessity for the colliery manager to be a man of scientific training and education. He considered that it was of national importance that a university of mining should be established in order to furnish the colliery managers of the future with the technical knowledge and scientific training required to enable them to work the deeper coal seams.

For the summer meeting of the Institution of Mechanical Engineers, which opened on July 30 at Aberdeen under the presidency of Mr. T. Hurry Riches, an interesting programme of papers was arranged. Mr. William Simpson's paper on granite quarrying in Aberdeenshire was specially noteworthy in that it furnished information on a subject regarding which the technical literature is remarkably sparse. Nowhere in the whole of Great Britain is there such a large exposure of granite as in north-east Scotland, and the supply of granite of the highest durability and beauty is practically inexhaustible. The quarrying presents many features of difficulty. The overburden is costly to remove, and the top rock unremunerative. As a rule the quality of the rock improves with the depth, and there is a temptation to deepen without a proportionate surface area. Where this has been done the quarry has assumed the form of a conical pit with a small floor, difficult and costly to work. Mr. Herbert Bing submitted a paper on portable pneumatic tools. Of recent years there has been great progress made in these tools, and in the range of work to which they are applicable. At the present time they will be found in use in practically all engineering works, shipyards, and mines. Mr. C. E. Larard described an electrically controlled single-lever testing machine at the Northampton Polytechnic Institute, London. The machine constitutes quite a new departure in many of its arrangements, and has given very satisfactory results in testing, due primarily to the good control over the rates of loading and straining. Papers were also contributed by Mr. J. M. Henderson, on cableways used on shipbuilding berths, and by Mr. D. J. Macdonald, on jute preparing and spinning.

In October, 1905, a committee was appointed by the council of the Royal Institute of British Architects to draw up rules for guidance in the use of reinforced concrete. The report of this committee has recently been published, and in the *Engineer* of July 26 the rules drawn up are compared with the French Government instructions. In the more important matters there is uniformity in treatment, and the rules proposed by the committee are by no means revolutionary.

The fuels committee of the Motor Union of Great Britain and Ireland has issued a valuable report on motor-car fuels, of which a summary is published in the *Engineer* of July 26. Readers of the report will find cause for a despondent view of the petrol supply, and will probably agree that a famine in petrol appears to be inevitable in the near future, owing to the fact that the demand is increasing at a rate much greater than the rate of increase of the supply. In 1904 the consumption of petrol in the United Kingdom was 12,000,000 gallons; in 1907 it had risen to 27,000,000 gallons. In November, 1904, the trade price was 7*d*. per gallon; in December, 1906, it was 13*d*. Having recognised that the time is not far distant when a substitute for petrol must be sought, the committee discusses in the report other possible fuels. The supply is divided into two parts. The first includes all fuels limited in quantity; they are the spirits of a specific gravity between petrol and paraffin, paraffin itself, coal dust, gas, and benzol. The second group contains one item only—alcohol—and it is evident from the whole tone of the report that the committee expects to find in denatured vegetable spirits the fuel of the future.

An article on the natural regeneration of the "dhowra" tree, *Anogeissus latifolia*, in the Panch Mahal division of Bombay, is communicated by Mr. R. F. Pearson to the May number of the *Indian Forester*. Owing to the occurrence of a large number of trees of an even age, the author was led to examine the conditions under which such extensive seedling growth was developed. Whilst the rainfall in the year of germination was distinctly favourable, the opinion is expressed that, in addition, the seed must have been unusually fertile. The fertility of seeds from trees is a question deserving the attention of foresters. Mr. Pearson attributes the fertility of the seed in this instance to the stimulus or shock caused by the drought of the previous year. A note on the Kashmir trout fisheries refers to the attempts, finally successful, made by Mr. F. Mitchell whereby the Harwan stream and the Dhal Lake have been stocked with brown trout.

With reference to afforestation, in a paper printed in the Transactions of the Royal Scottish Arboricultural Society, vol. xx., part ii., Mr. A. C. Forbes discusses the problem of planting up waste land, and places on record certain data, obtained by the measurement of sample plots of Scots pine, larch, and spruce on plantations in Northumberland and Cumberland, showing an annual increment varying from 50 cubic feet to 80 cubic feet per acre. Figures are also presented, on the authority of Lieut.-Colonel F. N. Innes, for plantations in Aberdeenshire. Other papers in the volume include a summary of a paper by Mr. M. Henry on the interrelation between forests and rainfall, arboricultural notes from Portuguese East Africa contributed by Mr. J. A. Alexander, and an account of the work at Eberswalde Forest Academy by Mr. A. F. Wilson.

A dissertation on the physiological significance of caffein and theobromin, by Dr. Th. Weevers, is published in *Annales du Jardin botanique de Buitenzorg*, ser. ii., vol. vi. These xanthin derivatives were found in all parts except the roots of *Thea assamica* and *Coffea arabica*, but only in the early vegetative stages of *Coffea stenophylla* and *Cola acuminata*. From a comparison of the quantities obtained in young and maturing leaves, also in leaves placed in air devoid of carbon dioxide, the author concludes that these substances are formed as secondary products in the breaking down of proteins, and are subsequently absorbed in protein synthesis; in the seeds they are plentiful, forming a nitrogenous reserve.

A bulletin, No. 187, issued by the United States Department of Agriculture, deals with the digestibility and nutritive value of legumes, recording the results of experiments conducted by Dr. C. E. Wait at the University of Tennessee. Although these tend to prove that legumes are not so thoroughly digested as many other foods, the author recommends their inclusion as a source of protein in the diet, and directs attention to the value of cow-peas, the product of *Vigna Catiang*.

We have received copies of two issues, No. 68, part i., and No. 69, of the Bulletin of the U.S. Bureau of Entomology, the former, by Mr. Dudley Moulton, dealing with the pear-thrips (*Euthrips pyri*), while in the latter Mr. F. M. Webster discusses the ravages of the chinch-bug (*Blissus leucopterus*). The pear-thrips flourishes in the districts around San Francisco Bay and the Sierra Nevada foot-hills, but whether it is an indigenous species which has become unusually numerous owing to the development of orchards, or whether it is introduced, has not yet been ascertained. In 1905, when this insect was exceedingly numerous, the pear-crops were hopelessly blighted, but how much of the injury was due to the thrips and how much to wet weather is uncertain. Owing to the long period spent by the thrips underground, remedial measures are difficult to apply. Practically the whole of the eastern half of the United States is infested by the chinch-bug, which is represented by a short-winged maritime phase and a long-winged inland form. It is a migratory, two-brooded species, which originally fed upon the native grasses, but has now turned its attention to wheat and other cereals. On reaching a suitable food-supply, the insects congregate on the plants until these are literally covered with individuals of various ages, ranging in colour from the vermilion of the older larvæ to the black and white of the adults. When the plant is drained of its juices, the larvæ move on to the next one, the adults alone making long migrations.

THE African honey-guides (Indicatoridæ), which have acquired parasitic habits parallel to those of cuckoos, are wiser in their generation than the latter, for (as we are told by Mr. A. K. Haagner in the Journal of the South African Ornithologists' Union for June) they are in the habit of breaking the eggs of the birds they select as foster-parents for their offspring. This is illustrated by a plate in the same issue, where two of the fractured eggs are shown. In some cases, however—probably when they are attacked by the future foster-parents—they do not succeed in breaking the rival eggs, in which event it is probable that the strong hooks on the tip of the beak of the young honey-guides come into play for the purpose of aiding in the ejectment of the other occupants of the nest. A nestling of one species of honey-guide is represented in a second plate. It may be added that most of the plates in this issue are lettered vol. iii., whereas the cover is lettered second series, vol. i., No. 1. The idea of commencing a second series with the third volume of this serial thus seems to have been an afterthought—and a by no means happy one.

SLUGS, according to Mr. B. B. Woodward's presidential address to the Malacological Society for 1907, are more specialised creatures than snails, for among molluscs of all classes there appears to be a general tendency, more especially in the carnivorous types, to discard the shell as the result of the assumption of more active habits than ordinary. Other instances of adaptive modifications in the group are mentioned in the same address.

IN *Science Progress* for July (ii., No. 5), Dr. Bashford discusses the application of experiment to the study of cancer, and summarises the results obtained by a study of the development of transplanted cancer in mice.

WE are asked by the author, Mr. Arthur Trewby, to state that the little volume entitled "Healthy Boyhood," which was reviewed in our issue of July 25, may be obtained post free for 1*s.* 6*d.* from the author, Fenton House, The Grove, Hampstead Heath, N.W.

OUR ASTRONOMICAL COLUMN.

ASTROGRAPHIC CATALOGUE WORK AT THE PERTH OBSERVATORY (W.A.).—Mr. W. Ernest Cooke, Government astronomer of Western Australia, informs us that the prospects for the astrographic catalogue work are not now so hopeless as they appeared from the report referred to in NATURE of May 23 (p. 89). He says that the present Government recognises the importance of the work, and a start has been lately made to measure the plates. It is feared, however, that the images will deteriorate before the completion of the work. Upon comparing a plate taken a few years ago with a recent one of the same region, the image of a ninth-magnitude star on the former was found to be about equal to that of a 9·5 magnitude on the latter. With reference to the 10,000 standard stars which have to be observed by means of the transit circle, Mr. Cooke hopes to obtain good positions of all these stars (three observations of each) in ten or twelve years, and certain zones have been completed already. It is proposed to make this list of stars the standard work at the Perth Observatory, observing and re-observing exactly the same list, in order to obtain good determinations of the position of each star every ten years or so.

DANIEL'S COMET (1907*d*).—This comet is now approaching the naked-eye stage, and may be found quite readily with small opera glasses. On August 9 it will rise at about 12h. 45m., some $3\frac{3}{4}$ hours before the sun. On August 14 the comet will be about 46′ north of γ Geminorum. An observation made on August 1 showed no indication of a tail, but the comet has a well-defined nucleus.

MARS.—Telegrams received from the Lowell expedition to the Andes announce that on July 2 Mr. Slipher photographed several of the canals, and that on July 6 canals were seen double and oases were photographed (*Astronomische Nachrichten*, No. 4193, p. 291, July 26).

In vol. xxvi., No. 1 (p. 1, July), of the *Astrophysical Journal*, Prof. Newcomb discusses the optical and psychological principles involved in the interpretation of the so-called canals of Mars. From the optical point of view he shows that in the best refracting telescopes the effects of aberration, diffraction, and atmospheric softening will materially increase the breadth of any linear marking. As a rough estimate he submits that a perfectly black line on Mars three miles in breadth might be visible if the surface of the planet were perfectly uniform, but, as it is not, the actual breadth would have to be increased to eight or ten miles in order that the feature might be differentiated from those surrounding it. Aberration, &c., would spread a marking of this width for some twenty miles on each side, so that the apparent breadth in the telescope would be fifty miles or upward. Allowing this width to each of the 400 canals mapped by Lowell, the total area covered would be 33,000,000 square miles, the actual surface of Mars extending over some 55,000,000 square miles. Although this large relative area does not disprove the objective reality of the canal system, it shows how wide the interpretation of the results must of necessity be, when the whole network is crowded on to a disc only 20″ in diameter. Concerning the interpretation of such features by different observers, Prof. Newcomb gives some illustrated results of a number of interesting experiments he has carried out in this direction.

SOME NEW APPLICATIONS OF THE SPECTROHELIOGRAPH.—Using a temporary spectroheliograph of 30 feet focal length, Prof. Hale has obtained spectroheliograms with the primary slit set on some of the dark lines which are found strengthened in the sun-spot spectrum. The lines employed in this preliminary work were those which appear to be strengthened in the umbra and penumbra and on the photosphere for some distance from the spots, and the resulting photographs show the umbra and penumbra much darker than they appear on plates taken with the light of the continuous spectrum; the diameter of the spot also appears to be considerably increased. Lines weakened in sun-spots were also tried and gave definite results, which are, however, less marked than in the case of the strengthened lines. For work with the numerous faint lines of the spot spectrum a large dispersion is absolutely essential, and a suitable instrument is being constructed for use with the new vertical telescope.

Prof. Hale has also obtained some spectroheliograms for stereoscopic examination, which, when viewed with a stereoscope, show the masses of flocculi standing boldly above the general level of the hemisphere. A pair of these, taken at an interval of 2h. 5m., are reproduced in the *Astrophysical Journal* (vol. xxv., p. 314, June). It is hoped that by examining such pairs of spectroheliograms in the stereocomparator changes may be detected in the appearance of the flocculi, &c., which might otherwise escape detection.

THE "ANNUARIO" OF THE RIO DE JANEIRO OBSERVATORY.—The twenty-third annual publication of the Rio de Janeiro Observatory, for 1907, which we have just received, is very much like its predecessors, and contains an exposition of various calendars, numerous tables and data useful to astronomers, and a compilation of various physical data which will be found of general use.

PERSEIDS—COMET DANIEL.

On the night of August 4 several bright Perseids were observed, and this marked return of the shower at so early a date presages a display exceeding the ordinary richness this year. There is evidence that the shower is pretty strong every ten years, for there were considerable numbers of Perseids seen in 1877, 1887, and 1897. It will be desirable to watch the phenomenon during its ensuing apparition, with special regard to the fact alluded to, and to ascertain the hourly number of Perseids visible throughout the nights of Sunday and Monday, August 11 and 12. The latter date will probably be found to represent the time of maximum. St. Lawrence's Day, August 10, is no longer contemporary with the Perseid display at its best.

The diurnal motion of the radiant, amounting to one degree in a direction to E.N.E., was first definitely observed by the writer in 1877 and announced in NATURE at the time. Every year supplies fresh evidence of the displacement and corroborates the facts described in Monthly Notices, vol. lxii., pp. 161–9.

Daniel's comet has been visible to the naked eye since the first few days of July, and is now sufficiently conspicuous to arrest the immediate attention of anyone who will look towards the eastern sky before the morning twilight becomes too strong. On August 5, at 3 a.m., the nucleus of the comet appeared like a blurred star of $2\frac{1}{2}$ magnitude, and the tail extended westwards over nearly 3°, but it was difficult to assign limits, as it faded gradually away into the tone of the sky. Ephemeris by Dybeck (*Ast. Nach.*, 4194):—

Berlin Mean Midnight.

1907	R.A. h. m. s.	Dec. ° ′	Brightness.
Aug. 10	5 56 56	+17 23	17·6
,, 14	6 33 1	+17 15	19·0
,, 18	7 7 6	+16 47	20·0
,, 22	7 39 2	+16 4	21·0
,, 26	8 8 58	+15 11	20·5
,, 30	8 37 12	+14 9	20·0
Sept. 1	8 50 45	+13 35	19·5

W. F. DENNING.

THE ANNUAL MEETING OF THE BRITISH MEDICAL ASSOCIATION.

The seventy-fifth annual meeting of the British Medical Association was held last week at Exeter under the presidency of Dr. Henry Davy, physician to the Royal Devon and Exeter Hospital.

The subject of the presidential address was "Science in its Application to National Health." After giving some particulars concerning Exeter and the Royal Devon Hospital, Dr. Davy proceeded to point out that every organ, muscle, and structure in the body required a proper amount of work to keep it healthy. Exercise was therefore very important, and he deplored the present tendency to watch games rather than to participate in them. Physical culture was one of the most pressing questions of the day, and it should not be left to professors of Swedish exercises to lecture on physical culture and to direct the kind of exercise to be employed; in such questions the medical man should be consulted. Schools should have proper playgrounds and gymnasiums, and trainers in physical exercises were as necessary as school teachers. The question of food was another important one, and the "man in the street" should be able to obtain from his medical attendant precise details of the quantity required and of its nature. As regards infective diseases, pyæmia was now almost unknown, thanks to the labours of Lord Lister, typhoid fever was diminishing, and it was now tuberculosis that required to be attacked. Something, it was true, had been done in this direction, but much more remained; are no precautions to be insisted on with regard to disinfection? Are we for ever to allow consumptives to disseminate their infectious expectoration? Are consumptives alone to be allowed to stay in hotels and lodgings without taking precautions?

The address in medicine was delivered by Dr. Hale White, whose subject was "A Plea for Accuracy of Thought in Medicine." He instanced such terms as "irregular" or "suppressed gout" and "liver out of order" as really being only a cloak for ignorance, which it would be much better to confess. "Selective action" was another mystery, *e.g.* why does alcohol pick out the anterior tibial nerve and lead the musculo-spiral? Why do beer drinkers get "beer-drinkers' heart" in Munich but not in London? Unreflecting adhesion to authority has a particularly serious effect in keeping back the advent of correct knowledge.

Mr. Butlin discussed the "Contagion of Cancer in Human Beings: Autoinoculation" in his address in surgery. He brought forward a number of cases in which cancer in a part was followed by cancer of the same type in another part in contact with the first, *e.g.* cancer in one lip followed by cancer in the other lip.

In the section of medicine there was a discussion on the indications for operation in cases of intra-cranial tumour introduced by Dr. Risien Russell, Dr. Gardner Robb read a paper on the recent outbreak of cerebro-spinal fever in Belfast, and Dr. Rivière one on the tuberculin treatment of tuberculosis in children.

In the section of pathology there were important discussions on pernicious anæmia and on phagocytosis. In the section of tropical diseases, Prof. Simpson read a paper on anti-malarial sanitation, in which he discussed how recent discoveries have rendered anti-malarial sanitation more precise and less costly than formerly.

In the section of State medicine, Dr. Newsholme delivered an address on the need for coordination of the public medical services. Voluntary effort, as illustrated in the hospitals, and State-aided treatment under the Poor Law, failed entirely to produce an adequate result for the vast sums expended. A coordinated system of State-paid and State-directed medical service would speedily justify itself from an economical standpoint, and must of necessity ally itself with preventive medicine.

Dr. Gilchrist read a paper on the necessity of increasing the degree of immunity against small-pox, and Mr. Garrett Horder one on the new vaccination order. A resolution was passed by the meeting recommending the council of the association to approach the Local Government Board on the subject of the new vaccination order.

The association was received by the civic authorities at the Guildhall, and numerous garden-parties and excursions helped to pass an instructive and pleasant week in the delightful old city.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MANCHESTER.—Harling fellowships in physics have been awarded to Mr. J. N. Pring and Dr. Hans Geiger.

The University has made arrangements for a number of public lectures in the autumn which are to be given by leading men of science and others.

Dr. Graham Steell has been appointed by the council of the University of Manchester professor of medicine in the university.

OXFORD.—The Romanes lecture will be delivered by Lord Curzon, Chancellor of the University, in the Sheldonian Theatre, on Saturday, November 2. The subject of the lecture will be "Frontiers."

SHEFFIELD.—Mr. D. H. de Souza has been appointed demonstrator in physiology, and Mr. W. F. G. Swann assistant lecturer and demonstrator in physics.

PROF. VON LEYDEN has resigned the professorship of clinical medicine at the University of Berlin, and Prof. His, of Göttingen, has been appointed to succeed him in the chair.

DR. GEOFFREY MARTIN, a former student of the Merchant Venturers' Technical College, Bristol, has been appointed lecturer and demonstrator in chemistry at University College, Nottingham.

A "PROF. TAIT'S MEMORIAL FUND" of the value of 200*l.* per annum, for the encouragement of physical research in the University of Edinburgh, has been endowed by Sir John Jackson.

Two research studentships in science of the value of 60*l.* and 40*l.* respectively have been founded at University College, London, by an anonymous donor; they will be awarded for the first time next session.

A MOVEMENT is on foot in Glasgow to recognise in a suitable manner the scientific services of Prof. J. G. McKendrick, F.R.S., and a committee of former pupils and friends has been formed to raise a memorial to the late Prof. Pirie, Aberdeen.

MR. W. E. CURNOCK has been appointed head of the department of mechanical engineering and building trades at the Battersea Polytechnic. Mr. Curnock has for the past three years been head of the engineering department of the Technical College, Huddersfield.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 29.—M. A. Chauveau in the chair.—New contribution to the study of the trypanosomiasis of the Upper Niger: A. **Laveran.** An account of a new trypanosome to which the name *T. soudanense* has been given. This parasite, from a morphological point of view, resembles *T. evansi*, but differs from it in its pathogenic action on animals, especially mice. Experimental evidence is given that the trypanosome of Mal de la Zousfana and El Dabab is probably *T. soudanense*.—The function of the spleen in trypanosomiasis: A. **Laveran** and M. **Thiroux.** A criticism of a paper on the same subject by MM. Rodet and Vallet. The latter regard the spleen as possessing trypanolytic properties, but this view is disputed by the authors of the present note.—The early diagnosis of tuberculosis by the ophthalmo-reaction with tuberculin: A. **Calmette.** This reaction, as applied by the author, consists in the application to the eye of a 1 per cent. solution of dry tuberculin precipitated by alcohol. In healthy subjects no reaction is produced, but in tuberculous subjects a characteristic conjunctival redness is produced within twenty-four hours. This reaction has been utilised in nearly a thousand cases with very satisfactory results, and in many instances, especially of children, has revealed tuberculous lesions the presence of which had not been suspected.—Mr. E. C. Pickering was elected a correspondant for the section of astronomy, in the place of the late M. Rayet.—A point in the theory of the sun of M. Julius: Henri **Bourget.**—Linear homogeneous representations of finite groups: M. **de Séguier.**—Differential equations of the third order with fixed critical points: M. **Chazy.**—Differential equations of the third order the integral of which is uniform: René **Garnier.**—The representation of integral equations of any degree: J. **Massau.**—The determination of the altitude of the summit of Aconcagua: Fr. **Schrader.** The mean of two observations was 6953 metres. Full details are given of the method used.—Ionisation by bubbling through liquids: L. **Bloch.** A question of priority regarding a recent note by M. de Broglie.—The compressibility of gases in the neighbourhood of atmospheric pressure: Daniel **Berthelot.** The variation of pv with the pressure has been studied for carbon dioxide, nitrous oxide, and sulphur dioxide for pressures between 0·25 and 2·0 atmospheres. Between these limits of pressure the variation of pv is not, as has been assumed by M. Guye, a linear function of the pressure, but is a linear function of the density.—Nitrate of silver: calorimetry at high temperatures: M. **Guinchant.** The calorimeter is isolated by a vacuum jacket, and heated electrically. It has been applied to measure directly the latent heats of fusion of tin, mercuric iodide, and silver nitrate.—Ortho- and pyro-arsenic acids: E. **Baud.** Pure pyro-arsenic acid can be obtained by keeping $As_2O_5.4H_2O$ over strong sulphuric acid at a temperature of 15° C. to 20° C. From thermochemical experiments the author concludes that orthoarsenic acid exists only in solution. The crystals which separate from this solution are the hydrate of pyroarsenic acid.—The direct oxidation of phosphorus: E. **Jungfleisch.** A detailed study of the combustion of phosphorus in oxygen at low pressures, phosphorus anhydride being formed. Under special conditions as much as 95 per cent. of the phosphorus can be converted into P_4O_6.—The properties and constitution of tantalum steels: Léon **Guillet.** Four samples of steel were prepared containing about 0·17 per cent. of carbon, 0·2 per cent. of manganese, 0·2 per cent. of silica, and proportions of tantalum varying from 0·09 per cent. to 1·05 per cent. These steels were studied micrographically and as regards their mechanical properties. Contrary to what has been claimed for these steels, they show no property of any importance.—Some derivatives of menthone: Eyvind **Bœdtker.**—Two new glucosides, linarine and pectolinarine: T. **Klobb.** These are obtained from the flowers and leaves of *Linaria vulgaris*.—The production of high temperatures in laboratory researches: Léon **Guillet.** Reclamation of priority against M. Chabrié.—The mode of distribution of the muscular glycogen in well fed and in starved subjects. The influence of the seasons on the proportion of glycogen in the muscles: F. **Maignon.**—The relative toxicity of the salts of chromium, aluminium, and magnesium; comparison with the analogous properties of the rare earths: Alexandre **Hébert.**—The influence of acids on the action of laccase: Gabriel **Bertrand.**—The influence of manganese salts on alcoholic yeasts: E. **Kayser** and H. **Marchand.**—The urinary chromogen resulting from the administration of indol-carboxylic acid: Ch. **Porcher** and Ch. **Hervieux.**—The dwarf coffee plant of Sassandra, *Coffea humilis*: Aug. **Chevalier.**—The buccal incubation in *Arius fissus*: Jacques **Pellegrin.**—*Coccus anomalus* and the disease causing the blueing of champagnes: E. **Manceau.**—The pharmacodynamical action of kolatine: J. **Chevalier** and A. **Goris.**—Some ophthalmological experiments made with the aid of a mercury vapour lamp: P. **Fortin.** Certain details of structure very difficult to observe with ordinary light are readily perceived by the light of a Cooper-Hewitt lamp. This light is also very useful in the study of colour blindness.—The discovery of the sulpho-gypsum formation in the basin of Seybouse: J. Dareste **de la Chavanne.**—The fishes of the family of Cichlideæ found in the Tertiary strata at Guelma: H. E. **Sauvage.**

CONTENTS.

THURSDAY, AUGUST 15, 1907.

CORNISH GEOLOGY.

The Geology of Falmouth and Truro, and of the Mining District of Camborne and Redruth. By J. B. Hill and D. A. MacAlister, with Petrographical Notes by J. S. Flett. Memoirs of the Geological Survey. Pp. x+335; with 65 illustrations and 24 plates. (London: Wyman and Sons, Ltd., 1906.) Price 7*s*. 6*d*.

OF the new series one-inch map of England and Wales, few sheets are of greater interest than No. 352 (colour-printed, price 1*s*. 6*d*.), which represents that portion of western Cornwall that contains the oldest and richest mines in the county; and the value of the map is greatly enhanced by the admirable explanatory memoir, which contains a description of the older slaty rocks, the granites, elvans, and greenstones of this area, together with particulars of the metalliferous veins. Attention is given to the genesis of the ores, and to their mode of occurrence, to the methods of dressing the tin ore, and to the mineral output. In short, the description is much more detailed than is usual in a Geological Survey sheet explanation.

The original geological survey was carried out by De la Beche, whose results were published in 1839. New editions of the maps were published in 1866, with additional lodes inserted by Sir Warington Smyth. A comparison of the new map with the older one shows that the additions that have been made are of great importance. The area formerly represented as Devonian has been subdivided into Lower Devonian and three subdivisions, based on lithological characters, designated by the terms Portscatho, Falmouth, and Mylor. These three subdivisions, together with the Veryan beds, formerly classed as Lower Silurian, are shown to be Lower Palæozoic. The grits of Grampound and Probus, representing the base of the Devonian rocks, are taken as the equivalents of the conglomerate on the Helford River (one-inch map, 359).

The igneous rocks are divided by Mr. Hill into four groups: (1) the greenstones, the oldest, which are epidiorites derived from dolerites and basalts; (2) the granite, the dominant representative, with which the mineral products of the area are intimately associated; (3) the elvans, which represent the dyke phase of granite, and were intruded after its consolidation; and (4) the mica traps, the age of which is uncertain. Chapters are devoted to a description of the contact metamorphism effected by the granite and of the faults. The fractures are the product of the later Carboniferous period, and have a trend of about E.N.E. Many of them occur in the mineral areas, where they form the home of the lodes. They are traversed by a second set of faults, of early Tertiary age, which are known to the miner as cross-courses. The Pliocene deposits receive careful attention, the Polcrebo gravels appearing to represent a patch of the Pliocene deposits which formerly spread over the killas platform of this area, and are represented at St. Erth, St. Agnes, and Crousa Downs in adjacent districts. With the exception of these gravels, this area affords no evidence of stratified deposits from the Palæozoic period until the Pleistocene, which is represented by the raised beaches underlying the Head, that is probably a product of the Glacial age.

The second part of the work, which is written by Mr. MacAlister, deals with the mining industry of the district. Modern theories of the genesis of ore deposits are applied to the Cornish tin and copper ores, and detailed descriptions of the mines are given, illustrated by more than fifty sketches. Statistics of production since 1845 are set forth in detail, and ten pages are devoted to a description of the tin-ore dressing processes employed in the Camborne area. Products from the various operations have been subjected to microscopic examination, the results showing that grains of cassiterite which are less than the average size of the grains in the concentrates tend to be lost in the tailings of subsequent operations. The dressing operations are elucidated by means of excellent reproductions of photographs.

On the whole, the work is a very creditable production. It forms an excellent introduction to the geology of Cornwall; and it is satisfactory to note that the price at which it is published is not such as to preclude its use by students of economic geology.

MODERN INTRODUCTIONS TO PHYSICAL THEORIES.

(1) *Elektromagnetische Schwingungen und Wellen.* By Dr. Josef Ritter von Geitler. Pp. viii+154. (Brunswick: Fried. Vieweg und Sohn, 1905.) Price 4.50 marks.

(2) *Theorie der Elektrizitat.* By Dr. A. Foppl and Dr. M. Abraham. Vol. i., pp. xviii+443; vol. ii., pp. x+404. (Leipzig: B. G. Teubner, 1904 and 1905.)

(3) *Ueber den gegenwärtigen Stand der Frage nach einer mechanischen Erklärung der elektrischen Erscheinungen.* By Dr. Hans Witte. Pp. xii+232. (Berlin: E. Ebering, 1906.) Price 7.50 marks.

(4) *Die Fortschritte der kinetischen Gastheorie.* By Dr. G. Jäger. Pp. ix+119. (Brunswick: F. Vieweg und Sohn, 1906.) Price 3.50 marks.

(5) *An Elementary Treatise on Theoretical Mechanics.* By J. H. Jeans, F.R.S. Pp. viii+364. (Boston and London: Ginn and Co., n.d.) Price 10*s*. 6*d*.

A COMPARISON of text-books of the last year or two with those published, say, a quarter of a century ago affords a clear and definite measure of the great changes which have occurred during the interval in our commonly accepted physical theories. All the books now before us reflect these changes in a greater or less degree, but we take Dr. von Geitler's manual as our first example because the author has closely followed the historic order of development in leading his readers from the simple early notions of action at a distance to the modern theories of electrical oscillations and their applications to wireless telegraphy.

Starting with Newton's discovery of the law of gravitation, the reader is led up to Faraday's researches on the electromagnetic field, and he first learns the dependence of this field on the nature of the medium filling it, and the interdependence of electrostatic and magnetic phenomena. While the author in his preface directs attention to the great difficulty of treating the subject in a popular way, it is noticeable that he has been remarkably successful in overcoming this difficulty, and the liberal use of diagrams illustrating lines of force, as shown both from plotting and by experiment, does much to impart a reality to the discussions. The second section is devoted to Clerk Maxwell's electromagnetic theory of light, and emphasis is rightly laid on the discovery of the coincidence between the "*v*" of the physicist and the velocity of light. The third section deals with Hertz's classical experiments, culminating in the realisation of electric waves; while the last section is devoted to those further developments which have established the identity in character of electric and optical phenomena and have resulted in wireless telegraphy. This section includes the study of polarisation, dispersion, optical resonance, and the determination of wave-lengths. The author is very clever in the way he keeps mathematical formulæ in the background, and at the same time leaves the reader perfectly conscious of their existence.

Drs. Foppl and Abraham's two volumes deal with the same phenomena treated from the point of view of the advanced student of physics instead of that of the popular reader. For this purpose the historic method of our older books is now quite unsuitable, and we are glad to see its place taken by a more powerful method of treatment. The present writer has clear reminiscences of the difficulties into which the text-books in use in the 'eighties of last century led the reader. We were taught that quantities of electricity and quantities of magnetism acted on each other according to the law of the inverse square, that the units could be so chosen as to give unit force at unit distance, and that the forces in every case were derivable from a potential. We believed these statements implicitly, and then we were introduced to statements inconsistent with the first under "specific inductive capacity," with the second under "electrostatic and electromagnetic units," and with the third under "electromagnetic induction."

Dr. Abraham's readers start by equipping themselves much better with the analytical methods required for arriving at a clear conception of electromagnetic phenomena. The first section, extending to 122 pages, written by Dr. A. Foppl, deals exclusively with vector analysis and vector fields, and the latter subject is introduced by means of hydrodynamical analogies. It may truly be said that if the study of the dynamics of perfect fluids has not led to many practical applications, it possesses great educational value in affording a simple and intelligible representation of the quantities and equations occurring in electromagnetism. By the time the student has grasped these introductory notions he is able easily to follow the sections on electrostatics and magnetostatics without falling into any misconceptions regarding their limitations, and he can then pass on directly to the study of electromagnetic induction and electric waves. Especially careful is the author in avoiding the old pitfalls in connection with the "Dimensions of Units." His equations are all written with the three constants, and he then shows how the electrostatic, electromagnetic, and Gauss's systems of units may be obtained by putting two out of these three constants equal to unity. We should, however, have liked to see the dimensions of the units tabulated in terms of force (or perhaps energy), length and time instead of mass, length and time. The formulæ are then much simpler, and better express the fact that electrical phenomena in general manifest themselves to our senses by the *forces* they produce on material bodies, though the existence of these phenomena is independent of the concept of mass as commonly understood.

So much for the first volume, which, as the author points out in his preface to the second volume, covers what may be described as the "first floor" of modern electrical theory. The second floor, which has now been built up as a superstructure on the first, consists of the modern electron theory discussed in this second volume.

The first chapter deals with the definition of an electron and its elementary properties, while the second deals with radiation from electrons. In chapter iii., which deals with the dynamics of a system of electrons, certain assumptions have to be made. In most cases Dr. Abraham follows Lorentz's theory. In the second section, in dealing with ponderable bodies in motion, comparisons are made showing the differences in the results obtained by Lorentz's and Hertz's assumptions.

In a book like the present, dealing with theories about which differences of opinion exist, the list of formulæ collected for reference at the end is particularly useful, as it enables the reader to see at a glance what hypotheses are made. While the book contains an excellent exposition of the electron theory, based on these hypotheses, we only have to turn to the table at the end of Dr. Witte's book to find that there are twelve different conceivable mechanical theories of electric phenomena of which the great majority are classed as recognised theories.

Of these theories, two are theories of action at a distance, and the third is Newton's emission theory, all of which are easily dismissed as insufficient to account for known phenomena. The remaining theories, which Dr. Witte describes as undulation theories, and their classification is a simple matter of permutations and combinations. We have two kinds of energy of the ether, electrostatic and electromagnetic, which have to be potential or kinetic, or partially potential and partially kinetic. These possibilities lead to six different combinations or nine different permutations. The cases where each part of the energies is wholly kinetic or wholly potential lead to three combinations, namely, Mie's group (both energies potential), Lord Kelvin's (one potential and one kinetic), and Hertz's (both energies kinetic). But another totally independent line of classification is also pointed out in the separation of theories of the ether into atomic hypotheses and hypotheses of a continuous medium, and this line of discussion brings us very close to the electron theory. What the author has really done is to apply the method of exhaustion to mechanical theories of the electromagnetic medium, and he finds that when atomic theories of the ether are taken into account the number of possible hypotheses is very large. Perhaps, as the author points out, no mechanical theory may be found to be capable of explaining satisfactorily all the phenomena of nature. The subject-matter of the present book is certainly only a very small fraction of all that might be written on mechanical theories of the ether, and probably no physicist would regard the arguments as conclusive except so far as they show that certain hypotheses are insufficient to account for the results of experience. But at the same time, if the book does nothing else, it shows that clearer and more definite ideas of existing electromagnetic theories may be obtained by an attempt to exhaust and classify the different possibilities which present themselves.

It is in connection with irreversible phenomena that mechanical theories present the greatest difficulties. As a consequence, the kinetic theory of gases has not received much attention from physicists very recently. But Dr. Jäger points out in the preface to his book that meanwhile an atomic theory of electricity has been built up, bringing us back to the fundamental notions of the kinetic theory of gases. The present book contains a good outline of those applications of the kinetic theory which are most easily understood. Under this heading we include the error law of distribution with special reference to spherical molecules; the virial theorem, a brief account of Boltzmann's minimum theorem without examination of its difficulties, and a discussion of applications to viscosity and other convection phenomena. This book is a very good introduction to place in the hands of the student of physics whose time is very limited, but he must remember that there is a great deal more to be said about the kinetic theory than meets the eye in these pages.

Whether "Theoretical Mechanics" is properly described as a branch of physics or of applied mathematics is a matter of opinion. But the ever-increasing part played by mechanical theories in the study of physical phenomena is sufficient justification for Prof. Jeans's book. It is becoming every year more and more difficult for the science student to keep pace with the demands made on his time by modern developments of physics, and a book which starts with the laws of motion and leads the reader up to Lagrange's equations, all in the compass of a single volume, is certain to prove a great boon to a large class of students. In his preface Prof. Jeans discusses the reasons for carrying the subject so far as the study of generalised coordinates, but in view of the fact that Lagrange's equations are freely used in treatises on electricity—for example, in discussing the effects of mutual and self-induction in electric circuits—no defence of their inclusion in the present volume seems to be needed. In the chapter on motion of rigid bodies we should like to have seen a little more about "uniplanar" motion. This would enable the student to obtain a much more tangible and definite conception of the meaning of a moment of inertia than is possible when he is rushed on at once to Euler's equations. Moreover, the proof of these equations is unnecessarily cumbersome and difficult for the beginner, and space could easily be saved by simplifying it. The equations of § 250 for moving axes, when generalised for any vector, such as angular momentum, immediately lead to Euler's equations. Instead of doing this, Prof. Jeans gives what is nothing more than an alternative proof of the vector differentiation formulæ, as applied to angular velocity in § 252, and after all this trouble the student has learnt nothing about the fundamental principle involved in both applications.

Returning to the earlier chapters, Prof. Jeans makes an attempt in chapter iii. to prove the parallelogram of forces by the now usually discarded dynamical method. He escapes the fallacies of the old books in connection with the parallelogram of velocities, but is led into the usual *non sequitur* in assuming that the acceleration which the forces produce when acting simultaneously must be compounded of the accelerations which they would produce if acting singly. In connection with his proof of the property that any motion of a rigid body is compounded of a motion of translation and one of rotation, he defines rotation as motion with one point fixed; the subsequent paragraph, headed "Axis of Rotation," is so extraordinary that it is best reproduced here in full. It runs as follows:—

"In a motion of rotation, let P be the point which remains fixed. Take any plane A through P and let B be the position of the plane A after the rotation has occurred. These two planes both pass through P, and must therefore intersect in some line PQ passing through P. This line is called the *axis of rotation*. The rotation can be imagined as a turning about an imaginary pivot running along the axis of rotation."

The absurdity of this statement is evident if we suppose that the chosen plane A does not contain the axis of rotation.

The book is freely illustrated by examples. Many of these are very useful, but others are calculated to inculcate very extraordinary ideas in the mind of the reader. For example, on p. 68 we have an impossible figure of a nut-cracker, neither the nut nor the cracker being in equilibrium. The ladder in the next example is free from this objection, but it contains a superfluity of trigonometry which is hardly justified by the preface. The question can be solved by geometry with half the work. On p. 194 is given a construction for placing a chute in such a position that the time of sliding from a ship's side on to a pier may be as short as possible. If any reader were to put the matter to a practical test, he would certainly not get the same result, even if he got the objects to slide at all. The correct construction is obtained by placing the chute along a chord of a certain circle touching the ship's side, but the tangent to this circle at the point where it meets the pier should be inclined at the angle of friction to the horizon instead of being horizontal.

Suppose next that the inquiring reader wishes to put the examples on the motion of pulleys of given mass on pp. 202, 203 to a practical test. He goes to a scientific instrument maker, and orders some expensive pulleys. However well he oils their bearings to make them smooth, it is pretty certain they will never move with the accelerations given by Prof. Jeans's formulæ. The tensions of a string may be equal on both sides of a pulley so long as that pulley remains at rest, but so soon as it begins to rotate differences of tension will be set up, and no amount of lubrication applied to the bearings will affect the result. Of course, if the inertia of the pulley is small, the tension differences will also be small, but the masses of the pulleys are "given" in the questions, and the proper lesson to be learnt is that a solution of the problems which does not take account of rotational as well as translational inertia is incorrect.

There are several good features, however, which well deserve mention. Among these are the treatment of strings, including the early references to Hooke's law, the example on p. 53, with its neat geometrical solution, the example on p. 360, in which accelerations in polar coordinates are deduced from Lagrange's equations, and finally the omission of all references to poundals, slugs, and other abominations of the same nature. It is a pity that some of the examples involve the usual tedious and uninteresting drudgery in the form of multiplication or division by 2240 or 5280 or 1728 or 33,000, or another of the same series of objectionable numbers. We do not blame Prof. Jeans for following the common practice in this respect, as most of us find ourselves forced to do the same, but surely the time has come when examples involving the metric system may figure more freely than they do in treatises on theoretical mechanics, especially when those treatises are particularly adapted for students of physics. G. H. B.

THEORETICAL ELECTROCHEMISTRY.

The Electrolytic Dissociation Theory. By Prof. R. Abegg; translated by Dr. Carl L. von Ende. Pp. ix+180. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd.) Price 5*s*. 6*d*. net.

Electrochemistry. Part I., Theoretical Electrochemistry and its Physico-chemical Foundations. By Dr. Heinrich Danneel; translated by Dr. Edmund S. Merriam. Pp. vii+181. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd.) Price 5*s*. 6*d*. net.

THE advent of the translation of these two little books into English shows that the subject of electrochemistry, or rather, we should say, physical chemistry, with an electrochemical bias is coming more and more to the front. But while we have had of late a large number of books upon the theoretical side of the subject, there is not very much literature dealing with the practice of electrochemistry and its applications to industrial problems.

Prof. Abegg's book is a translation of the author's "Die Theorie der elektrolytischen Dissociation," which appeared in 1903 in the "Sammlung chemischer und chemisch-technischer Vorträge." Prof. Abegg starts off in an elementary manner, and explains the dissociation theory so that the beginner may understand the subject. On several occasions he uses the term osmotic pressure, but throughout the book he does not explain what osmotic pressure is or how it is measured. Although the commencement of the book is quite simple, it is not long before Prof. Abegg revels in mathematics, which, combined with the slavish style of the translation, makes the reading rather uninteresting. The section upon equilibria among several electrolytes is very long, and includes subsections upon hydrolysis, avidity or affinity of acids and bases for each other. The style of the book may perhaps be shown by the following passage:—

"Since in the case of equal concentration the ionic concentrations of pure (unmixed) acids are to each other as the roots of their dissociation constants, we may with Arrhenius also express this equation thus, that both acids divide themselves between the base in the same ratio as their degrees of dissociation would be, if each were present alone in the volume considered."

A section is also devoted to "non-aqueous solutions," and in it the author explains some of the difficulties which occur when one tries to bring the behaviour of solvent and solute into line with a similar substance dissolved in water; for example, the complications arising by the phenomena of the association of the non-ionised portion of the electrolyte. The book is a useful review of the ionic theory written entirely with the view of supporting the theory.

Dr. Danneel's book, although it explains the ionic theory in considerable detail, is an exposition of general theoretical electrochemistry. The book begins with an explanation of the terms work, current, and voltage. The gas laws lead up to osmotic pressure, which is fully and lucidly presented. The theory of electrolytic dissociation and conductivity brings us up to p. 114. The average student who is called upon to study the ionic theory will obtain, we venture to think, a better grip of the subject by a study of Danneel's book than from that of Abegg. The latter book treats the subject more fully, but Danneel's style is more interesting, and he leaves none of the salient facts out. Chapter v. treats of electromotive force and the galvanic current, and chapter vi. of polarisation and electrolysis. The last chapter, which is very short, treats of the electron theory. We find it here stated that "The electron acts chemically like an element. It combines with other elements to form saturated compounds, which are the ions"; thus

$$Cl + \ominus = Cl\ominus = Cl'.$$

It would have been of special interest had Dr. Danneel enlarged upon this subject; he has, however, just given enough to make it suggestive.

OUR BOOK SHELF.

Christiaan Huygens, Traité: De iis quae liquido supernatant. Rédigé par D. J. Korteweg. Pp. lxxxiii+210. (Extrait des Oeuvres complètes de Christiaan Huygens. Tome xi., n.d.)

THIS treatise of about a hundred quarto pages, printed from a hitherto unpublished MS. of Huygens, forms part of the eleventh volume of the collected edition of his works which is now in progress. The accomplished editor, Prof. Korteweg, of Amsterdam, who has himself made valuable contributions to hydrodynamics and to mathematical history, has judged wisely in issuing it separately, and so rendering it accessible to a wider public.

The contents are certainly remarkable. Book i. begins by deriving the Archimedean conditions of equilibrium of floating bodies from the principle that the altitude of the centre of gravity of the whole system composed of solid and fluid must be a *minimum*, and the same principle is then applied to the question of stability for angular displacements. Owing to the manner in which the problem is stated, *stable* positions are alone the subject of investigation; the recognition of the fact that the conditions of equilibrium are equally satisfied by a *stationary* altitude of the centre of gravity, belongs to a later period. The special cases of the paraboloid of revolution, and the cone, floating with the axis vertical, are treated in some detail.

In Book ii. we find a somewhat elaborate, but not quite complete, treatment of the problem of the stability in different positions of a floating log of rectangular section; but the method followed is different, and is more closely related to Archimedean principles. Book iii. deals, on similar lines, with the problem of the floating cylinder.

This brief recital will show how great is the historical interest attaching to this tract. The interest is increased when we are told that it was a youthful essay, which the author himself condemned as fragmentary and incomplete. A note appended to the MS. reads: "Haec de corporibus solidis in liquido supernatantibus in prima adolescentia scripsi, cum nullum adhuc majoris momenti argumentum sese obtulisset . . . E primis Theorematis quaedam retineri possent, item de Cylindris. Reliqua vulcano tradenda." The student of mathematical history will be glad that this elegant, and in some respects significant, essay should have escaped the fate here threatened, and will be grateful to the editor for having now placed it beyond the reach of accident.

The volume, which is (by the way) most beautifully printed, contains a valuable introduction and commentary by Prof. Korteweg, who points out in detail the relation of Huygens's work to later developments of the theory. It includes also reprints of other MS. notes by Huygens on the same subject, with interesting facsimile reproductions of the original diagrams.

H. L.

A Health Reader. By Dr. C. E. Shelly and E. Stenhouse. Books i. and ii. Pp. vi+160 and viii+196. (London: Macmillan and Co., Ltd., 1907.) Price 1*s.* and 1*s.* 4*d.*

THE great importance of imparting to children, while at school, a knowledge of the broad principles of healthy living is generally recognised; and the past few years have witnessed the outcome, in response to a growing demand, of many handbooks upon elementary hygiene for school purposes. Some of these have erred on the side of attempting to explain too much, and the book, whether designed to meet the needs of the school-teacher or of the scholar, has dealt with non-essentials in an unnecessarily technical manner.

These two small works, both of which are fully illustrated, have been compiled with great discretion, for the subject-matter is that which every child should know, and it is treated in such a manner that the child, while acquiring useful information, will be interested.

The earlier book is designed for use among children of nine to ten years of age, and the later volume for pupils of from ten to twelve years of age. A noteworthy feature of both books is the omission of all technical terms. For instance, the cranium and sternum are called the brain-case and the breastbone, and the red blood corpuscles of the blood are described as "grains of red jelly"—"the oxygen-boats." Another noteworthy feature is the due appreciation shown of the importance of presenting the subject-matter in the simple manner which appeals to the child-reader. Those who are unfamiliar with the difficulty of appealing to the child of from ten to twelve years with a subject such as hygiene may judge Book ii. to be too elementary; but others will not share that view.

It is most desirable that a health reader, the information of which can (where necessary) be supplemented or explained by occasional conversational digressions, should be introduced into every school; for it is doubtless the easiest and the most effective way of teaching the subject. The works under review are exceedingly well designed to serve this purpose.

Ptolemäus oder Kopernikus? Eine Studie über die Bewegung der Erde und über den Begriff der Bewegung. By Dr. Karl Neisser. Pp. vi+154. (Leipzig: J. A. Barth, 1907.) Price 3 marks.

THE author of this little book aims at showing that all motion is relative, and that the people who three hundred years ago disputed as to whether the earth moved round the sun or the sun round the earth were all equally right, and were only fighting about words. In the first chapter it is set forth with needless prolixity how all apparent phenomena produced by the motion of an observer will be the same if he is at rest, and all the surrounding objects are in motion with the same velocity in the opposite direction. The author next deals with the system of Copernicus, and points out how it could only claim to represent the planetary motions in a somewhat simpler manner, but that the relative positions of the earth and a planet were exactly the same according to the old and the new system. But everything was changed by the discovery of the proper motions of the fixed stars, which made it theoretically impossible to refer the celestial motions to a fixed origin of coordinates, while the sun's own motion through space shows that the earth cannot describe a closed curve round it. As regards the rotation of the earth, the author maintains that the deviation of a falling body towards the east and Foucault's pendulum do not absolutely prove that it is the earth and not the whole rest of the universe which is turning. Whether we say that the earth or the heavens, or both, move is thus a mere matter of taste depending on the point of view; and the two first laws of motion are incapable of proof, since there is no such thing anywhere as motion in a straight line.

The most unsatisfactory part of the author's reasoning is the way in which he lightly skims over the aberration of light in a footnote only. One might grant him that everything else he brings forward is conceivable, but the human mind is hardly capable of imagining that all stars might move in the course of a year in circles, the planes of which are parallel to each other. If aberration is not an absolute proof of the earth's annual motion, we may give up the hope of proving anything.

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 intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

British Association; Section A.

As an old member interested in the welfare of Section A, and appreciative of the useful work it has long done in bringing physicists and mathematicians of various kinds together, I want to suggest that the comparatively recent practice of crowding all its multifarious work on to a few days, and getting through it by sitting in duplicate and by hurry, is unsatisfactory. This suggestion is not intended as a complaint, but as a warning that such a method of dealing with Section A must sooner or later result in its disintegration into two or more sections.

So long as it keeps together—and it is much to be desired that it should keep together, so that workers in different fields may hear something of each other's results—it is necessary that it should take all the time allowed to it, and sit as a rule both on Saturday and on Wednesday. The Saturday meeting is especially important. In the old days the mathematicians frequently had an excellent opportunity on that day, of which they took full advantage. So also the final meeting on Wednesday, for some of the papers on minor experimental points, and for such as had been postponed from other days, has also been often quite interesting.

If Saturday is not utilised, some of the senior members are apt to leave at the week end, and the discussions on future days then lack some of their interest and importance.

The only reason for not meeting on Saturday is on account of excursions. It is to be hoped that excursions will not be allowed to ruin the meeting. Saturday excursions are an innovation: they began as visits to works and the like, in the immediate neighbourhood, on the afternoon; and the full-day excursions were kept for the second Thursday.

An attempt was made to diminish the excursions by abolishing the second Thursday, with the unfortunate result that excursions have now encroached on and consumed the Saturday—which is much worse. There are sections perhaps, such as C, and no doubt others, of which excursions are an important feature; but it is not so with A. Let me urge the officers of that section to return to the older practice, and to aim at taking meteorology on Monday, general physics and astronomy on Thursday and Monday, pure physics on Friday and Tuesday, pure mathematics on Saturday, and an overflow, together with experimental papers, on Wednesday. Then allied sections, such as B and G, can take papers of more interest to physicists on the Monday, as indeed used to be, and perhaps is, their custom; and Section L might perhaps then assist Section A with some of the interesting and important papers on details connected with teaching.

Another minor matter is to express my belief that sectional committee meetings would be more convenient, and likely to be better attended, in the afternoon than in the early morning. But on that there may easily be differences of opinion.

Oliver Lodge.

Fecundity of the Leopard Moth.

A specimen of the above (*Zeuzera aesculi*) was sent to me by post in a tin box a few days ago from Felixstowe. The moth was dead when it reached me, but had laid eggs in the box. As there seemed to be such a large number I had the curiosity to have the eggs counted, and it was found that there were 725. It is, of course, impossible to say whether this represents the whole family or whether she may have laid some eggs previous to capture.

The relative fecundity of different species of insects in relation to their life-habits is an interesting subject from the selectionist's point of view. The caterpillar of this moth is a wood borer, and the conditions for favourable nutrition may be difficult to find, so that a high fecundity has been developed in order to meet precarious conditions of survival. Other wood borers seem also to lay large numbers of eggs, but I do not know whether the families have ever been counted. As a contribution to the subject this observation appeared worthy of record.

Nairn, N.B., August 10. R. Meldola.

THE SECOND INTERNATIONAL CONGRESS ON SCHOOL HYGIENE.

The Second International Congress on School Hygiene was opened on August 5, and closed on August 10. The papers were mainly practical. At the first congress (Nuremberg, 1904) there was a distinctly greater proportion of research work; but this was due to the fact that the medical examination of school children had been longer established in Germany, Austria, and other European countries than it has been in England. Such scientific investigation as the present congress has evoked is almost exclusively directed towards justifying immediate administrative measures, or developing existing organisations. For example, medical inspection has, in England and Scotland, now all but become a widespread reality, and the hygiene of school buildings and school work has rapidly grown into a speciality. We here indicate the main problems raised for discussion.

(1) *Methods of Medical Inspection.*—The desirability of medical inspection has been assumed at every section. The chief concern is to what extent it shall proceed. Dr. Méry (Paris) maintained that the first examination on entry to school should include (*a*) an anthropometric record of weight, height, chest measure, dynamometric observations; (*b*) physiological record of the primary educational senses—eye and ear; (*c*) a medical record of all the organs—throat, lymphatic system, skin, skeleton, lungs, heart, &c. He insisted on the extreme value of minute thoracic measurements, as shown by insurance results. Experiment has shown that spirometry as a test of lung conditions is not practicable with children. The minute measurements required to establish the "thoracic index" can be carried out only by skilled specialists.

The other papers on medical inspection recommend only a medical examination, conducted strictly in relation to the school-work required. Accounts were given of the methods of report and examination employed in Sweden, Breslau, Wiesbaden, Leipzig, Nice, and other places.

Dr. Clement Dukes (Rugby) gave the results of an elaborate physical examination of 1000 boys of ages thirteen to fifteen. The boys were taken as they entered the public school. This paper is of great practical value. It deals with boys whose home-nurture was of the best possible. As tested by Dr. Roberts's standard tables, 522 boys were above the normal height; 113 were average; 365 below normal. In weight, 472 were above normal; 57 average; 471 below normal. In chest measurement, 445 were above normal; 132 average; 423 below. Acquired deformities (such as spinal curvatures, pigeon-breast, bow legs, flat feet) were surprisingly numerous. *E.g.* there were 529 cases of knock-knee; of lateral curvature of spine, 445; of flat-feet, 329. There were 13 cases of eustachian deafness; 19 of aural deafness. Hypermetropia, 40; myopia, 128; astigmatism (considerable), 27. Heart disease, 10. Albuminuria, 157. This is a startling figure. As to puberty, 317 had attained the state between thirteen and fifteen years; in a few cases, not until fifteen. This research is the most elaborate yet published regarding English public school boys. It has an important bearing on the question of environmental *versus* germinal deterioration.

(2) *Effect of School on Health.*—Dr. Hüttel (Prague) records that the upper classes suffer more in nutrition than the lower from bad teeth. Myopia is admitted to be a result of school work. Girls suffer more than boys from spinal curvature. Nervous diseases, headaches, insomnia, night-terrors, are more frequent in the higher classes.

Tuberculosis.—Dr. Oldwright (Toronto) deals with the schoolroom as a factor in tuberculosis. As to teachers, he shows that, in the returns of six great cities (Baltimore, District of Columbia, New York, Brooklyn, Philadelphia, Boston), female teachers in schools rank next to highest in order of mortality from consumption, printers and pressmen being highest. This is confirmed by other returns. The ratio of consumption-deaths per 1000 deaths is found uniformly higher among teachers (male and female) than in all other occupations. Chalk dust is suggested as one factor in causing this exceptional incidence.

Dr. Arthur Newsholme (Brighton) states, as the result of a careful examination of 806 children (conducted by Dr. Lecky), and a comparative analysis of other figures from Dundee, Dunfermline, and Edinburgh, that he is inclined "to think that there is not, on the average, more than 1 in 300 children in schools showing revealed or diagnosable pulmonary tuberculosis." But "latent tuberculosis" is considerable. Naegeli "found in autopsies of children aged one to five 17 per cent., and of children aged five to thirteen that 33 per cent. had tuberculous lesions." But the origin of the tuberculous infection is almost certainly domestic, not scholastic; though school conditions and work may, and do, provoke latent tuberculosis into activity.

Measles.—The scientific grounds for school closure in measles epidemics were discussed by Dr. Thomas (London) on the basis of 5512 carefully investigated cases. Measles tends to spread when a class accumulates unprotected numbers to the extent of between 30 and 40 per cent., and when spread has begun it extends until the proportion is reduced to between 15 and 20 per cent. unprotected. School closure to be of any use must occur before the first "crop" falls. This conclusion is confirmed by Dr. Davies (Woolwich).

Diphtheria.—Dr. Niven (Manchester) states, as the result of numerous investigations, that the "year of maximum incidence precedes the years of school life," and that the "great drop at age six" is probably due to widespread establishment of immunity. The sanitary condition of the schools has probably less to do with outbreaks than the absence of playgrounds; but aggregation multiplies the chances of infection. The "slight or latent" cases far outnumber the discoverable cases. But many "latent" cases proceed so slowly that an antitoxin is naturally produced, and immunity thus established. In practice, it is well, as Newsholme suggests, "to exclude diphtheria convalescents from school for six weeks after discharge from school and recovery at home." Diphtheria "contacts" may, though not themselves showing any marked symptom, spread the disease.

(3) *School-work and Healthy-mindedness*.—Prof. James Sully, from the standpoint of general psychology, concludes that current educational ideals overemphasise Rousseau's half-truth that "education is essentially a process of following nature, of observing, understanding, and safeguarding a natural process of development." Healthy-mindedness means vigorous intellectual faculties strongly predisposed to exercise their proper functions. But many facts show that present-day school-work, by excess of book-learning and neglect of the actualities of life, tends to reduce mental vigour and to predispose the average person to accept opinions without examination or test. But there are signs that the schools are conscious of this. Prof. Sully does not seem to allow sufficiently for the large positive content of the reaction against books. This positive content is more obvious in American methods than here. But all agree with him that education ought to produce a "healthy, vigorous attitude of mind."

(4) *Age for School Attendance*.—The science of the English custom of sending to the day-school infants of three to five was examined by Dr. Newsholme. His main conclusion is against the custom, first, on the practical ground that the danger of fatal infection is vastly increased (though the facts are too few to be conclusive); second, because there is no educational advantage. On the opposite side, it was contended that the school, if properly adapted as a play-place, not a work-place, fulfils the functions of the home by giving scope and atmosphere for infantile play-energies and dispositions, which are the biological prelude to education proper. The problem is of profound importance; for it involves the whole theory of the *crèche*, the kindergarten, and the play-centre. But there is no body of scientific evidence to make even a provisional conclusion possible. It is certain, on the other hand, that many schools as they exist are quite unfit for the work of tending infants of three to five, and there is no general "play-curriculum" adapted to their needs. Biologically, it is a doubtful gain to leave the delicate organism of three absolutely to the chance environment of "home" or street, where an ineradicable bias to evil mental habits may readily be produced. Scientifically, the problem remains for future congresses.

A related topic is the vacation camp or holiday home. Many practical descriptions were given, but no criticised quantities. Captain Polvliet (Amsterdam) described in detail the practice of a holiday camp in Holland, and the conditions of healthy freedom combined with sport programmes seemed to be realised. The results to health were undoubted.

(5) *Physical Training*.—The tendency of the practical educationist is rather to rest in "systems" of muscular training than to make an effort to discover fundamental principles. Such an effort, however, was made by Dr. Hulbert (London), who showed how intimately the voice is affected by the stiffness or elasticity of the body, and so forms an indicator of physical conditions. Position in voice-using must be good, but absolutely free from rigidity. Control of breathing must be acquired by cultivating elasticity of the elastic parts of the chest. Respiration for voice-production should depend on the essential muscles of respiration, not on the external. When the right quality of muscular movement and of muscle is secured by training, good voice naturally results. The ordinary "systems" fail in this, because they rely on coarse muscular movements. For good tone, physical training of the right kind is essential. There are three main factors—position, control of breathing, and the abdominal press.

Dr. Gulick (New York) described the place and limitations of folk-dancing as an agency in physical training. School gymnastics fail to establish habits of exercise, especially in girls. Selected dances can be adapted to the feminine physiological, psychological, social and æsthetic needs. They involve large masses of muscle, and can be carried on two or three times as long as gymnastics without fatigue—a fact of cardinal importance. The instinct feelings are tied up with the neuro-muscular system in a fundamental way, and the dance evokes them in the individual. But dancing fails to correct the faulty postures due to school-desks. It is a useful adjunct to training, but not alone adequate. But the interest excited has led to its securing a high place in the New York elementary and high schools.

(6) *School Work—Duration, Sequence of Lessons, and Seasons*.—Dr. Leo Burgerstein (Vienna) opened a general discussion on this subject, commenting on the practical difficulties of obtaining trustworthy measurements of fatigue. But it is certain that work con-

tinued in a state of fatigue is of no value for obtaining skill. Lessons should never exceed forty-five minutes in high schools, and for pupils under age of puberty. The earlier lessons of the day should last longer than the later. Six-year-old children should not be kept sitting at work for more than half an hour without exercise and rest. For infants and junior pupils, writing should be interrupted every five or ten minutes by change to a comfortable position. Rests should never be used for the purpose of instruction or punishment. Lessons requiring mental effort or memory work should be taken early in the day. Lessons in drawing or needlework should not follow a lesson in bodily exercise. Two lessons requiring mental concentration or near-vision should not follow each other. Season has an effect on quality and quantity of work, school-work being harder in summer.

Prof. Chabot (Lyons) analysed carefully the same problems. In the French elementary school, a lesson does not last more than thirty or forty minutes, but the day's session lasts about an hour and a half, the only rest being change of subject. The official regulations, however, permit a margin of variation, and no lesson must exceed an hour. After discussing fatigue and the details of typical time-tables, Prof. Chabot suggests that from age seven to ten a lesson should run from fifteen to thirty minutes; from age ten to fourteen it should run from thirty to forty-five minutes; after age fourteen, the lessons may last for an hour or an hour and a half. The limit of daily work should be six hours from age seven to twelve; seven hours from age twelve to fifteen; eight hours after fifteen. The rhythm of mental effort—invention or assimilation, analysis or synthesis—depends more on the consecutive masters than on the distribution of subjects; but abstract lessons should be followed by concrete lessons and practical exercises. It is preferable to have two or three classes in forenoon and two in afternoon. There is a growing opinion in England that afternoon work is worth little.

(7) *School Suicides.*—Prof. Chlopin (St. Petersburg) gave a paper on suicide and attempted suicide among pupils of Russian middle schools. He had investigated 337 actual and 95 attempted cases. Among school children, the suicide rate is three times higher than among the general population. Shooting, hanging, and poisoning are the leading methods. The chief causes are mental and nervous derangements.

Prof. Eulenberg (Berlin) gave similar facts from Germany (as Prof. Gurlitz has already done in a book recently published in criticism of German school methods). He had traced during the last twelve years 1152 cases of actual suicide among school children. More than 50 per cent. of these were traceable to failure in examinations or overwork at school.

(8) *Economics of Neglected School Children.*—Dr. Cronin (New York) gave an estimate of the waste due to diseases and defects of school children. In 1902 (New York) there were 24,000 exclusions, which, at the known cost of 20 cents a day, represents a loss of 4800 dollars in three months. In a school population of 650,000, 30 per cent. were from one to two years behind their proper class—a loss of about 40 dollars per child, if only one lost year be counted. Thirty per cent. (or 195,000) lose one year in six—a loss of 1,666,666 dollars in each school year. Most of the diseases were preventable, and it is economic waste not to prevent them.

(9) *Anthropometry in School.* — Dr. Shrubsall (London) sketched what the British Association regard as essential in school anthropometry—stature, weight, hair-coloration, iris colours, maximum length and breadth of head, chest in deep inspiration and expiration, diameters of chest, breadth across shoulders and trochanters, height of head. (The report of the Physical Training Commission [Scotland] contained all these and some other measurements of 1200 school children.) The opinion is general that this work should form a special investigation, and should not be expected of the education authority at the ordinary medical inspection. It certainly takes more time than medical inspection; but the data wanted are of value for anthropology. No results were produced at the congress. Mr. Gray gave details of a uniform scheme of yearly measurements of school children as a basis for estimating deterioration of the race.

Dr. Schuyten (Antwerp) presented a summary of ten years of research in the pædological laboratories of Antwerp. It is difficult to overestimate the value of those researches. The chief general conclusions are, (1) that the child, on entering the ordinary school, undergoes physical and mental depression; (2) that growth in muscular power is not regular during the school year, there being a distinct depression in March; (3) that, as tested by the dynamometer, muscular power varies with the season; (4) that voluntary attention decreases from January to July, and increases from October to December; (5) that fatigue increases during the school year from one end to the other without perceptible recovery of energy due to holidays; (6) that the validity of æsthesiometric methods of determining fatigue is now demonstrated (a view contested by Dr. Altschul, of Prague, who criticises Prof. Griesbach's results, and maintains that his own are conclusive against Griesbach's method). The methods used by Dr. Schuyten are ingenious. For instance, in drawings of a "little man" on a uniform-sized white surface by children of different ages, it was found that there is a regular increase in the length and breadth of the figure from $3\frac{1}{2}$ to 6 years of age. At age six, on entrance to school, there is roughly a 40 per cent. reduction in the dimensions, which again increase with age. Schmidt Monnard noted actual slackening in the child's own development at this age.

It is important to have some confirmation of Prof. Griesbach's method of testing fatigue by the æsthesiometer. It has been subjected to much criticism; but its simplicity and ease of application are strong inducements to further definitive experiment. It is undoubtedly the simplest method yet suggested for school children, and research will probably centre round it for some time to come.

(10) *Relations of Medicine and Paedagogy.*—Prof. Griesbach (Muelhausen), who first suggested an international congress on school hygiene, and, as president, carried through the Nuremberg congress with untiring energy, wound up the London congress with an evening lecture on the "Relations between Medicine and Pædagogy." He gave a really encyclopædic view of the whole vast subject, and his printed lecture will remain one of the most important documents of the movement. In a series of elaborate tables he outlined the whole educational curriculum of elementary and higher schools in Germany, giving body to his comments by large masses of analysed observations and records. His table on the relations between circumference of head and mental capacity is a striking record of observations made by himself. The numbers examined were not stated, but they were large enough to justify averages. When the full lecture is published, this table will deserve careful criticism. It sustains the view that, on the average, the larger head goes with the greater mental capacity. The lecture was, in every respect, a worthy close to a great congress.

ELECTRICITY IN BULK.

HOWEVER far we may still be from a proper understanding of the actual nature of the phenomena connected with the production of electrical energy, the past twenty years has clearly shown that in its economic aspects it follows certain well established laws. Just as the great increase in the scale of wholesale production and the invention of new and more rapid means of distribution enables the big manufacturer and stores to compete with the local workshop, or shopkeeper, so the lower first cost of producing electricity on a large scale, and the higher electrical pressures used in its transmission, enable the central authority to compete with the smaller local source of production.

The economy of concentration and bulk production of electricity was recognised by Ferranti nearly twenty years ago, and that his attempt to carry it out at Deptford in 1889 was unsuccessful was solely due to the fact that there, as in the case of the "Great Eastern," the idea was in advance of the state of manufacturing knowledge.

The size of units proposed for the Deptford station in 1889, 10,000 h.p., and the pressure used, 10,000 volts, have since been exceeded, and the latest serious proposal for the supply of electricity wholesale to London, was based upon 20,000 h.p. units, and 20,000 volts pressure. But although the premature attempt to concentrate electricity production at Deptford did not meet with the success it deserved, the correctness of the principle was not lost sight of. Another company, the Metropolitan Electric Supply Company, in the succeeding ten years carried out a policy of partial concentration in its own area, abolishing a number of small stations in the West End, and replacing them by a larger station at Willesden. But nothing so radical has taken place in electricity as has been the case in gas supply. The Ordnance Maps of forty years ago recall the existence of some seventeen or eighteen gas works, scattered throughout the Metropolitan area, nearly all of which have now been dismantled. To-day, 90 per cent. of the gas used in London is produced at Beckton, on the Greenwich Marshes, or at Nine Elms.

There are still, however, more than seventy electric generating stations in Greater London, and at present little prospect of their number being reduced. For Parliament has now rejected the third and last possible alternative for solving this knotty but urgent problem. The freedom with which the process of concentration was carried out in the case of gas arose largely from the fact that the undertakings were entirely in private hands, and that no political questions were raised in connection with their abolition.

The need for improvement, and the technical soundness of the methods suggested for improving existing electrical conditions, have now been generally admitted, both by those who favour municipalisation and those who favour private enterprise under municipal control. The fact that the existing stations, which have cost 45*l.* to 50*l.* per kw., could now be built for 10*l.* per kw., that the present cost of production is more than 1*d.* per unit, and in a new station need only be 0·2*d.* per unit, that the consumption of electricity in London is only one-tenth of that in other great cities, are no longer questions of discussion.

During the past three years three serious attempts have been made to carry out a similar concentration, the first by private enterprise, and the second by the London County Council. Although the first only failed to become law by a few days, neither of these proposals succeeded in obtaining Parliamentary sanction. It was, therefore, hoped that the third and last alternative, that of co-operation between municipal and private enterprise, which was put before Parliament this year, would have been more successful. The fact that it also shared the fate of the previous proposals, and has been rejected, is therefore the more to be regretted, for it appears as though the scientific solution of London's electricity supply difficulties will now be indefinitely postponed. Private enterprise cannot be expected perpetually to provide the money for promoting schemes which are endorsed by Parliamentary Committees on their merits and rejected by the House of Commons on political grounds. The London County Council naturally does not feel justified in making further proposals for establishing a wholesale supply of electricity at the ratepayers' expense, in view of the recent elections. The supporters of complete municipalisation, however, have indicated that they are unwilling to agree to any proposal other than one for the complete municipalisation of electricity supply, and hence the present deadlock.

NOTES.

WE are glad to be able to notify that the honour of a knighthood of the Most Honourable Order of the Bath (Civil Division) has been conferred upon Sir Archibald Geikie.

THE *Times* announces the death of Dr. W. D. Miller, professor of odontology at Michigan University, the author of many treatises on the teeth, and until last year professor of odontology in the University of Berlin.

BY the death of Angelo Heilprin on July 17, at the age of fifty-four, science loses an enthusiastic naturalist, geologist, and explorer. He was born in Hungary, but at an early age emigrated with his parents to the United States. His education was completed in England at the Royal School of Mines during the years 1874–7, when he showed especial aptitude for natural history and gained the Edward Forbes medal. Returning to the United States, he was in 1879 appointed professor of invertebrate palæontology and curator in charge of the Academy of Natural Sciences at Philadelphia, and for a time he was professor of geology at the Wagner Free Institute of Science in the same city. He was author of a handbook on the local "town geology," of a memoir on the Tertiary geology of the United States (1884), as well as of works on the Bermuda Islands and west coast of Florida. For the International Scientific Series he wrote the "Geographical and Geological Distribution of Animals" (1887). He was author of an essay on the Arctic problem, and in 1892 he led the Peary relief expedition to the Polar regions. In later years he turned to volcanic phenomena. In 1902 he visited Mont Pelée while it was still in eruption, and wrote a work entitled "Mont Pelée and the Tragedy of Martinique" (ed. 2, 1903); while in a recent article, published in *Science* (New York, 1906), he discussed the "Concurrence and Interrelation of Volcanic and Seismic Phenomena."

THE first meeting of the Italian Association for the Advancement of Science will take place at Parma from September 23 to 29. According to the *Lancet*, the medical sciences will be strongly represented, particularly in anatomy, human and comparative; and the section devoted to anthropology, ethnography, and palæoethnology will have special attractions because of its programme. It is expected also that fresh light will be thrown at the meeting upon the subjects of forest growth, rainfall, and hygiene.

THE second International Congress on Physiotherapy will meet in Rome under the presidency of Senator Guido Baccelli in October next, and bids fair to be a great success, representatives from Great Britain, France, Germany, Austria, Denmark, Sweden, Norway, Belgium, Holland, Switzerland, and Japan having already intimated their intention of being present. The Italian Government is granting special travelling facilities to those attending the congress. The general secretary of the congress is Prof. Carlo Colombo, Via Plinio, Rome. The English secretary is Mr. W. Deane Butcher, Holyrood, Ealing.

A REUTER telegram from New York states that the main expedition of the Peary Arctic Club has been postponed for a year in consequence of the new boilers in the *Roosevelt* having been delayed; the vessel meanwhile is to be taken to Etah, Greenland, for the purpose of establishing a coal depôt, and will return by the end of September.

ACCORDING to the *Athenaeum*, a scientific expedition for the exploration of Central Asia has been organised by the Russian Geographical Society. It will be under the leadership of M. Kozlow, and will leave in October next. The expedition proposes to spend two years in the close examination of southern Mongolia and the western parts of the Chinese provinces of Kansuh and Szechuen. It is stated by our contemporary that the entire cost of the expedition will be borne by the Czar.

IT is stated in the *Western Electrician* that wireless telegraph stations have been erected on Spitsbergen and at Hammerfest and Trömso in order that wireless communication may be kept up with the Wellman Arctic Expedition.

ACCORDING to the *Electrical Review*, a committee of inquiry into the question of electric-railway working in the United States is about to leave Berlin for New York, in connection with the long-discussed scheme for the introduction of electric traction on German railways, and particularly on the Berlin city railways. The committee intends to inspect, among other lines, the Baltimore-Washington-Annapolis Railway, which is equipped on the Westinghouse single-phase system, together with the elevated and tunnel railways in the United States. It is stated that the Berlin State Railway Administration will soon prepare plans for the conversion of certain lines as a result of a recent order made by the Minister for Railways, although nothing of practical value can really be accomplished until the return of the committee and the presentation of its conclusions.

THE Mississippi Valley Laboratory of the United States Department of Agriculture has, according to *Science*, been abolished, and the work in forest pathology will in future be carried on at Washington, D.C.

THE Alvarenga prize of the College of Physicians of Philadelphia for the present year has been awarded to Dr. W. Louis Chapman for his investigations on "Post-operative Phlebitis, Thrombosis and Embolism."

THE council of the Selborne Society has for some time had under its consideration a suggestion that the work of the society could be done much more efficiently if sections were formed, consisting of members specially interested in any particular objects. It is thought, for example, that one group of members might deal with the protection of plants, another with the question of the wearing of feathers, a third with the preservation of ancient buildings, a fourth with that of places of natural beauty, a fifth with general amenities, and so on. The matter has now been referred to the general purposes committee, and members who are interested in any matter coming within the society's objects are invited to communicate with the honorary general secretary, that a report may be made to the council as to the possibility of carrying out the idea.

THE Gypsy Lore Society, which was founded in 1888 and met an untimely end four years later, has now been revived, with its headquarters at 6 Hope Place, Liverpool. The first number of the new Journal illustrates the difficulties which surround the problem of the origin of this mysterious people. The most important contribution is Mr. John Sampson's article on "Gypsy Language and Origin," which contains a useful summary of the literature of the subject. The linguistic evidence seems to connect the Gypsy speech of Europe with that of Kashmir or Dardistan, but the intervening links, particularly the dialects of Syria and Armenia, are still little known, and much work remains to be done before a comparative grammar and dictionary can be compiled. The society, however, must resist the tendency to confound the ethnological with the linguistic problem. It may perhaps be admitted that the basis of Gypsy speech is to be found in that of one of the vagrant tribes of India. But it is probable that this Dravidian race element has now largely disappeared in the European branch of the tribe, and anthropometry can throw little light on the varied elements from which it has been recruited. All students of anthropology, linguistics, and folk-lore offer a friendly welcome to the revived society, which will, it may be hoped, enjoy a longer lease of life than its predecessor. It has been suggested that, with the collaboration of members of the Gypsy Lore Society, an anthropological survey of the Gypsies should be undertaken, with the view of classifying them from that point of view and determining their ethnographical position among the races of India. Members of the society who are interested in this subject, and especially those who are in a position to take part in the work, are invited to communicate with Mr. J. W. Scott Macfie, Rowton Hall, Chester.

AN institute entitled the Istituto Therapeutico Italiano has been established at Milan under the directorship of Dr. Zanoni, the work of which will be the investigation of the action of new drugs, especially in regard to serum-therapy and hypodermic medication.

THE Vienna correspondent of the *Lancet* states that the new premises of the Vienna Serum Institute have been recently opened. The institute serves two distinct purposes, viz. scientific research and the preparation of sera against certain diseases for the supply of medical institutions and practitioners. It is stated that 71,506 bottles of anti-diphtheritic serum were made in the institute and sold in 1905, and 75,000 bottles in 1906, together with 7500 doses of anti-scarlatinal serum and 2000 doses of dysentery serum. Since 1906 the institute has been self-supporting, as the sale of the sera to private patients covers the cost of manufacture. The quantity of blood taken from each animal amounts to six litres (eleven pints) each time, and as this is repeated ten times a year, 110 pints of blood have to be reproduced by the organism within a year.

THE French Association for the Advancement of Science recently met at Rheims under the presidency of Dr. Henrot. In the presidential address, after remarking that with notification, isolation, and disinfection, with certain exceptions, we may hope to stamp out infectious diseases, Dr. Henrot proceeded to deal with the question of child-life protection. Various societies have been founded in France to care for the mother, both before and after the birth of the child, and to educate the parents in the proper feeding and care of their children. For this purpose, associations for the supply of proper milk, comparable to our infants' milk depôts, have been established. Crèches also have been organised to look after the children while the mothers are at work. Children abandoned or in immoral surroundings are cared for by the State, and in France there are no less than 178,000 of these, for whom schools are established where, as they become old enough, various trades are taught. The families which have the most numerous members should be the best housed, and at Nancy the "Bureau de Bienfaisance" has provided dwellings with gardens for those families where there are children.

An interesting report by Dr. Leslie Mackenzie and Captain A. Foster has been issued by the Scotch Education Department on a collection of statistics relative to the physical condition of children attending the public schools of the School Board for Glasgow. The figures show that the one-roomed child (*i.e.* the child of a family occupying one room only), whether boy or girl, is always on the average distinctly smaller and lighter than the two-roomed; the two-roomed than the three-roomed; and the three-roomed than the four-roomed. "The numbers examined are so large, and the results are so uniform that only one conclusion is possible, viz. that the poorest child suffers most in nutrition and in growth. It cannot be an accident that boys from two-roomed houses should be 11·7 lb. lighter on an average than boys from four-roomed houses and 4·7 inches smaller. Neither is it an accident that girls from one-roomed houses are, on the average, 14 lb. lighter and 5·3 inches shorter than the girls from four-roomed houses." The report contains a number of elaborate tables and diagrams.

The Bulletin of the Johns Hopkins Hospital for June-July contains a number of papers of interest to the pathologist and clinician, mostly from the laboratories of the medical clinic of the hospital. The August number of the same Bulletin is principally devoted to tuberculosis, and contains an article, by Dr. Pohlman, on "The Purple Island" by Phineas Fletcher, a seventeenth-century layman's poetical conception of the human body.

The Journal of the Royal Sanitary Institute for August (xxviii., No. 7) contains the inaugural address by Sir Charles Cameron at the Dublin conference, in which he demonstrated how sanitation has reduced the death-rate, and discussed the questions of tuberculosis, milk supply, and infant mortality.

After quoting a considerable portion of Sir H. H. Johnston's article on big-game protection which appeared in vol. lxxvi., p. 37 (1907), of Nature, a writer in the *American Naturalist* for July asks the question whether we cannot do without furs, remarking that the lack of "buffalo-robes" due to the extermination of the bison is not felt in America. He then goes on to raise a protest against collecting skins and eggs for museum purposes, observing that their scientific value is but slight, while it is a question whether oology has any right to rank as a science at all. In his opinion a museum with specimens of species as rare in collections as the great auk is of less value for educational purposes than a barn where swallows nest. "In these days of inexpensive and quite accurate pictures, collections are not necessary for identification, and science is advanced by detailed studies of common forms, rather than by collecting luna and imperial moths."

The July number of the *Emu* (forming the first part of vol. vii.) opens with an account by Mr. I. Batey of the changes which have taken place in the bird-life on an estate of fifteen thousand acres in Victoria during the last sixty years. In its early days the tract was a veritable bird paradise, but, largely owing to the felling of its timber, many of the species have now completely disappeared, some of them from an area of much wider extent than that occupied by the estate. Wedge-tailed eagles abounded in 1846, and but little effect was made on their numbers by the shot-guns then in use, although the introduction of strychnine soon led to their practical extermination.

The July issue of the *American Naturalist* opens with some interesting personal reminiscences of Louis Agassiz related by Mr. C. W. Eliot at a meeting of the "Saturday Club" in connection with the Agassiz centenary. Emphasis is laid on the great naturalist's eminence as a teacher and expositor, and the novel methods of education he adopted. The son of a distinguished surgeon was, for instance, set to study a few trilobites, upon which he was expected to work for several weeks without any aid from books or illustrations, and at the same time to be his own artist. His powers of organisation and of obtaining financial support were also very noteworthy in these early days of science teaching. Years ago it was remarked that "Agassiz will get more money out of the Commonwealth of Massachusetts for his subjects than any of you have dreamed of getting, than any of you could possibly get; but he will so equip his subject, he will set such a standard for collections in all subjects, that every department of learning in the University will profit by his achievements." These words have proved absolutely prophetic.

In the August issue (No. 3) of *British Birds*, Miss E. L. Turner announces that the ruff has made its re-appearance as a breeding species in Norfolk, where the last known nest was recorded so long ago as 1889. In June of the present year a keeper discovered a reeve's nest containing four eggs, which, together with the parent bird, was successfully photographed. It is probable that another pair of ruffs also nested in the county during the present summer, while as young birds were killed during the two previous seasons, there is reason to believe that the species has nested in Norfolk since 1904. Ruffs have been reported as breeding in Yorkshire in 1901 and the two succeeding years. In the same issue Mr. F. Smalley points out that the alleged occurrence of the Pacific eider-duck (*Somateria v-nigrum*) in the British Isles is due to ornithologists having failed to recognise that drakes of the ordinary eider-duck may show a faint dark chevron on the throat. A specimen of the Sardinian warbler (*Sylvia melanocephala*), killed near Hastings in June last, definitely adds another species to the British list.

We have received a memoir by Dr. Alvan A. Tenney on "Social Democracy and Population," issued in the series of "Studies in History, Economics and Public Law" of Columbia University. By "social democracy" the author means "that form of society . . . in which every man has a chance and knows that he has it," a form of society based primarily on the maintenance of a reasonable plane of living for all, and it is the object of the essay to discuss the influence of biological factors on such a form of society, assuming it possible of attainment. Thus the maintenance of a social democracy requires a rate of increase of population that is not too rapid as compared with the rate of progress in the arts; this probably implies that the democracy would be outstripped in population by nations of a lower standard of living, and hence might be only capable of survival in the case of a nation living in an easily defended situation. The low rate of increase postulated would not, the author considers, sensibly lessen the action of selection, as the latter acts in too many ways, nor would it be likely to lead to degeneration. But a recognition of the existence of hereditary individual differences and of the importance of selection is sufficient to warrant "conscious social interference in the biological process," interference which already takes place in such matters as the control of immigration. The question arises whether the principle should not be extended for the purpose of maintaining the level of natural ability in the population. As regards the United States, the author considers that the attainment of social democracy should be possible if they do not enter into the struggle for foreign markets in competition with peoples of a lower plane of living.

IN the Journal of the Society of Arts for July 26 Mr. T. E. Younge gives an account of the "sand-counter" (ψαμμίτης) of Archimedes, which may help to revive popular interest in this very remarkable tract. Practically, Archimedes uses a scale of notation the radix of which is a myriad (10,000), and shows that by means of this scale it is possible to estimate the number of grains of sand in a sphere of the size of the earth. His estimate, of course, is only approximate, and his data imperfect; but considering the state of Greek science at the time, it is a most interesting achievement, and it is quite clear that Archimedes could have used more exact data with equal facility. Mr. Younge has checked Archimedes' numerical calculations, and found them all correct.

IN the *Monthly Weather Review* for April, issued by the U.S. Department of Agriculture, Mr. H. Helm Clayton proposes a new method of weather forecasting by analysis of atmospheric conditions into waves of different lengths. Data in support of his theory were published by the author in the *American Meteorological Journal* of July, 1885, and June, 1891, and after further research into the laws underlying the drift of weather conditions he concludes that the meteorological elements at any place may be analysed into oscillations or waves differing in length, each having a distinct physical existence; further, that the waves drift generally from west to east, with a velocity inversely proportional to their length. Specimens of the movements of pressure and temperature waves over the United States illustrate the investigation, and the author considers that the results not only open the way to an improvement in forecasting weather from day to day, but furnish a scientific basis for long-range forecasts.

PROF. H. EBERT describes in the March number of *Terrestrial Magnetism* an extremely sensitive arrangement he has used for investigating the pulsations of short period in the strength of the earth's magnetic field. For observations of the vertical component, a wire 3000 metres in length is formed into a coil of fifteen turns, and is placed on the ground. In series with it is a sensitive "filament galvanometer" of the Einthoven type. Any change in the number of magnetic lines through the coil will produce a current through the galvanometer, and the arrangement will indicate a change in the vertical component of the earth's magnetic field equal to 1/400,000 of its mean value. Prof. Ebert finds that periodic changes of certain frequencies most often occur, and one of these has the period 1/6 to 1/7 second, which is that of the oscillation of an electrical charge on a sphere of the size of the earth. The observations are being continued, and will probably play an important part in the search for an explanation of the phenomena of terrestrial magnetism.

THE Carnegie research memoirs submitted at the meeting of the Iron and Steel Institute in May last, brief summaries of which were given in NATURE (this vol., p. 65), have now been published in full in a special volume of the Journal of the institute (vol. lxxiv.). The volume contains papers by Mr. P. Breuil (Paris), on copper steels; by Mr. W. H. Hatfield (Sheffield), on cast iron as cast and heat treated; by Mr. E. F. Law (London), on the non-metallic impurities in steel; and by Dr. O. Stutzer (Freiberg), on the geology and origin of the Lapland iron ores. There is also a paper on boron steels, by Dr. L. Guillet (Paris), received since the meeting. These steels have not hitherto been the subject of systematic investigation, and the researches described show the commercial interest attaching to these products when quenched. Boron steels will probably never prove of commercial use in the raw state, but they may prove useful after quenching. In that condition they possess high tensile strength and a remarkable degree of elasticity. The best results were obtained with a steel containing 0·50 per cent. of boron. The volume concludes with a reprint of considerable historical interest. It is an address on the effect of air and moisture on blast furnaces, delivered at Bradford in the year 1800 by Joseph Dawson, of Lowmoor.

IN summarising the work of the United States Geological Survey during 1906 in the investigation of ores, Mr. S. F. Emmons directs attention to the way in which science is handicapped. The increasing exodus of members of the economic staff of the survey in consequence of their employment by large mining organisations at salaries much greater than those they have been receiving from the Government seriously impairs the efficiency of the work of this branch of the survey. The loss of trained men in this work is, for a time, irreparable, as it is only by years of practical experience in the field that the geologist becomes competent to carry on independent work of this kind.

IN the Journal of the Franklin Institute (vol. clxiv., No. 1) Mr. Albert Obholzer describes the methods used to avoid piping in steel ingots at the Hungarian Government steel foundries at Diosgyör. With the addition of thermite to the charge of open-hearth steel, homogeneous ingots are obtained. The method presents considerable advantages over the very successful Harmet process, which necessitates the use of elaborate machinery.

THE number of the Bulletin of the College of Agriculture (vol. vi., No. 3), Tokio University, lately received, contains several short papers on the physiological action of various chemical substances on plants. Prof. O. Loew and Dr. K. Aso discuss the importance of culture solutions being physiologically balanced, and allude to the use of lime in averting the injurious action of an excess of magnesium salts. They also touch upon the beneficial action of treating the soil with bactericidal substances such as carbon disulphide, attributing the effect to the breaking down of living matter. Mr. T. Takeuchi refers to the use of shoots of *Aralia cordata*, called in Japan "udo," as a salad or a vegetable, comparable with celery or asparagus.

A SEMI-POPULAR article on the phylogeny of the various groups of the plant kingdom is contributed by Prof. M. Möbius to *Naturwissenschaftliche Wochenschrift* (June 30 and July 7). To the Flagellatæ is accorded the lowest position, from which arose the algæ, bacteria, diatoms, and other elementary groups. From the green algæ were derived the brown and red seaweeds, the connection of the latter being through Coleochæte or through an Ulva-Bangia link. With regard to the mosses, the author favours the view that they have been derived from an early type of the Jungermanniaceæ, and that the prototype of the ferns and fern-allies was probably a plant akin to Anthoceros. Finally, the origin of the monocotyledons is traced through the dicotyledons to the conifers, and thence back to the lycopods.

FOUR papers dealing with the identification of new plants chiefly from Mexico are published in the Proceedings of the American Academy of Arts and Sciences (July). Mr. J. M. Greenman is responsible for new species of the liliaceous genus Schoenocaulon; among the diagnoses prepared by Mr. M. L. Fernald are a group of Salvias. The collections brought by Mr. C. C. Deam from Guatemala and Mexico yielded, amongst others, *Streptochaeta sodoriana*, a grass already known from Ecuador, and a curious Euphorbia. The majority of the identifications by Mr. B. L. Robinson are additions to the Compositæ, and include two new genera, Cymophora and Loxothysanus, also a series of species of Eupatorium.

IN the account of the grasses of British Somaliland contributed to the *Kew Bulletin* (No. 6), Dr. O. Stapf establishes half a dozen new species, including the economically important "durr" grass, *Andropogon cyrtocladus*, and *Sporobolus fruticulosus*, another shrubby species. These shed their leaves and young shoots in the dry season, but produce large, feathery branches after the rains set in. The culms of *Panicum turgidum* and *Pennisetum dichotomum* are persistent, and form a tough fodder suited to the hard-mouthed camel. Phytogeographically the grasses of Somaliland have affinities with the grasses of Eritræa, eastern Nubia, and tropical Arabia. A considerable number of new fungi are recorded by Mr. Massee as additions to the wild fauna and flora of the gardens; a Hypholoma and several parasitic Melanconiaceæ and Hyphyomyceteæ provide the types of new species. Mr. Botting Hemsley has a note on a new species of Rhododendron from China described by Mr. E. H. Wilson.

THE Annual Report and Transactions of the Manchester Microscopical Society for the year 1906 has just reached us. The society is, we are pleased to see, in a satisfactory condition. The volume before us contains the address delivered in January last by the president, Prof. S. J. Hickson, F.R.S., on "The Differentiation of Species of Cœlenterata in the Shallow Water Seas," and many papers of interest to students of microscopical science.

As a member of the International Congress of Geologists meeting in Mexico in 1906, Prof. H. F. Cleland, of Williams College, took the opportunity of visiting, in the company of trained observers of the Mexican Geological Survey conversant with the regions investigated, several of the Mexican volcanoes, and describes in the August number of the *Popular Science Monthly*, under the title of "Some Little-known Mexican Volcanoes," the volcanoes known as the Volcano Colima and the Nevado de Toluca, and the cinder cones of Valle de Santiago. The article is well illustrated.

PROF. KARL PEARSON'S Robert Boyle lecture, entitled "The Scope and Importance to the State of the Science of National Eugenics," delivered at Oxford on May 17 last, has now been issued by Mr. H. Frowde at one shilling net.

OUR ASTRONOMICAL COLUMN.

HELIUM ABSORPTION IN THE SOLAR SPECTRUM.—In a letter to the *Observatory* (No. 386, p. 315, August) Mr. Nagaraja, of the Kodaikanal Observatory, records the results of some further observations of the helium line, D_3, as a dark line in the spectrum of the sun. Having already frequently observed this dark line in the regions of the photosphere adjacent to sun-spots, he suspected that he had also seen it as a faint line in the ordinary solar spectrum, but for several reasons found the observation difficult to confirm. He now states that, with a recently mounted large grating spectrograph, he obtained a photograph of the D_3 region on April 19, and on examination found that it shows both the darkening and the chromospheric (bright) line, where a spot was close to the limb, and, further, both the dark and the bright lines appear to be a continuation of a faint line in the normal solar spectrum. Further examination is necessary ere the identity of this faint line with the helium line can be definitely affirmed, and to this end Mr. Nagaraja proposes to carry on the research.

In the same journal Mr. A. A. Buss discusses at some length the appearance of dark and bright helium in various solar regions.

POSSIBLE CHANGES IN THE "OWL" NEBULA (M. 97).—In a paper communicated to the Royal Astronomical Society, Prof. Barnard compares the results of his recent observations of the "Owl" nebula, made with the 40-inch refractor of the Yerkes Observatory, with those made with Lord Rosse's large reflector in 1848. The latter were embodied in the well-known drawing of this object which shows a small star placed in each of the two holes, or "eyes," seen in the nebula, each star representing the pupil of the "eye" in which it was placed.

But according to Prof. Barnard's observations in recent years these stars are clear of the dark openings, and are seen on the nebulosity itself, although quite near to the dark spaces. It follows, then, that either the older drawing, which is corroborated by the observer's notes, did not correctly represent the relative positions of the stars, or that a change has occurred in the nebula, for the two stars have not changed their places in the sky. As a working hypothesis, Prof. Barnard suggests the possibility of the nebula having rotated from west to east on an axis having the position angle of 50°, and states that, if the velocity of rotation were great enough, the two stars in question would have occupied the positions in the holes as shown on Lord Rosse's drawing (Monthly Notices R.A.S., vol. lxvii., No. 8, p. 543, June).

A QUICKLY CHANGING VARIABLE STAR.—According to the results of observations made at the Yerkes Observatory by Mr. Naozo Ichinohe, the variable star 87.1906 Draconis has the very short period of only 10h. 37m. 35s. The light increases from minimum (mag. 11·6) to maximum (mag. 10·9) in about three hours, decreases to minimum in about five hours, and remains at minimum for the remainder of the period.

An ephemeris accompanies Mr. Ichinohe's note in No. 4194 of the *Astronomische Nachrichten* (p. 293, August 2), and the position of this object, for 1900, is given as 16h. 33m. 43·3s. + 58° 2′ 36″.

VENUS AS A LUMINOUS RING.—A brief note by Messrs. H. N. Russell and Z. Daniel, published in No. 1, vol. xxvi., of the *Astrophysical Journal* (p. 69, July), describes an observation of the ring-phase of Venus made at Princeton Observatory, with the 5-inch finder, at 5h. 7m. (G.M.T.) on November 29, 1906.

At that time Venus was about $1^\circ 40'$ from the sun's centre, and in moments of atmospheric steadiness the complete outline of the planet's disc was seen distinctly. The space within the circle always appeared a shade darker than that without, but this was probably a subjective effect. A bright spot was several times suspected in the bright part of the ring. If the atmospheric conditions are very favourable, the ring-phase of this planet may be seen again in 1914; after that there will be no further opportunity until 1972.

OBSERVATIONS OF JUPITER, 1906–7.—During the opposition of 1906–7, the Rev. T. E. R. Phillips observed Jupiter on 106 occasions, and records the results of his observations in a paper communicated to the Royal Astronomical Society (Monthly Notices, vol. lxvii., p. 522, June).

The most remarkable change, as compared with the previous opposition, was observed in the great development of the N. equatorial belt, which had become broader and darker, and, in August, was marked with numerous white rifts and dark reddish streaks along its S. edge.

Later in the apparition this belt was seen to be triple, the S. component being the darkest of the three. Changes of colour were also observed in this belt and on the whole of the disc lying between the N.N. temperate belt and the N. pole. Observations of the dark matter in the great S. tropical disturbance tend to confirm, in principle, Major Molesworth's hypothesis concerning the sudden transference of the dark matter from the following to the preceding end of the red spot, for this transference took place in about two weeks instead of taking nearly three months as it should do under normal conditions of transit.

AUGUST METEORS, 1907.

ENCOURAGED by the appearance of several bright Perseids on the nights of August 4 and 6 to expect a somewhat plentiful return of this shower, a careful watch was maintained of the sky on August 10, 11, and 12, but the results scarcely realised expectation. The display was by no means an abundant one, and the individual meteors were not so bright generally as in ordinary years.

The results of watches were as under:—

August 10.

10h. to 12h., twenty-five meteors per hour, of which half were Perseids; 13h. to 14h., forty-five meteors, of which two-thirds were Perseids; 14h. to 15h., twenty-five meteors seen, but there were many passing clouds from west. Two other observers at Bristol counted thirty-one meteors between 11h. and 12h.

August 11.

9h. to 10h., fifteen meteors; about half of them were Perseids; 13h. to 14h., thirty-six meteors, of which twenty-two were Perseids. Sky rather misty. The shower was regarded as very poor for August 11.

Miss Irene Warner, of Horfield Common, Bristol, obtained the following results:—

9h. 25m. to 10h. 5m., eleven meteors, including eight Perseids; 10h. 5m. to 11h. 5m., thirty-three meteors, including twenty-seven Perseids; 11h. 5m. to 11h. 40m., twelve Perseids.

The horary number was about twenty-eight meteors, of which about twenty-four were Perseids.

Two other observers at Bristol, watching from 9h. to 11h., counted thirty-five meteors.

August 12.

Miss Warner watched as follows:—

9h. 15m. to 9h. 40m., five meteors; 10h. 10m. to 11h. 20m., twenty-one meteors; 11h. 20m. to 12h. 20m., twenty-three meteors. Fine meteor seen at 10h. 55m. with train. The path was from δ to α Cygni. At 11h. 20m. one as bright as Venus from about $35^\circ + 58^\circ$ to $60^\circ + 47^\circ$.

11h. to 12h., about forty-five meteors, including thirty-three Perseids; 13h. to 14h., about fifty meteors, including thirty-five Perseids.

There were many passing clouds, rendering observation difficult, and the horary numbers were derived from the number of objects seen during clear intervals.

Radiant point on August $10 = 44^\circ + 56^\circ$.

Radiant point on August $12 = 47^\circ + 57^\circ$.

A brilliant flash was noticed on August 11, 13h. 17m., probably given by a large Perseid falling in the southern sky, but this quarter was hidden from the observer by a building.

I would be glad to hear of any duplicate observations of the following objects seen on August 10:—

	h. m.				
(1)	10 22	...	$1\frac{1}{2}$	..	$339° + 66$ to $306 + 57\frac{1}{2}$
(2)	10 30	...	1	..	$5 + 26$,, $8 + 22\frac{1}{2}$
(3)	11 6	...	$1\frac{1}{2}$		$2\frac{1}{2} + 65$,, $54 + 73$

No. 2 was a fine, bluish-white Cygnid, which flashed out suddenly in a short diving course. No. 3 was from the direction of the λ Aquilid radiant, and it moved very slowly, occupying $3\frac{1}{2}$ seconds in sailing along its path of 19°. The nucleus was yellow, and it threw off a trail of reddish sparks.

Other showers were seen on August 10–12 from $332^\circ + 50^\circ$ and $333^\circ + 28^\circ$.

W. F. DENNING.

TREASURY GRANTS TO UNIVERSITY COLLEGES.

THE report of the permanent advisory committee appointed on January 31, 1906, to advise the Treasury as to the distribution of the grant in aid of colleges furnishing education of a university standard, has now been published.[1] The report states that a study of the problem how education of a university standard may be most advantageously assisted by State grants shows that there is at the present time considerable complexity surrounding the question, not only by reason of the overlapping due to various educational bodies carrying on similar work in the same areas, but also by reason of public money derived from rate or tax being voted for higher education by different authorities with insufficient information as to one another's operations. For these reasons the committee has obtained permission to shorten from five years to two the period for which the present re-allocation shall hold good. It is hoped that it will be possible by April 1, 1909, to make recommendations for a permanent arrangement.

With regard to the question of standard, the committee finds that it is only in comparatively few of the university colleges that the majority even of the day students have passed a matriculation examination or equivalent test. A well-recognised standard once established would make it easier for the colleges to coordinate their curricula with those of secondary schools. For the present, the report continues, a step may be taken in this direction by excluding rigorously from the category of university work all classes which are preparing students for matriculation.

The committee appointed two inspectors to visit the colleges which already receive grants and certain other institutions which had applied for recognition. Sir Thomas Raleigh, K.C.S.I., and Dr. Alex. Hill undertook this task, and their reports on the various institutions visited are printed as an appendix to the report.

After summarising the financial assistance received by the colleges from Imperial funds and recapitulating the rules laid down for its guidance in various Treasury minutes, the committee recommended that a new maximum limit for all grants be set up, and 10,000*l*. has been decided upon. This maximum relates only to the annual grants for general purposes, and is exclusive of grants for special purposes which may be made from time to time.

The grants recommended for the intervening period of two years, pending a settlement of the general questions referred to in the report, are shown in the following table:—

[1] "University Colleges (Great Britain)." Grant in Aid. [267]. Price 1*s*. 6*d*.

College.	Grant, 1906–7. £	Proposed Grant. £
Victoria University of Manchester	12,000 ...	10,000
University of Liverpool	10,000 ...	10,000
University College, London	10,000 ...	10,000
University of Birmingham	9,000 ...	9,000
University of Leeds	8,000 ...	8,000
King's College, London	7,800 ...	7,800
Armstrong College, Newcastle-on-Tyne...	6,000 ...	6,000
University College, Nottingham	5,800 ...	5,000
University of Sheffield	4,600 ...	5,000
Bedford College for Women, London ...	4,000 ...	4,000
University College, Bristol	4,000 ...	4,000
University College, Reading	3,400 ...	3,400
Hartley University College, Southampton	3,400 ...	2,250
London School of Economics	— ...	500

The report gives the committee's reasons for the diminution of the grant in the case of Manchester, Nottingham, and Southampton, and for the grant to the London School of Economics.

After a consideration of the reports of the inspectors who visited the institutions and of the statistics provided by them, the committee decided not to recommend a grant in the case of the Birkbeck College, the East London College, and the Royal Albert Memorial College, Exeter.

The grants enumerated in the table above amount to 84,950*l.*, leaving, if the grant of 1000*l.* to Dundee University College is continued, a balance of 14,050*l.* available for grants for special purposes.

THE BRITISH ASSOCIATION.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY SILVANUS P. THOMPSON, D.Sc., F.R.S., PAST PRESIDENT OF THE INSTITUTION OF ELECTRICAL ENGINEERS, PRESIDENT OF THE SECTION.

It would be impossible for any assembly of engineers to meet in annual gathering at the present time without reference to the severe loss which the profession has so recently sustained by the death of Sir Benjamin Baker. Born in 1840, he had attained while still a comparatively young man to a position in the front rank of constructive engineers. His contributions to science cover a considerable range, but were chiefly concerned with the strength of materials, into which he made valuable investigations, and with engineering structures generally. His name will doubtless be chiefly associated with the building of great bridges, to the theory of which he contributed an important memoir entitled "A Theoretical Investigation into the Most Advantageous System of Constructing Bridges of Great Span." In this work he set forth the theory of the cantilever bridge. Upon the plan there laid down he built the Forth Bridge, besides many other large bridges in various parts of the world. With that memorable structure, completed in 1890, his name will ever be associated; but he will be remembered henceforth also as the engineer who was responsible for the great dam across the Nile at Assouan, a work which promises to have an influence for all time upon the fortunes of Egypt and upon the prosperity of its population. Sir Benjamin Baker was, moreover, closely associated with the internal railways of London, both in the early days of the Metropolitan Railway and in the later developments of the deep-level tubes. He was elected a Fellow of the Royal Society in 1890, became President of the Institution of Civil Engineers in 1895, and was a member of Council of the Institution of Mechanical Engineers, besides being an active member of the Royal Institution and of the British Association. He was also a member of the Council of the Royal Society at the time of his death.

He enjoyed many honorary distinctions, including degrees conferred by the Universities of Cambridge and Edinburgh. In 1890 there was conferred upon him the title of K.C.M.G., and in 1902 that of K.C.B.

He had but just returned from Egypt, whither he had gone in connection with the project for raising the height of the Assouan dam, so as to increase its storage to more than double the present volume, when he died very suddenly on May 19, in his sixty-seventh year.

The Development of Engineering and its Foundation on Science.

We live in an age when the development of the material resources of civilisation is progressing in a ratio without parallel. International commerce spreads apace. Ocean transport is demanding greater facilities. Steamships of vaster size and swifter speed than any heretofore in use are being built every year. Not only are railways extending in all outlying parts of the world, but at home, where the territory is already everywhere intersected with lines, larger and heavier locomotives are being used, and longer runs without stopping are being made by our express trains. The horsed cars on our tramways are now being mostly superseded by larger cars, electrically propelled and travelling with greatly increased speeds. For the handling of the ever-increasing passenger traffic in our great cities electric propulsion has shown itself a necessity of the time; witness the electric railways in Liverpool and the network of electrically worked tube railways throughout London. In ten years the manufacture of automobile carriages of all sorts has sprung up into a great industry. Every year sees a greater demand for the raw materials and products, out of which the manufacturer will in turn produce the articles demanded by our complex modern life. We live and work in larger buildings; we make more use of mechanical appliances; we travel more, and our travelling is more expeditious than formerly; and not we alone but all the progressive nations. The world uses more steel, more copper, more aluminium, more paper; therefore requires more coal, more petroleum, more timber, more ores, more machinery for the getting and working of them, more trains and steamships for their transport. It requires machines that will work faster or more cheaply than the old ones to meet the increasing demands of manufacture; new fabrics; new dyes; even new foods; new and more powerful means of illumination; new methods of speaking to the ends of the earth.

We must not delude ourselves with imagining that the happiness and welfare of mankind depend only on its material advancement; or that moral, intellectual, and spiritual forces are not in the ultimate resort of greater moment. But if the inquiry be propounded what it is that has made possible this amazing material progress, there is but one answer that can be given—science. Chemistry, physics, mechanics, mathematics, it is these that have given to man the possibility of organising this tremendous development. And the great profession which has been most potent in applying these branches of science to wield the energies of Nature and direct them to the service of man has been that of the engineer. Without the engineer how little of all this activity could there have been; and without mathematics, mechanics, physics, and chemistry, where was the engineer?

If looking over this England of Edward the Seventh we try to put ourselves back into the England of Edward the Sixth—or for that matter of any pre-Victorian monarch—we must admit that the differences to be found in the social and industrial conditions around us are due not in any appreciable degree to any changes in politics, philosophy, religion, or law, but to science and its applications. If we look abroad, and contrast the Germany of Wilhelm the Second with the Germany of Charles the Fifth, we shall come to the like conclusion. So also in Italy, in Switzerland, in every one indeed of the progressive nations. And it is precisely in the stagnant nations, such as Spain, or Servia, where the cultivation of science has scarcely begun, that the social conditions remain in the backward state of the Middle Ages.

Interaction of Abstract Science and its Applications.

In engineering, above all other branches of human effort, we are able to trace the close interaction between abstract science and its practical applications. Often as the connection between pure science and its applications has been emphasised in addresses upon engineering, the emphasis has almost always been laid upon the influence of the abstract upon the concrete. We are all familiar with the doctrine that the progress of science ought to be an end in itself, that scientific research ought to be pursued without regard to its immediate applications, that the importance of a discovery must not be measured by its apparent utility at the moment. We are assured that research in pure science is bound to work itself out in due time into technical applications of utility, and that the pioneer ought not to pause in his quest to work out potential industrial developments. We are invited to consider the example of the immortal Faraday, who deliberately abstained from busying himself with marketable inventions arising out of his discoveries, excusing himself on the ground that he had no time to spare for money-making. It is equally true, and equally to the point, that Faraday, when he had established a new fact or a new physical relation, ceased from busying himself with it and pronounced that it was now ready to be handed over to the mathematicians. But, admitting all these commonplaces as to the value of abstract science in itself and for its own sake, admitting also the proposition that sooner or later the practical applications are bound to follow on upon the discovery, it yet remains true that in this thing the temperament of the discoverer counts for something. There are scientific investigators who cannot pursue their work if troubled by the question of ulterior applications; there are others no less truly scientific who simply cannot work without the definiteness of aim that is given by a practical problem awaiting solution. There are Willanses as well as Regnaults; there are Whitworths as well as Poissons. The world needs both types of investigator; and it needs, too, yet another type of pioneer—namely, the man who, making no claim to original discovery, by patient application and intelligent skill turns to industrial fruitfulness the results already attained in abstract discovery.

There is, however, another aspect of the relation between pure and applied science, the significance of which has not been hitherto so much emphasised, but yet is none the less real—the reaction upon science and upon scientific discovery of the industrial applications. For while pure science breeds useful inventions, it is none the less true that the industrial development of useful inventions fosters the progress of pure science. No one who is conversant with the history, for example, of optics can doubt that the invention of the telescope and the desire to perfect it were the principal factors in the outburst of optical science which we associate with the names of Newton, Huygens, and Euler. The practical application, which we know was in the minds of each of these men, must surely have been the impelling motive that caused them to concentrate on abstract optics their great and exceptional powers of thought. It was in the quest—the hopeless quest—of the philosopher's stone and the elixir of life that the foundations of the science of chemistry were laid. The invention of the art of photography has given immense assistance to sciences as widely apart as meteorology, ethnology, astronomy, zoology, and spectroscopy. Of the laws of heat men were profoundly ignorant until the invention of the steam engine compelled scientific investigation; and the new science of thermodynamics was born. Had there been no industrial development of the steam engine, is it at all likely that the world would ever have been enriched with the scientific researches of Rankine, Joule, Regnault, Hirn, or James Thomson? The magnet had been known for centuries, yet the study of it was utterly neglected until the application of it in the mariners' compass gave the incentive for research.

The history of electric telegraphy furnishes a very striking example of this reflex influence of industrial applications. The discovery of the electric current by Volta and the investigation of its properties appear to have been stimulated by the medical properties attributed in the preceding fifty years to electric discharges. But, once the current had been discovered, a new incentive arose in the dim possibility it suggested of transmitting signals to a distance. This was certainly a possibility, even when only the chemical effects of the current had yet been found out. Not, however, until the magnetic effects of the current had been discovered and investigated did telegraphy assume commercial shape at the hands of Cooke and Wheatstone in England and of Morse and Vail in America. Let us admit freely that these men were inventors rather than discoverers: exploiters of research rather than pioneers. They built upon the foundations laid by Volta, Oersted, Sturgeon, Henry, and a host of less famous workers. But no sooner had the telegraph become of industrial importance, with telegraph lines erected on land and submarine cables laid in the sea, than fresh investigations were found necessary; new and delicate instruments must be devised; means of accurate measurement heretofore undreamed of must be found; standards for the comparison of electrical quantities must be created; and the laws governing the operations of electrical systems and apparatus must be investigated and formulated in appropriate mathematical expressions. And so, perforce, as the inevitable consequence of the growth of the telegraph industry, and mainly at the hands of those interested in submarine telegraphy, there came about the system of electrical and electromagnetic units, based on the early magnetic work of Gauss and Weber, developed further by Lord Kelvin, by Bright and Clark, and last but not least by Clerk Maxwell. Had there been no telegraph industry to force electrical measurement and electrical theory to the front, where would Clerk Maxwell's work have been? He would probably have given his unique powers to the study of optics or geometry; his electromagnetic theory of light would never have leapt into his brain; he would never have propounded the existence of electric waves in the ether. And then we should never have had the far-reaching investigations of Heinrich Hertz; nor would the British Association at Oxford in 1894 have witnessed the demonstration of wireless telegraphy by Sir Oliver Lodge. A remark of Lord Rayleigh's may here be recalled, that the invention of the telephone had probably done more than anything else to make electricians understand the principle of self-induction.

In considering this reflex influence of the industrial applications upon the progress of pure science it is of some significance to note that for the most part this influence is entirely helpful. There may be sporadic cases where industrial conditions tend temporarily to check progress by imposing persistence of a particular type of machine or appliance; but the general trend is always to help to new developments. The reaction aids the action; the law that is true enough in inorganic conservative systems, that reaction opposes the action, ceases here to be applicable, as indeed it ceases to be applicable in a vast number of organic phenomena. It is the very instability thereby introduced which is the essential of progress. The growing organism acts on its environment, and the change in the environment reacts on the organism—not in such a way as to oppose the growth, but so as to promote it. So is it with the development of pure science and its practical applications.

In further illustration of this principle one might refer to the immense effect which the engineering use of steel has had upon the study of the chemistry of the alloys. And the study of the alloys has in turn led to the recent development of metallography. It would even seem that through the study of the intimate structure of metals, prompted by the needs of engineers, we are within measurable distance of arriving at a knowledge of the secret of crystallogenesis. Everything points to the probability of a very great and rapid advance in that fascinating branch of pure science at no distant date.

History of the Development of Electric Motive Power.

There is, however, one last example of the interaction of science and industry which may claim closer attention. In the history of the development of the electric motor one finds abundant illustration of both aspects of that interaction.

We go back to the year 1821, when Faraday, after studying the phenomena of electromagnetic deflexion of a needle by an electric current (Oersted's discovery), first succeeded in producing continuous rotations by electromagnetic means. In his simple apparatus a piece of suspended copper wire, carrying a current from a small battery, and dipping at its lower end into a cup of mercury, rotated continuously around the pole of a short bar-magnet of steel placed upright in the cup. In another variety of this experiment the magnet rotated around the central wire, which was fixed. These pieces of apparatus were the merest toys, incapable of doing any useful work;

nevertheless they demonstrated the essential principle, and suggested further possibilities. Two years later, Barlow, using a star-wheel of copper, pivoted so that the lowest point of the star should make contact with a small pool of mercury, found that the star-wheel rotated if a current was sent through the arm of the star while the arm itself was situated between the poles of a steel horseshoe-magnet. Shortly afterwards Sturgeon improved the apparatus by substituting a copper disc for the star-wheel. The action was the same. A conductor, carrying an electric current, if placed in a magnetic field, is found to experience a mechanical drag, which is neither an attraction nor a repulsion, but a lateral force tending to move it at right angles to the direction of flow of the current and at right angles to the direction of the lines of the magnetic field in which it is situated. Still this was a toy. Two years later came the announcement by Sturgeon of the invention of the soft-iron electromagnet, one of the most momentous of all inventions, since upon it practically the whole of the constructive part of electrical engineering is based. For the first time mankind was furnished with a magnet the attractive power of which could be increased absolutely indefinitely by the mere expenditure of sufficient capital upon the iron core and its surrounding copper coils, and the provision of a sufficiently powerful source of electric current to excite the magnetisation. Furthermore the magnet was under control, and could be made to attract or to cease to attract at will by merely switching the current on or off; and, lastly, this could be accomplished from a distance, even from great distances away. How slowly the importance of this discovery was recognised is now a matter for astonishment. To state that Sturgeon died in poverty twenty-six years later is sufficient to indicate his place among the unrequited pioneers of whom the world is not worthy. Six years elapsed, and then there came a flood of suggestions of electric motors in which was applied the principle of intermittent attraction by an electromagnet. Henry in 1831 and Dal Negro in 1832 produced see-saw mechanisms so operated. Ritchie in 1833 and Jacobi in 1834 devised rotatory motors. Ritchie pivoted a rapidly commutated electromagnet between the poles of a permanent magnet—a true type of the modern motor—while Jacobi caused two multipolar electromagnets, one fixed, one movable, to put a shaft into rotation and propel a boat. A perplexing diminution of the current of the battery whenever the motor was running caused Jacobi to investigate mathematically the theory of its action. In a masterly memoir he laid down a few years later the theory of electric motive power. But in the intervening period, in 1831, Faraday had made the cardinal discovery of the mechanical generation of electric currents by magneto-electric induction, the fundamental principle of the dynamo. Down to that date the only known way—save for the feeble currents of thermopiles—to generate electric currents had been the pile of Volta, or one of the forms of battery which had been evolved from it. Now, by Faraday's discovery, the world had become possessed of a new source. And yet again, strange as it may seem, years elapsed before the world—that is, the world of engineers—discovered that an important discovery had been made. Not until some thirty years later were any magneto-electric machines made of a sufficient size to be of practical service even in telegraphy, and none were built of a sufficient power to furnish a single electric light until about the year 1857. In the meantime in America other electric motors, to be driven by batteries, had been devised by Davenport and by Page; the latter's machine had an iron plunger to be sucked by electromagnetic attraction into a hollow coil of copper wire, thereby driving a shaft and flywheel through the intermediate action of a connecting-rod and crank. Page's was, in fact, an electric engine, with 2-foot stroke, single-acting, of between 3 and 4 horse-power. The battery occupied about 3 cubic feet and consumed, according to Page, 3 lb. of zinc per horse-power per day. This must have been an under-estimate; for if Daniell's cells were used the minimum consumption for a motor of 100 per cent. efficiency is known to be about 2 lb. of zinc per horse-power per hour.

Electric Motive Power Impossible in 1857.

Upon the state of development of electric motors fifty years ago information may be gleaned from an exceedingly interesting debate at the Institution of Civil Engineers upon a paper read April 21, 1857, "On Electromagnetism as a Motive Power," by Mr. Robert Hunt, F.R.S. In this paper the author states that, though long-enduring thought has been brought to bear upon the subject, and large sums of money have been expended on the construction of machines, "yet there does not appear to be any nearer approach to a satisfactory result than there was thirty years ago." After explaining the elementary principles of electromagnetism, he describes the early motors of Dal Negro, Jacobi, Davenport, Davidson, Page, and others. Reviewing these and their non-success as commercial machines, he says: "Notwithstanding these numerous trials . . . it does not appear that any satisfactory explanation has ever been given of the causes which have led to the abandonment of the idea of employing electricity as a motive power. It is mainly with the view of directing attention to these causes that the present communication has been written." He admits that electromagnets may be constructed to give any desired lifting power; but he finds that the attractive force on the iron keeper of a magnet of his own, which held 220 lb. when in contact, fell to 36 lb. when the distance apart was only one-fiftieth of an inch. To this rapid falling off of force, and to the hardening action on the iron of the repeated vibrations due to the mechanical concussion of the keeper, he attributed the small power of the apparatus. Also he remarked upon the diminution of the current which is observed to flow from the battery when the motor was running (which Jacobi had, in his memoir on the theory, traced to a counter electromotive force generated in the motor itself), and which reduced the effort exerted by the electromagnets; this diminution he regarded as impairing the efficiency of the machine. "All electromagnetic arrangements," he says, "suffer from the cause named, a reduction of the mechanical value of the prime mover, in a manner which has no resemblance to any of the effects due to heat regarded as a motive power." Proceeding to discuss the batteries, he remarked that as animal power depends on food, and steam power on coal, so electric power depends on the amount of zinc consumed; in support of which proposition he cited the experiments of Joule. He gives as his own results that for every grain of zinc consumed in the battery his motor performed a duty equivalent to lifting 86 lb. 1 foot high. Joule and Scoresby, using Daniell's cells, had found the duty to be equivalent to raising 80 lb. 1 foot high, being about half the theoretical maximum duty for 1 grain of zinc. In the Cornish engine, doing its best duty, 1 grain of coal was equivalent to a duty of raising 143 lb. 1 foot high. He put the price of zinc at 35*l*. per ton as compared with coal at less than 1*l*. per ton, which makes the cost of power produced by an electric motor—if computed by the consumption of zinc in a battery—about sixty times as great as that of an equal power produced by a steam-engine consuming coal. He concludes that "it would be far more economical to burn zinc under a boiler and to use it for generating steam power than to consume zinc in a battery for generating electromagnetical power."

In the discussion which followed, several men of distinction took part. Prof. William Thomson, of Glasgow (Lord Kelvin), wrote, referring to the results of Joule and Scoresby: "These facts were of the highest importance in estimating the applicability of electromagnetism, as a motive power, in practice; and, indeed, the researches alluded to rendered the theory of the duty of electromagnetic engines as complete as that of the duty of water-wheels was generally admitted to be. Among other conclusions which might be drawn from these experiments was this: that, until some mode of producing electricity as many times cheaper than that of an ordinary galvanic battery as coal was cheaper than zinc, electromagnetic engines could not supersede the steam-engine." Mr. W. R. Grove (Lord Justice Sir William Grove) remarked that a practical application of the science appeared to be still distant. The great desideratum, in his opinion, was not so much improvement in the machine as in the prime mover, the battery, which was the source of power. At present the only available use for this power must be confined to special purposes where the danger of steam and the creation of vapour were sought to be avoided, or where economy of space was a great consideration. Prof. Tyndall agreed with the last speaker, but suggested that there might be some way of mitigating the apparent diminution of power due to the induction of opposing electromotive forces in the machine itself. Mr. C. Cowper spoke of some experiments, made by himself and Mr. E. A. Cowper, showing the advantage gained by properly laminating the iron cores used in the motor. He put the cost of electric power at 4*l.* per horse-power per hour. He deprecated building electric motors with reciprocating movements and cranks; described the use of silver commutators; and mentioned the need of adjusting the lead given to the contacts. There was, he said, no reason to suppose that electric motors could be made as light as steam-engines. Even in the case of small motors of one-tenth or one-hundredth of a horse-power, for light work, where the cost of power was of small consequence, a boy or a man turning a winch would probably furnish power at a cheaper rate. Mr. Alfred Smee agreed that the cost would be enormous for heavy work. Although motive power could not at present be produced at the same expense on a large scale by the battery as by coal, still they were enabled readily to apply the power at any distance from its source; the telegraph might be regarded as an application of motive power transmitted by electricity. Mr. G. P. Bidder considered that there had been a lamentable waste of ingenuity in attempting to bring electromagnetism into use on a large scale. Mr. Joule wrote to say that it was to be regretted that in France the delusion as to the possibility of electromagnetic engines superseding steam still prevailed. He pointed out, as a result of his calorimeter experiments, that if it were possible so to make the electric engine work as to reduce the amount to a small fraction of the strength which it had when the engine was standing still, nearly the whole of the heat (energy) due to the chemical action of the battery might be evolved as work. The less the heat evolved, as heat, in the battery, the more perfect the economy of the engine. It was the lower intensity of chemical action of zinc as compared with carbon, and the relative cost of zinc and coal, which decided so completely in favour of the steam-engine. Mr. Hunt, replying to the speakers in the discussion, said that his endeavour had been to show that the impossibility of employing electromagnetism as a motive power lay with the present voltaic battery. Before a steam-engine could be considered, the boiler and furnace must be considered. So likewise must the battery if electric power were to become economical. Then the President, Mr. Robert Stephenson, wound up the discussion by remarking that there could be no doubt that the application of voltaic electricity, in whatever shape it might be developed, was entirely out of the question, commercially speaking. The mechanical application seemed to involve almost insuperable difficulties. The force exhibited by electromagnetism, though very great, extended through so small a space as to be practically useless. A powerful magnet might be compared to a steam-engine with an enormous piston, but with exceedingly short stroke; an arrangement well known to be very undesirable.

In short, the most eminent engineers in 1857 one and all condemned the idea of electric motive power as unpractical and commercially impossible. Even Faraday, in his lecture on "Mental Education" in 1854, had set down the magneto-electric engine along with mesmerism, homœopathy, odylism, the caloric engine, the electric light, the sympathetic compass, and perpetual motion as coming in different degrees amongst "subjects uniting more or less of the most sure and valuable investigations of science with the most imaginary and unprofitable speculation, that are continually passing through their various phases of intellectual, experimental, or commercial development, some to be established, some to disappear, and some to recur again and again, like ill weeds that cannot be extirpated, yet can be cultivated to no result as wholesome food for the mind."

Fifty Years Later.

Fifty years have fled, and Hunt, Grove, Smee, Tyndall, Cowper, Joule, Bidder, and Stephenson have long passed away. Lord Kelvin remains the sole and honoured survivor of that remarkable symposium. But the electric motor is a gigantic practical success, and the electric motor industry has become a very large one, employing thousands of hands. Hundreds of factories have discarded their steam-engines to adopt electric-motor driving. All travelling cranes, nearly all tramcars, are driven by electric motors. In the Navy and in much of the merchant service the donkey-engines have been replaced by electric motors. Electric motors of all sizes and outputs, from one-twentieth of a horse-power to 8000 horse-power, are in commercial use. One may well ask: What has wrought this astonishing revolution in the face of the unanimous verdict of the engineers of 1857?

The answer may be given in terms of the action and reaction of pure and applied science. Pure science furnished a discovery; industrial applications forced its development; that development demanded further abstract investigation, which in turn brought about new applications. It was beyond all question the development of the dynamo for the purposes of electrotyping and electric light which brought about the commercial advent of the electric motor. For about that very time Holmes and Siemens and Wilde and Wheatstone were at work developing Faraday's magneto-electric apparatus into an apparatus of more practical shape; and the electric lighthouse lamp was becoming a reality which Faraday lived to see before his death in 1867. That eventful year witnessed the introduction of the more powerful type of generator which excited its own magnets. And even before that date a young Italian had made a pronouncement which, though it was lost sight of for a time, was none the less of importance. Antonio Pacinotti in 1864 described a machine of his own devising, having a specially wound revolving ring-magnet placed between the poles of a stationary magnet, which, while it would serve as an admirable generator of electric currents if mechanically driven, would also serve as an excellent electric motor if supplied with electric currents from a battery. He thereupon laid down the principle of reversibility of action, a principle more or less dimly foreseen by others, but never before so clearly enunciated as by him. And so it turned out in the years from 1860 to 1880, when the commercial dynamo was being perfected by Gramme, Wilde, Siemens, Crompton, and others, that the machines designed specially to be good and economical generators of currents proved themselves to be far better and more efficient motors than any of the earlier machines which had been devised specially to work as electromagnetic engines. Moreover, with the perfection of the dynamo came that cheap source of electric currents which was destined to supersede the battery. That a dynamo driven by a steam engine furnishing currents on a large scale should be a more economical source of current than a battery in which zinc was consumed, does not appear to have ever occurred to the engineers who, in 1857, discussed the feasibility of electric motive power. Indeed, had any of them thought of it, they would have condemned the suggestion as chimerical. There was a notion abroad—and it persisted into the 'eighties—that no electric motor could possibly have an efficiency higher than 50 per cent. This notion, based on an erroneous understanding of the theoretical investigations of Jacobi, certainly delayed the progress of events. Yet the clearest heads of the time understood the matter more truly. The true law of efficiency was succinctly stated by Lord Kelvin in 1851, and was recognised by Joule in a paper written about the same date. In 1877 Mascart pointed out how the efficiency of a given magneto-electric machine rises with its speed up to a limiting value. In 1879 Lord Kelvin and Sir William Siemens gave evidence before a Parliamentary Committee as to the possible high efficiency of an electric transmission of power; and in August of the same year, at the British Association meeting at Sheffield, the essential theory of the efficiency of electric motors was well and admirably put in a lecture by Prof. Ayrton. In 1882 the present author designed, in illustration of the theory, a graphic construction, which has been ever since in general use to make the principle plain. The counter-electromotive force generated by the motor when running, which Hunt and Tyndall deplored as a defect, is the very thing which enables the motor to appropriate and convert the energy of the battery. Its amount relatively to the battery's own electromotive force is the measure of the degree to which the energy which would otherwise be wasted as heat is utilised as power. Pure science stepped in, then, to confirm the possibility of a high efficiency in the electric motor *per se*. But pure science was also brought into service in another way. An old and erroneous notion, which even now is not quite dead, was abroad to the effect that the best way of arranging a battery was so to group its component cells that its internal resistance should be equal to the resistance of the rest of the circuit. If this were true, then no battery could ever have an efficiency of more than 50 per cent. It was supposed in many quarters that this misleading rule was applicable also to the dynamo. The dynamo makers discovered for themselves the fallacy of this idea, and strove to reduce the internal resistance of the armatures of their machines to a minimum. Then the genius of the lamented John Hopkinson led him to apply to the design of the magnetic structure of the dynamo abstract principles upon which a rational proportioning of the iron and copper could result. A similar investigation was independently made by Gisbert Kapp, and between these accomplished engineers the foundations of dynamo design were set upon a scientific basis. To the perfection of the design the magnetic studies of our ex-President, Prof. Ewing, contributed a notable part, since they furnished a basis for calculating out the inevitable losses of energy in armature cores by hysteresis and parasitic currents in the iron when subjected to recurring cycles of magnetisation. Able constructive engineers, Brown, Mordey, Crompton, and Kapp, perfected the structural development, and the dynamo within four or five years became, within its class, a far more highly efficient machine than any steam engine. And as by the principle of reversibility every dynamo is also capable of acting as a motor, the perfection of the dynamo implied the perfection, both scientific and commercial, of the motor also. The solution in the 'eighties of the problem how to make a dynamo to deliver current at a constant voltage when driven at a constant speed, found its counterpart in the solution by Ayrton and Perry of the corresponding problem how to make a motor which would run at constant speed when supplied with current at a constant voltage. Both solutions depend upon the adoption of a suitable compound winding of the field magnets.

A little later alternating currents claimed the attention of engineers; and the alternating current generator, or "alternator," was developed to a high degree of perfection. To perfect a motor for alternating currents was not so simple a matter. But again pure science stepped in, in the suggestion by Galileo Ferraris of the extremely beautiful theorem of the rotatory magnetic field, due to the combination of two alternating magnetic fields equal in amplitude, identical in frequency and in quadrature in space, but differing from each other by a quarter-period in phase. To develop on this principle a commercial motor required the ingenuity of Tesla and the engineering skill of Dobrowolsky and of Brown: and so the three-phase induction motor, that triumph of applied science, came to perfection. Ever since 1891, when at the Frankfort Exhibition there was shown the *tour de force* of transmitting 100 horse-power to a distance of 100 miles with an inclusive efficiency of 73 per cent., the commercial possibility of the electric transmission of power on a large scale was assured. The modern developments of this branch of engineering and the erection of great power-stations for the economic distribution of electric power generated by large steam plant or by water-turbines are known to all engineers. The history of the electric motor is probably without parallel in the lessons it affords of the commercial and industrial importance of science.

But the query naturally rises: If a steam-engine is still needed to drive the generator that furnishes the electric current to drive the motors, where does the economy come in? Why not use small steam-engines, and get rid of all intervening electric appliances? The answer, as every engineer knows, lies in the much higher efficiency of large steam-engines than of small ones. A single steam-engine of 1000 horse-power will use many times less steam and coal than a thousand little steam-engines of 1 horse-power each, particularly if each little steam-engine required its own little boiler. The little electric motor may be designed, on the other hand, to have almost as high an efficiency as the large motor. And while the loss of energy due to condensation in long steam-pipes is most serious, the loss of energy due to transmission of electric current in mains of equal length is practically negligible. This is the abundant justification of the electric distribution of power from single generating centres to numerous electric motors placed in the positions where they are wanted to work.

Education and Training of Engineers.

Interplay of action and reaction make for progress not only in the evolution of the scientific industries, but also in the development of the individual engineer. In him, if his training is on right lines, pure theory becomes an aid to sound practice; and practical applications are continually calling him to resort to those abstractions of thought, the underlying principles, which when known and formulated are called theories. Recent years have brought about a so much better understanding of education, in its bearing upon the professions and constructive industries, that we now seldom hear the practical man denouncing theory, or the theorist pooh-poohing practice. It is recognised that each is useful, and that the best uses of both are in conjunction, not in isolation. As a result of this better understanding distinct progress is being made in the training of engineers. Of this the growth of the engineering departments of the universities, and of the technical colleges and schools, affords striking evidence. The technical schools, moreover, are recognising that their students must have a sound preliminary education, and are advancing in the requirements they expect of candidates for admission. They are also finding out how their work may best supplement the practical training in the shops, and are improving their curricula accordingly. In the engineering industry, too, Great Britain is slowly following the lead taken in America, Germany, and Switzerland, in the recognition afforded to the value of a systematic college training for the young engineer, though there is still much apathy and even distrust shown in certain quarters. Yet there is no doubt that the stress of competition, particularly of competition against the industry and the enterprise of the trained men of other nations, is gradually forcing to the front the sentiment in favour of a rational and scientific training for the manufacturer and for the engineer. As William Watson, in his "Ode on the Coronation," wrote in a yet wider sense of England:—

> For now the day is unto them that know,
> And not henceforth she stumbles on the prize:
> And yonder march the nations full of eyes.
> Already is doom a-spinning. . . .

Truly the day is "unto them that know." Knowledge, perfected by study and training, must be infused into the experience gained by practice: else we compete at very unequal odds with the systematically trained workers of other nations. Nor must we make the mistake here in the organisation of our technical institutions of divorcing the theory from its useful applications. In no department is this more vital than in the teaching of mathematics to engineering students. For while no sane person would deny that the study of mathematics, for the sole sake of mathematics, even though it leads to nothing but abstract mathematics, is a high and ennobling pursuit, yet that is not the object of mathematical studies in an engineering school. The young engineer must learn mathematics not as an end in itself, but as a tool that is to be useful to him. And if it is afterwards to be of use to him, he must learn it by using it. Hence the teacher of mathematics in an engineering school ought himself to be an engineer. However clever he be as a mathematical person, his teaching is unreal if he is not incessantly showing his learners how to apply it to the problems that arise in practice; and this he is incapable of doing if these problems do not lie within his own range of experience and knowledge. Were he a heaven-born senior wrangler, he is the wrong man to teach mathematics if he either despises or is ignorant of the ways in which mathematics enter into engineering. The fact is that for the great majority of engineering students, the mental training they most need is that which will enable them to think in physics, in mechanics, in geometric space, not in abstract symbols. The abstract symbols, and the processes of dealing with their relations and combinations, are truly necessary to them: but they are wanted not for themselves, but to form convenient modes of expressing the physical facts and laws, and the interdependence of those physical facts and laws. When the student loses grip of the physical meaning of his equations, and regards them only as abstractions or groupings of symbols, woe betide him. His mathematics amount to a mere symbol-juggling. That is how paper engineers are made. The high and dry mathematical master who thinks it beneath him to show a student how to plot the equations $y=A \sin x$, or $r=b \sin \theta$, or who never culls an example or sets a problem from thermodynamics or electricity, must be left severely on one side as a fossil. Better a living Whitworth scholar than a dry-as-dust Cambridge wrangler. He at least knows that elasticity is something more real than the group of symbols $E=p \div \frac{\Delta x}{x}$, which any mathematician may "know," even though he be blissfully ignorant whether the force required to elongate a square-inch bar of steel by one one-millionth of its length is ten ounces or ten tons.

One evidence of the wholesome change of opinion that is springing up concerning the training of engineers is the abandonment of the system of taking premium pupils into works with no other test or qualification than that of the money-bag. Already many leading firms of engineers have been finding that the practice of taking sons of wealthy parents for a premium does not answer well, and is neither to their own advantage nor in many cases to that of the "pupil," whom it is nobody's particular business in the shops to train. Premium pupilage is absolutely unknown in the engineering firms of the United States or on the Continent of Europe. The firms who have abandoned it are finding themselves better served by taking the ablest young men from the technical schools and paying them small wages from the first, while they gain experience and prove themselves capable of good service. Messrs. Yarrow and Co. have led the way with a plan of their own, having three grades of apprenticeship, admission to which depends upon the educational abilities of the youths themselves. Messrs. Siemens have adopted a plan of requiring a high preliminary training. The Daimler Motor Company has likewise renounced all premiums, preferring to select young men of the highest intelligence and merit. Messrs. Clayton and Shuttleworth have quite recently reconstructed their system of pupil-apprenticeship on similar lines. The British Westinghouse Company and the British Thomson-Houston Company have each followed an excellent scheme for the admission of capable young men. Even the conservatism of the railway engineers shows signs of giving way; for already the Great Eastern Railway has modernised its regulations for the admission of apprentices. What the engineering staffs of the railway companies have lost by taking in pupils because of their fathers' purses rather than for the sake of their own brains it is impossible to gauge. But the community loses too, and has a right to expect reform.

To this question, affecting the whole future outlook of engineering generally, a most important contribution was made in 1906 by the publication by the Institution of Civil Engineers of the report of a committee (appointed in November, 1903) to consider and report to the Council upon the subject of the best methods of education and training for all classes of engineers. This Committee, a most influential and representative body consisting of leading men appointed by the several professional societies, the Institutions of Civil, Mechanical, and Electrical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Institution of Gas Engineers, the Institution of Mining Engineers, and two northern societies, was ably and sympathetically presided over by Sir William H. White. Its inquiries lasted over two years and included the following sections: (1) Preparatory Training in Secondary Schools; (2) Training in Offices, Workshops, Factories, or on Works; (3) Training in Universities and Higher Technical Institutions; (4) Post-graduate Work. The findings of this Committee must be received as the most authoritative judgment of the most competent judges. So far as they relate to preparatory education they suggest a modernised secondary school curriculum in which there is no one specialised scientific study, but with emphasis on what may be called sensible mathematics. They also formulated one recommendation so vital that it must be quoted in full:—

"A leaving examination for secondary schools, similar in character to those already existing in Scotland and Wales, is desirable throughout the United Kingdom. It is desirable to have a standard such that it could be accepted by the Institution [of Civil Engineers] as equivalent to the Studentship Examination, and by the Universities and Colleges as equivalent to a Matriculation Examination."

One may well wonder why such a reasonable recommendation has not long ago been carried out by the Board of Education. Perhaps it has been too busy over the religious squabble to attend to the pressing needs of the nation.

The second set of recommendations relates to engineering training. It begins with the announcement that "long experience has led to general agreement among engineers as to the general lines on which practical training should proceed"; but goes into no recommendations on this head beyond favouring four years in workshops, on works, in mines, or in offices, expressing the pious desire that part of this practical training should be obtained in drawing-offices, and suggesting that during workshop-training the boys should keep regular hours, be subject to discipline, and be paid wages. It then lays down a dozen recommendations as to the "academic" training suitable for the average boy. He should leave school about seventeen; he should have a preliminary year, or introductory workshop course of a year, either between leaving school and entering college, or after the first year of college training. If the workshop course follows straight on leaving school there must be maintenance of studies either by private tuition or in evening classes, so that systematic study be not suspended. For the average student, if well prepared before entering College, the course should last three academic years (three sessions); in some cases this might be extended to four or shortened to two. A sound and extensive knowledge of mathematics is necessary in all branches of engineering, and those departments of mathematics which have no bearing upon engineering should not claim unnecessary time or attention. The Committee strongly recommends efficient instruction in engineering drawing. The college course should include instruction (necessarily given in the laboratory) in testing materials and structures, and in the principles underlying metallurgical processes. In the granting of degrees, diplomas, and certificates, importance should be attached to laboratory and experimental work performed by individual students, and such awards should not depend on the results of terminal or final examinations alone.

All this is most excellent. It will be seen that it is entirely incompatible with the premium-pupil system, which may therefore be regarded as having been weighed and found wanting. For two things clearly stand out; that the young engineer must be college-trained, and that when he goes to works he should be regularly paid. It would have been well if the Committee could have been more explicit as to the proper course of workshop training; for instance as to the systematic drafting of the young engineer through the shops—forge, foundry, pattern-shop, fitting-shop, &c., and as to the proper recognition of the duty of the shop-foreman to allocate work to the novice in suitable routine. These are doubtless among the matters in which "long experience has led engineers to general agreement." But this being so, it would have been well to state them authoritatively. A notable feature of this report is its healthy appreciation of the advantages of training, and an equally healthy distrust of the practice of cramming for examinations. So soon as any subject is crammed, it ceases to afford a real training. "Nature provides a very convenient safety-valve for knowledge too rapidly acquired." It is even whispered that a new species of crammer has arisen to "prepare" candidates in engineering for the graduate examinations of the Institution of Civil Engineers. The distinguished framers of this epoch-making report on the education and training of engineers at least give no countenance to any such parasitical development. For the scheme of education and training at which the Committee has aimed is genuinely scientific, a happy federation of the theoretical with the practical. It seeks to place the training on a broad basis, and to secure to every future engineer worthy of the name the advantage of learning his professional work in both its aspects. It seeks, in short, to take advantage of that reflex action between science and its applications in which lies the greatest stimulus to progress. Its adoption will utilise for the young engineer, and therefore for the engineering industry as a whole, the facilities for training now so widely afforded throughout the country. If the institutions, schools, and colleges where engineering training is offered are but rightly developed and co-ordinated, the engineers of Great Britain need have no fear as to holding their own against the trained engineers of other countries. It is for the employers to make use of these institutions, and to show that sympathetic interest in their efficiency which is essential to their full success.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY D. G. HOGARTH, M.A., PRESIDENT OF THE SECTION.

Religious Survivals.

THE science of Anthropology, from its very nature, seldom touches the beliefs or customs of the higher actual civilisations; but exceptions occur when it enters the field of comparative religion. In coming to the aid of this fascinating study it can hardly help offending, sooner or later, certain prejudices which are deeply rooted and widely distributed, and that not only when it really contravenes the beliefs of pious minds, but, often enough, when its exponents neither wish to impair these beliefs, nor, as a matter of fact, are taking any steps to do so; for the opposition which meets science when it concerns itself with religion is very frequently arrayed before the opponent has taken the time or the trouble to ascertain whether anything vital or essential is concerned in the investigation. At any rate it will be allowed that the majority of the treatises on this study written in the English tongue do not, by any lack of reverent treatment or by any obvious oblivion of the responsibility resting on those who inquire into the religious basis of our social order, display any desire to offend. But just because some offence must almost inevitably be given, even by the most reverent anthropologist, in pursuing investigations which involve examination of actual pious beliefs, it is especially incumbent on students of this particular subject to proceed only along the most strictly judicial lines, careful not to force a conclusion from evidence which is in any respect dubious or even incomplete; and, moreover, to be quite clear in their own minds and to make it clear to others how far their investigation really touches actual religion in vital and essential points of belief as distinguished from mere points of observance or ritual, *i.e.*, religious accidents, as they might be called. Obvious as this caution may seem, neglect of it is very general, and has led to much needless suspicion of Anthropology as a science with covert and far-reaching purpose, subversive of all religion.

It is in the interests of definition and clearness in a controversial topic among the religious inquiries of anthropologists that I have chosen my theme to-day. I have small claim to expound the science, as usually understood, to which this Section is devoted, whether on its physical or on its social side, so far as the latter is principally concerned with actual custom and folklore. But as one who has spent more than twenty years in studying the ancient life of that region of the world in which three of the greatest actual systems of religion were developed, and a good part of his time among the modern peasantry of the region itself, I have had my attention particularly directed to the evolution of religious beliefs and observances during long periods of time, which are unusually well illuminated for us from first to last by the light of both monuments and literature; and that attention has often been arrested by striking instances of *cultus* continuity under successive religious systems or dispensations. I enjoyed the advantage of beginning travel in the Nearer East in the company of the acute observer who is now Sir William Martin Ramsay, and to his comments on what we saw together in the Phrygian highlands as long ago as 1887 I owe much of my earliest interest in the question of religious survival and my direction towards the lines on which I have since tried to study it. Some day let us hope that, prompted by such a lectureship as the Gifford Foundation, or encouraged by some discerning publisher, Sir William Ramsay may collect from his many books the observations scattered here and there upon the religious elements which survived from Anatolian heathendom into both Christian and Moslem observance, and adding to them others from the storehouse of his memory and his notebooks, produce a volume parallel to that "Religion of the Semites" which is the abiding memorial of his dead friend and ally.

I have called "Religious Survivals" a controversial topic. That is to put it mildly. Indeed, few anthropological topics generate so much heat. In addition to a common distaste with which one may sympathise, even if one does not share it, manifested by many reverent minds for all objective discussion of things religious, this topic challenges a certain very widespread prejudice, as irrational as it is strong—namely, the prejudice against the inclusion of orthodox religious beliefs and observances under the general maxim, "There is nothing new under the sun." The more sacred a man holds anything the less will he believe that evolution has had anything to do with it—evolution with its inevitable implication of embryonic and imperfect stages. The Athenian loved to think that the great patron goddess of his city sprang fully grown and fully armed from the head of the King of heaven. The devotees of all creeds have wished to believe that when the first founders of systems proclaimed their missions the old things passed away like a burning scroll and a wholly new earth and heaven began. Nothing is more repugnant to the ordinary orthodox Moslem than the suggestion that the Prophet borrowed theology and doctrine from earlier Semitic systems, notably the Hebraic, and that much of the ceremonial and observance now followed by the faithful in their most religious moments, those of the Meccan pilgrimage, survive from the times of ignorance. Yet what contentions are less controvertible in fact than these? The devotee can believe that every detail of a new dispensation was known from all time in heaven, but will refuse to allow that anything can have been known on earth. With that direct revelation which he thinks to have been vouchsafed at a given moment from on high, the slate of time must have been wiped clean of all previous religious thought and practice. I do not, of course, speak for one moment of the enlightened and scholarly doctors of our own creed or any other. These have always seen and often stated that the religious systems by which they hold have assimilated much from systems of earlier date; nor in admitting that have they found their faith take any harm.

How natural and compelling, however, is the prejudice in question may be estimated by the fact that it is extended to dispensations in other fields than the religious. For example, that message to civilisation which it was given to the pagan Hellene to deliver does not admit in the view of certain devout Hellenists of the view that the Greek artistic sense had any pedigree in pre-classical times. They resent as an insolent innuendo the contention that what is essential in the Greek spirit can be detected in the work of peoples living in the Hellenic area long before the rise of classic Hellenic art, and that from these peoples and from others who possessed older civilisations the fabric of Hellenism was built up in strata, which can still be observed, and referred to their pre-Hellenic authors. So close akin is *odium archæologicum* to *odium theologicum*! Yet, perhaps, in this case they are really one and the same, for perfervid Hellenism is the last half-conscious protest of the Western peoples of Europe against the dominance of an Asiatic religion.

Irrational is this prejudice in the first degree of course, because not only have we the clearest historical evidence that in our own religious practice, as in that of other races, details of earlier ritual and observance have survived, often by conscious and intentional adoption, but also, as Robertson Smith well said, "experience shows that primitive religious beliefs are practically indestructible, except by the destruction of the race in which they are ingrained." All apostles of new creeds have had to preach to and gain the adherence of societies which they could not hope to lead to a perfect way all at once or even in centuries of time, and all have had to take account of the pre-existing habits of religious thought and actual expressions of religious feeling, and by accepting some compromise to modify these to their purpose. And if this be obviously true of those societies which such an apostle as Mohammed could influence directly and retain under some sort of personal control, what must we say of the societies to which the truth only came at second hand or by many more degrees removed from the original prophetic utterance? What of the remote or scattered folk to whom it came not at all till after a long interval, and then faint and confused as a reverberating echo? For these at least there was no possibility of such utter change as revelation working through the human agency of a magnetic personality may have effected elsewhere; and of their belief and their practice much, perhaps the most, has remained primæval and local, and as the physical conditions of their life have prompted it from all time to be, and prompt still.

All this stratification in religious belief and practice it is the function of Anthropology to investigate; and thereby it may render no small service to religion itself by distinguishing accidental elements in ritual and observance which have persisted from systems worn out and abandoned. But while proclaiming that this investigation is not only legitimate but necessary, I wish to-day to utter a note of warning against a certain confusion of thought which is often manifested by the investigators in this particular field, and is apt to occasion unfortunate ethical consequences or, at the best, unnecessary scandal. It finds expression in the grouping of all the elements in belief, observance, and ritual, which have persisted from earlier systems to later, under one head as religious survivals, without due account being taken of very vital differences, both in their essential nature and in the history and reason for their persistence. The word "survival" itself is *per accidens* not a very fortunate one. Though in the broad sense perfectly appropriate to all things that persist, it has acquired in our modern speech, largely from its use in medical science, a certain particular connotation of opprobrious import. It suggests something which has lost its useful purpose, and is effete or even dead, persisting among living organisms usually to their detriment. Such is the sense in which many anthropologists seem to use the word in speaking of religious persistences without discriminating between divers kinds of these; and such, still more often, is the connotation which their readers attach to the word in this connection. Yet all religious persistences are not survivals in this pathological sense—nay, the class to which this connotation is suitable includes but a small proportion of the whole. It is to distinguishing these classes of survivals that I propose to address myself in the remainder of the time which is allotted to me to-day.

In the first place there is a most numerous and important body of religious persistences which ought not to be called survivals at all, if that word be used, as it usually is, with a causative implication; that is to say, there are elements of belief and practice the existence of which in actual cult is not necessarily due at all to the fact that they, or something very closely akin, existed in a previous cult. If religion is the expression of the instinctive desire of man to find an intelligible relation between his own nature and a nature which transcends its limitations, he appears unable to establish that relation by other than a very small and definite number of conceptions; and among certain races, and indeed in certain geographical areas, those conceptions seem not to vary over immense spaces of time and under successive dispensations. The just way to regard them, therefore, is as falling within categories of thought inevitably imposed on the human mind by its humanity and necessary conditions of any religious sense whatever. Man does not form these conceptions because his predecessors formed them, nor indeed because his contemporaries hold them; but because, as an individual limited by race and environment, he cannot otherwise satisfy his religious instinct. How important this class is, and how much it includes which has often been discussed by anthropologists under the head of religious survival, may be judged if we recall that there falls under it such an article of belief as the Incarnation of God with all its consequences of expression—the immaculate conception, atoning death, and bodily resurrection. Neither this belief nor any of its expressions, I need hardly say, make their appearance for the first time in Christianity. They are to be recognised as forms—necessary categories of creed if you will—under which races of the Nearer East and of other regions of the world also have conceived the relation between the human and the divine as far back as we know anything of their history. But since anthropological knowledge concerning this delicate and difficult instance has been set forth lately in full detail by a distinguished student of religious persistences, Mr. J. G. Frazer, in his "Adonis, Attis, and Osiris," I feel no obligation to deal with it further than to remind you that, apart from all question whether Christian tradition states historical facts in this matter, nothing which Anthropology has collected in the way of comparative facts from other creeds serves to place either this belief or its form of expression among religious survivals in the narrower sense—that is to say, among religious elements which appear in Christianity merely because they existed in earlier religions. Much accidental circumstance has beyond doubt attached itself to this Christian tenet from the previous cult observances and ritual of the many races which it has convinced; and to certain of these I shall call attention presently when I come to deal with another class, more properly to be called religious survivals; but as for the essentials of the belief, they have as much right to be regarded as independent conceptions of Christianity, despite their earlier appearance in other religions, as history proclaims them to have been endued by Christianity with a wholly new ethical significance.

But in order to fortify my generalities with a particular example, I may be allowed to deal in brief detail with another, though related, religious conception of the same class, which has not been so exhaustively treated by anthropologists. As a student of Mediterranean races and a frequent observer of their actual representatives, I have often been struck by the persistent dominance of femininity in their conception of the Divine, and equally by the distinction which that fact makes between their instinctive creeds and those of other races domiciled contiguous to them, but round an outer radius. In fact, it would not be difficult to draw a broad frontier line at a certain distance inland round the Mediterranean area from the Atlantic to the African deserts, within which a Goddess has always reigned supreme in the hearts of the unsophisticated folk, with a God occupying only a subordinate, and often demonstrably a less primæval, throne; while without it the God has been dominant and feminine divinity secondary. Within the frontier lie the peninsular and other littoral districts with a broad *hinterland* of mountainous or hilly regions. With the great continental plains begins the outer and contrasted circle. The predominance of a great Nature Goddess among all the races of the East Mediterranean basin in the earliest historic time is well known; and to what had been ascertained of her among the Semites, under her many names, Tanith, Al-Lat, Baalit, Ishtar, Atta, Ashtaroth—these last but variants of one appellation; among the Nilotic peoples also under many names, e.g., Neith and Isis; among the Anatolian races as the Great Mother, Kybele, Ma, and the unknown "Hittite" title; among the historic inhabitants of Greece and the Ægean as Rhea, Artemis, Britomartis, and a score of other appellations; among the Italic tribes, as Diana or local variants, there has been added latterly the discovery that a Goddess of character and attributes, readily to be compared with those of the Nature deity in various parts of the surrounding area, was dominant in the religion of that important artistic race which occupied the Ægean in the prehistoric age, and had so much influence on the momentous civilisation of its later time—that race which has been rescued from long oblivion by Schliemann in Greece and Troy, and by Evans and others in the Isles. The more we learn of this great Nature- or Mother-Goddess, the more primæval and predominant is the position she is seen to hold. All round the Eastern Mediterranean she was before all created things: she became the mother of a son by spontaneous generation or some other process independent of the male—an idea, it may be remarked, which presents no impossiblity to the minds of very primitive races, some of whom even at this day do not connect fertilisation and conception as cause and effect. With her son she produced all life: she gave her son to the humanity so created, and humanity killed him that it might live; he revived and returned again to his mother, was again killed, and so the cycle of the seasons revolved. So far as concerns Him in all his *avatars* Mr. Frazer's book may be consulted. As for Her, a Woman still holds the same place in the religious belief of the old races of the same region, wherever they have escaped assimilation by conquering races and faiths from beyond the border. Hear any Greek or Italian peasant in a moment of excitement or danger. He calls on no Person of the Trinity, but on the Virgin. For him her power does not come from her Motherhood of her Son. Indeed, I have known Christian countrymen of a West Anatolian valley to whom that motherhood was evidently unknown, and when spoken of remained without interest or significance. She is a self-sufficient, independent embodiment of divinity, to whom the ruder folk of Mediterranean lands offer their prayers and pay their vows alone. She and no other is beseeched to grant increase and fertility; she and no other is credited with the highest direction of human affairs. But to say, as so often is said, that, for instance, in Greek lands the Panaghiá is simply a survival of Artemis or Aphrodite under another name, is to convey a false impression. She stands for the same principle of divinity as they; she has taken on, as I shall point out presently, even the feasts and the ritual of her predecessor; and she has often made peculiarly her own the spots especially sacred to the earlier Mother-Goddess. But, as I take it, she is not worshipped now in Ephesus or Cyprus merely because there was once a dominant cult of Artemis or Aphrodite in those places, but because to the peoples of a wide Mediterranean region it is still, as it always was, a religious necessity to embody their idea of divinity in the feminine; and I would state the relation of the Christian Virgin-Goddess to the pagan one rather in this way—that, coming from without, she gained acceptance at once for herself, and probably also, in a great measure, gained acceptance for the whole creed with which she was connected, because she offered a possible personification of the same principle which had always been dominant in the local religion.

Why that principle was so deeply rooted in the peoples of this particular region I cannot pretend precisely to say. To ascribe it, as has been suggested, to the original prevalence of *Mutterrecht* is probably to mistake effect for cause. The principle has its roots deeper down than even the matriarchal system. In a general way we may hold it the result of a peculiar mental concentration upon the idea of generation and reproduction of life, upon the increase of man, the brute creation, and the earth. In these processes the more obvious part played by the female in Nature inevitably tends among primitive peoples, who are comparatively peaceful and more of agriculturists and herdsmen than warriors or hunters, to make woman seem the sole condition of their being and the predominant arbiter of their destinies. More we can hardly say. We cannot determine whether there were peculiar geographical conditions in the dawn of time, which, either in some other home or in the Eastern Mediterranean region itself, predisposed the ancestors of the actual races of the latter to this cult of the reproductive force. One can but bear witness that at the present day this idea is an obsession of these inhabitants wherever they remain in a comparatively simple state of society. All their thoughts, their prayers, and their actions seem to be inspired by it, and of all their thoughts, their prayers, and their actions—so far as they have not been warped to the Father-God of the Southern Semites by the armed pressure of an alien folk from the warlike steppes of Northern Asia—Mary, the Panaghiá, is the focus.

In her essential identification with the religious sense of these peoples, therefore, the Virgin is no mere survival. But in an accidental or secondary sense her actual personality may, perhaps, be so regarded in the region in question if we are careful to exclude from the word all connotation of superfluity or decaying energy. Her cult may be brought under that body of beliefs, observances, and practices which have demonstrably passed from earlier religious system to later by processes of transference, usually unconscious, but often half-conscious, and undoubtedly in some cases wholly conscious. Where the process has been unconscious or half-conscious these beliefs, observances, and practices have survived in the new system because the religious sense of the masses felt instinctively that they were necessary to its expression. They cannot therefore be regarded as survivals with any implication of decay or death. They were necessities under the former system; they remained necessities under the later, and may be living forces and vital expressions of the human desire for relation with the divine under the new as much as under the old. Where the process has been conscious a popular demand for their survival as necessities has been appreciated by leaders of the system, and observances and forms of ritual have been consciously taken from the old system to express a principle still active under the new. Often we are in a position to know that the old beliefs, observances, and forms did not accord with the highest ideals of the most advanced professors of the new system, and that they came to be consciously adopted by compromise in the interests of the more rapid and permanent establishment of the latter among inferior intelligences. They were better than the worse, if not as good as the best. Of these Dr. Bigg is speaking in the preface to his book "The Church's Task under the Roman Empire" when he says, "The most significant changes in history were not imposed upon the Church by the bishops from above, but forced upon the bishops by the pressure of popular opinion from below." A well-known example is supplied by the early history of Islam, when the Prophet, having learned in exile at Medina, what many of his apostles have since had to learn, that the Semitic masses could not be weaned to a perfectly spiritual system, came to terms with the primæval worship of the Arabian Goddess in Mecca and displaced her personality by retaining many expressions of the popular cult of her; and, as so often has happened in similar cases of religious transference, those expressions remaining to this day the most strictly observed by Moslems, testify still to the vitality of the religious necessity which lay and lies behind them. And not only the early history of Islam, but the early history of Christianity offers instances of such conscious transference, some of which may be read of in Sir William Ramsay's works, *e.g.*, in "The Church in the Roman Empire," where he deals with that strange story of Glycerius the Cappadocian deacon, who broke out at a certain great gathering of Christians at Venasa, one of the holiest of the pagan high places of the land, and revived the former orgiastic form of cult by leading a band of enthusiastic maidens dancing and singing through the hills to the glory of Christ crucified. Condemned in haste by the stern Basil of Cæsarea, the recalcitrant deacon found an apologist and a protector in no less saintly a priest than Gregory of Nazianzos, who knew better than his Metropolitan how real and deep a local religious instinct lay beneath this scandalous manifestation, and how much better it were to bend to the service of the Church, than to break, the religious zealots who had expressed it. Another curious collection of such transferences may be found in a recent work of Mr. Rendel Harris, which he entitled "The Heavenly Twins." Here are set out an immense number of facts and suggestions tending to show how the early Church adapted to its ends the cult of th Dioscuri or of similar twin gods known by other names both in the West and East, a cult which expressed a certain conception of the relation between human and divine, salutary and indeed necessary to many pagan minds. The book needs to be read in a critical spirit, for the author has been led on by the fascination of myth-interpretation to find his twin nature-gods wherever he turns to look for them; and often his reading of the legends is less convincing than would be (if it is allowed to use a frivolous instance in such a connection) a similar explanation applied to the story of Box and Cox—those obvious twins of Dark and Light who occupied, turn and turn about, their chamber, the World, under the benign influence of the landlady of the tale, a manifest Earth-Mother of mythology.

Many of the undoubted transferences which took place under the Christian system cannot at this time of day be certainly distinguished into the conscious and the unconscious. We know that saints of the Church have entered often into the honour and the local habitations of pagan deities. Mr. Frazer has told us how St. Felicita has replaced Mephitis, the heathen personification of the poisonous gas of the pool of Frigento, and how Adonis in Sicily and Sardinia lives on as St. John. These instances might be multiplied to many hundreds. We know, too, that almost all our stated ecclesiastical festivals are continuations of heathen feasts, so far as their dates and the general nature of their commemorative significance are concerned. What had to be changed has been changed, but not more. Christmas has succeeded to the festival of the winter solstice which celebrated the new birth of the Sun; Easter to the spring festival at which in many parts of the Mediterranean world the Nature-Goddess, and especially the death and resurrection of her Son, were commemorated. The Assumption of the Virgin replaces the August feast of Artemis and Diana in Greece and Italy. The anniversary of St. George, so great a day in modern Greece, seems to be the old Parilia; St. John the Baptist has taken on the heathen rites of midsummer, and you may see the folk of Smyrna, Christian and Moslem alike, jumping through fire to his honour on any St. John's Eve. Very rarely, as in the case of the Feast of All Souls, the late Christian adoption of which in the tenth century happens to be known, can we ascribe these transferences to any definite action of a leader of the Church. Usually we know no more than that where and when there was once a pagan saint or a pagan feast there are now saints and feasts of Christianity. But no reasonable person feels that the latter are discredited or lose anything of their actual significance by the fact of their having a pre-Christian pedigree. St. John may have succeeded to Adonis, but he is not Adonis. Christmas may be the heir of the Saturnalia, but it is the Saturnalia no longer. To feel that the sanctity of either is impaired by these facts is as if one were to refuse reverence to the art-types of early Christianity, because most unquestionably these were not invented fresh and new for the new religion. Why should they have been? If there were ready to hand images in pagan art, fit to express the early Christian ideas, it would have needed a miracle for the nascent Church to have invented new ones. The human creative faculty in matters of art is strictly limited as to types. Presentations of Apollo or Orpheus were used naturally for the new Christ, and those of the Nature-Goddess of Asia with her Son for the new Mother and Child. How else should gracious maternity have been represented? Last year I showed in this Section certain terra-cotta images of the Ephesian Goddess with her child, dated to the fourth century before Christ, which might easily have been mistaken for Madonna figures of the Italian Renaissance; and last winter I saw in a newly excavated Coptic chapel of the sixth century at Memphis a fresco painting of the Virgin suckling her Son which was indistinguishable from late representations of Isis.

As a matter of fact there is little fear that anthropologists in demonstrating the fact of transference in such categories of religious expression as these with which I have just been dealing will impair their religious efficiency. For, after all, how much is there not in the everyday expression of the religious sense among ourselves which has suffered a transference in time and space so obvious that no reflective mind can be unconscious of it? Consider only the religious phraseology current among the simplest Christians all that mass of images and ideas proper to an alien race and to the latitude and climate of the Mediterranean in which, for example, the Presbyterian of Scotland expresses the most pious of his aspirations. He sighs for the shadows of great rocks in a weary land, for the plash of running waters, for the shade of the fig and the vine; and, the most restless of men to whom all inaction is hateful, he aspires to a heaven floored with the crystal of Oriental imagery, where he shall for ever sit still. These ideas one meets at every turn, not only in religious, but in the secular, thoughts of every Oriental or South European. Among us they appear in religion only, known for manifest exotics, but not the less full of religious significance, even to the lease congruous Christian.

Ere I leave this second class of Survivals let me revert again for a moment to the cult of the Virgin in the Nearer East. It is possible, even probable, that Mary, the mother of Jesus, also owes her divine, or at least semi-divine, position in the Christian system to such a conscious effort by leaders of the Church as those to which we have just alluded. It is a well-known fact that neither the primary nor the secondary authorities for the first two centuries of Christianity supply any warrant for the position which she was to hold later. They are, in fact, almost silent about her. Nor has Christian archæology discovered any better evidence of her glorification above other holy women during that time. It seems established that it was not till the third century that she began to assume semi-divinity. By the fourth her position was sufficiently exalted to cause the schism associated with the name of Nestorius, whatever the real views of that ecclesiastic may have been; but it was not till A.D. 431 that she was officially acknowledged by a General Council to be divine in virtue of her Theotokiá, her Motherhood of God. It is difficult not to believe that this is one of the examples of the general fact which I have just quoted from Dr. Bigg, and that the bishops assembled at Ephesus on that occasion were tardily conceding a demand for the recognition of the feminine principle in divinity made even more and more openly by the voice of the common people all round the Eastern Mediterranean. We are told indeed in a contemporary letter written by one present in Ephesus at the time that the populace of the city itself, that immemorial seat of a Virgin-Goddess, gathered about the church while the Council was sitting, and put pressure on the bishops when they showed signs of wavering in their decision to proclaim the Theotókos by condemning Nestorius; and that when the decree had at last gone forth the Ephesians went wild with joy. Their Great Mother had come again to her own.

Once established, or, more probably, little by little while she was gaining recognition, the Christian Virgin appropriated the festival dates, the holy places, and even the rites of her predecessors. Here we approach a third class of survivals. The great August feast of Artemis, as I have said, became that of the Assumption of Our Lady; temples, groves, sacred springs, and other holy spots of Nature-worship were transferred to the new patroness of all life and fertility. There are hundreds of places in Anatolia, Greece, and Syria which might be called to testify. One of singular interest I visited a few years ago, that wild spot in the Lycian mountains where the ever-burning gaseous flames of the Chimæra break out in a clearing of the forest. Here, on the foundations of a temple, stands the ruin of a church built over the largest vent of the fire. Islam has decreed that the goddess of the earth-flames be no longer openly adored, but all the bushes which grow about the ruin I found hung with mouldering rags of quite modern date, witnesses that her cult is not yet dead in the hearts of shepherds and woodmen. On the wall of a ruined convent hard by is a half-effaced fresco of Mary. And for persistent rites and ceremonies let me quote once more the anointing of the great corner-stones of the ruined shrine of Paphian Aphrodite—the "Queen," as she is called shortly in inscriptions in the old Cypriote character. This observance takes place on the Feast of the Assumption of the Virgin, to whose honour, under the name Panaghiá Chrysopolitissa—the Lady of the Golden City—a church stands hard by in the precinct of the Temple. Even Moslems in Cyprus at times of stress reveal the pre-Islamic secret of their souls and bow down before the holy icon of the Virgin, painted, it is believed, by St. Luke, wafted oversea to the same Paphian shore as Venus of old, and kept by the Monastery of Kykko, and carried in procession round fields to bring rain and bless their increase. So too do they in the remoter parts of Egypt. When I was being taken over the Church of the Convent of St. Gemiana, in the marshland of the Northern Delta, I saw a woman kneeling and muttering prayers before an icon of the Virgin. It struck me she was no Copt, and I put a question to the monk who acted as guide. He shrugged his shoulders apologetically: "She is of the Muslamin," he said. "Her son is very ill. Why should she not? Who knows?"

Finally, let me return to Ephesus, whose cult with its environment I have peculiar reason to know. A phenomenon has taken place there latterly which illustrates singularly well both kinds of religious transference, the conscious and the unconscious. About fifteen years ago a Catholic priest of Smyrna who had been reading Clement Brentano's "Life of the Virgin," which is based on visions of the German mystic Anne Catherine Emmerich, and contains the story that Mary accompanied St. John to Ephesus, lodged in a dwelling at some distance from the city, and there died—a belief which we know from the French traveller Tournefort to have been held locally two centuries ago—identified the holy house with a ruined building, standing above a spring in the southern hills, and dedicated by the Orthodox Church to Panaghiá Kapouli—Our Lady of the Gate. He succeeded in buying the site and much ground about it, fenced it in, found the gardens which the Virgin had tended, and the path with its stations by which she had climbed daily to Calvary on the hill-top, and when I was there was sanguine of finding also her tomb. He proclaimed his discoveries far and wide and instituted two pilgrimages which now draw thousands of Catholics every year on the Wednesday in Easter week and in the octave of the Assumption. So far we are considering a conscious revival, located by a coincidence at the great Asiatic seat of the pagan Virgin Goddess. But there is a stranger coincidence of which the good priest was not conscious. The holy house stands far from all villages or haunts of men at the head of that same glen of Ortygia where we know, from Strabo and Tacitus, stood the original shrine of the great Ephesian Mother. It stands too on obviously earlier foundations, and, as I have said, over an *Aghiasma*, as it is called, that is, a holy spring. Indeed, very possibly it occupies the actual site of the Ortygian temple. How did this coincidence come about? On this wise. When searching the Ephesian district the Smyrniote priest asked the Orthodox peasants for places sacred to the Virgin, and was directed to this in the glen as the most holy of all. It had been, in fact, a place of pilgrimages and of intercession for the sick, for rain and fertility, and for the easy delivery of women as far back as local tradition ran. This it had been because it was Ortygia, though the villagers of Kirkinji and Arvalia knew it not. In virtue of that fact the priest appropriated it, though he never suspected the identity; and thither the faithful flock twice a year, even less aware of, but none the less compelled by, the persistent sanctity of Ortygia.

Such, then, are the religious survivals which are not survivals at all in what may be called the pathological sense, not, that is to say, elements in actual religion which have survived their utility in this system; and such should not, I urge, be treated by anthropologists without explicit reference to the fact that they are as full of meaning, as vital, and as necessary in actual cult as ever they were. They offer not so much examples of the conservatism of religion—a much used phrase of slightly contemptuous implication—as of the identity of the religious sense throughout the life of particular races and within certain geographical areas, and of the necessary conditions and limitations of its expression. They claim all the respect and tenderness of treatment due to beliefs which still make part of the foundations of our social order, and cannot be impaired or cut away, like a pathological survival, without the provision of substitutes equally efficient. Even when the rudest beliefs of primitive and simple folk are dealt with, *maxima debetur pueris reverentia*; and much, be it remembered, in the content of these great classes of religious persistences is concerned with the belief of folk who are by no means simple or primitive.

There remains, of course, an immense body of religious persistences which are more or less rightly to be regarded as survivals in the ordinary pathological sense, beliefs, observances, and rites, that is, which have indeed survived from earlier religious systems, and have lost or are losing their meaning, because they express nothing necessary or vital to the religious sense. So far as this class includes beliefs at all, these are of the kind which are called superstitions, and I venture, despite the reluctance of some anthropologists to admit a definite distinction between religion and superstition, to maintain that there is such a distinction, and that it is just this, that superstition includes only those beliefs which are held wholly or chiefly because they have always been held; which are, in effect, results of earlier religious systems, or survivals in the narrower pathological sense of the word. Some religious beliefs may be survivals in the wider sense; all superstitious beliefs are survivals in the narrower sense.

The most numerous content of the class, however, is composed of observances and ceremonies. These may often persist as pathological survivals in connection with beliefs of the really religious kind. The object of cult may be a survival of the necessary and vital class, as, for example, the Virgin mother; but the particular place and manner of her worship may be conditioned by survivals of the pathologic sort. The persistence of local sanctity supplies the most obvious illustration of the latter kind of survival. For instance, while the consideration of many holy places to Christendom is due to events or traditions of Christian history itself, to connection with the Gospel story or with early preachers, teachers, or other saints, to reputed epiphanies, and so forth, a much greater number owe the fact that they are still frequented by the pious to reasons of which the pious have not the dimmest consciousness, often to features of pre-Christian Nature-worship—to rocks or springs, or even objects which may have perished long ago, like sacred trees. What Greek votary in the shrines of St. George or St. Elias could give a satisfactory account of either of those saints, demonstrate their place in the history of his Church, or say why their shrines stand in certain valleys or on certain peaks of the hills? We often know better than he; for we can say definitely that many of these saints of the Orthodox Church and of Islam, whose churches and tombs dot the Nearer East, have never died because they never lived, but are the unsubstantial shadows of old gods, clinging to the sites of shrines and groves whence their names perished long ago with the victory of the Galilean.

The particularism, which communities—village, tribal, urban, and even national—display all the world over, has had, of course, much to do with local persistence of sanctity. A small body, blessed with a private deity of its very own for uncounted centuries, who has been identified with its particular interests, and has favoured it in its multifarious local feuds, will not readily resign it for a deity of more general jurisdiction. If it accepts the Christian Virgin in place of a pagan goddess, she will be the Virgin of that particular community, unconnected with any other Virgin, and in full sympathy with the insults which Latin peasants, for example, will heap upon the Madonna of the rival village across the valley. Indeed, an indistinctive distrust of and disinclination to accept an impartial god is characteristic of all imperfect humanity, and lies beneath the sectarianism which has been promptly and continuously developed within the pale of all the great universal religions—for instance, in both Islam and Christianity. The omnipresent, omniscient Deity is too far removed, too catholic, too vague. Man ever desires to focus divine attention on a smaller area, to establish for himself some preference in the eyes of his God; and, even when most anxious to bring the rest of the world into the fold, he often most jealously reserves to his own community the distinction of a Chosen People.

This great and well-known class of observances and rites, which represent true pathologic religious survivals, supplies the bulk of the matter of all the great treatises written on cult by anthropologists, such as those, for example, of Mannhardt and Bötticher on Tree-worship, as well as others to which I have already referred, and many more. With this class the anthropologist can deal freely. In the others it seems reasonable that he should move with greater reserve; and I venture to think that he will best avoid offence if he keep clearly in his own mind, and as clearly before his readers, the main distinction between the classes of religious survivals, which, quite independently of my presentation of it, is real, vital, and of momentous significance.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY AUGUSTUS D. WALLER, M.D., LL.D., F.R.S., PRESIDENT OF THE SECTION.

On the Action of Anaesthetics.

THE duty laid upon me by the Chair which I have the honour to occupy to-day is in the first place to copy the example of my predecessors by submitting to the Section some distinct and definite contribution to the advancement of science.

And inasmuch as the subject has firmly held my attention during the last fifteen years, I am naturally led to name Anæsthesia as the title of my Presidential Address to the Section of Physiology.

With due regard paid to the fact that the audience to which the British Association addresses itself is not principally medical nor exclusively scientific, I shall deal with the subject in a manner that may, I hope, justify my opinion that it is a subject capable of being usefully considered by all educated minds.

And surely, quite apart from its value as an illustration of the method of physiological inquiry, the subject is one with which any educated man may well desire to possess some rational acquaintance, since every one of us may some day require the saving boon of anæsthesia.

Most people have some idea of what is meant by an anæsthetic, and will recognise by name at least one anæsthetic drug—chloroform. It is even probable that the first stranger whom you should meet in the street might also name ether and "gas" as being anæsthetics. And pretty surely he would also know that the use of an anæsthetic is to abolish pain. But if you were to tell him that a plant can be anæsthetised—that seeds can be chloroformed or etherised—he might very possibly express surprise.

The popular notion of an anæsthetic, in conformity with the literal meaning of the word, is that it is something that abolishes sensibility and takes away pain. But how, then, can a plant be chloroformed? Does that mean that a plant is sensitive and can feel pain as we do? Well, probably not; nevertheless it is very certain that a plant can be anæsthetised, and when you have properly appreciated what this means I think you will admit that our notions of vital processes and of their anæsthesia by ether, or by chloroform, or by a host of other reagents have been considerably widened. For we shall then have realised that the state of a person or of an animal rendered insensitive of pain by an anæsthetic is a particular instance of the general principle that all protoplasm—vegetable as well as animal—is liable to be immobilised—put to sleep—more or less completely—temporarily or permanently—by the action of substances which we therefore designate as anæsthetics or narcotics. A volatile narcotic, like ether or chloroform, gets to the living cells of a plant by direct diffusion; in the case of ourselves and of the higher animals it gets to the living cells by the channels of respiration and of circulation. The molecule of chloroform (or of ether) is drawn into the lungs with the inspired air, passes from the pulmonary air to the pulmonary blood, combines with its corpuscles, is thus carried first to the heart and then distributed with the blood to all parts of the body; in the capillaries the molecule of chloroform parts company from hæmoglobin, passes from the blood to the tissues and tissue fluids, and enters into combination with the living cells which it immobilises more or less profoundly, temporarily or permanently. The various kinds of living cells that constitute our organs are unequally susceptible as regards the immobilising effect of this general invasion of the system by the narcotising molecules.

Of all the cells of the body, the most labile, and therefore the first immobilised, are the master cells of the body—the cells of the grey matter of the brain, that is, the seat of sensation and the organ of voluntary motion. The most stable, and therefore the last immobilised, are the executive cells of the body that constitute muscle and nerve. The order of lability from greatest to least is as follows:—Brain; spinal bulb and cord; terminal nerve cells, cardiac muscle; skeletal muscle; nerve fibres. And while all living cells and tissues of the body are subject to the immobilising action of narcotic substances, their individual differences of susceptibility are such that, whereas one part of chloroform in 5000 of blood is sufficient to immobilise cortical nerve cells, a nerve fibre requires a more than tenfold effective mass of chloroform before exhibiting any falling-off of its normal excitability.

Let us now briefly consider what happens when a patient is anæsthetised by, say, chloroform in the usual manner by inhalation of an unknown mass of vapour. The inhaled vapour, more or less diluted in air, diffuses into, and is distributed to, the entire body by the circulating blood. The lymph bath that sorrounds and permeates all the tissues and cells of the body becomes a weak solution of chloroform in water, and gradually within that weak chloroform atmosphere the most labile parts fall under the immobilising effect of the anæsthetic, first the organ of conscious sensation and movement—the cortical grey matter of the brain—then the organ of unconscious reactions, the medullary grey matter of the spinal bulb and cord. So that the order in which the effects unfold themselves are (after a brief stage of excitement or mobilisation) first a suppression of sensation and voluntary movement, then a suppression of reflex and automatic movements, inclusive of the movements of respiration. Finally—and if this finally is reached the immobilisation can no longer be recovered from—the heart stops beating. The patient is dead.

From life to death by the way of anæsthesia there are three principal finger-posts dividing the journey into three stages. Of these three finger-posts two are to be carefully watched for; the third should never be sighted.

During the first stage of anæsthesia—commencing, it may be, by some amount of preliminary agitation—sensation and voluntary motion become suppressed, while reflex and automatic movements are preserved. The finger-post between this first stage and the next is quite clear: if when the conjunctiva is touched the eye winks the anæsthesia is "light"; if the eye does not wink the anæsthesia is "deep."

During the second stage of anæsthesia not only *voluntary* but also *reflex* movements (of which the conjunctival reflex is the most convenient indicator) are wholly suppressed, while the *automatic* movements of respiration persist. This is the degree of anæsthesia required for any major surgical operation, and is therefore frequently spoken of as surgical anæsthesia. The finger-posts to its boundaries are: on this side the conjunctival reflex, on that side the movements of respiration.

The third and last finger-post—arrest of the heart's beat—should not be passed. Arrest of the pulse signifies an almost hopeless state. The time of grace between arrest of respiration and arrest of the pulse from which recovery is almost hopeless is very brief indeed—hardly more than a minute. The doctrine of the Edinburgh school—watch the respiration, not the pulse—is sound doctrine. Stoppage of respiration means danger; stoppage of the pulse means death.

I think this sketch, rough as it is, will be sufficient to bring before our minds a clear picture of the process of anæsthesia and of its principal danger—cardiac syncope. I do not wish to blur it with details. I shall therefore not enter into the question of primary cardiac syncope, nor call off your attention to other symptoms, such as the state of the pupil and the character of the pulse and the colour of the face. Nor shall I at present lay any stress upon the fact that chloroform can be of variable quality, and that like alcohol it may act differently upon different people.

First and foremost, if we are to secure the safe administration of a powerful poison like chloroform, we require to know how much of the drug is required for the production of the desired physiological effects, how much is dangerous, how much is necessarily fatal. Considering the fact that chloroform has now been in common use for sixty years,[1] and that the uniform experience of physiologists is to the effect that it is a dangerous drug as ordinarily used, it is astonishing that its administration should not rest upon any definite scientific basis.

[1] The first major operation under chloroform was performed by Sir James Simpson on January 19, 1847.

Occasional attempts have been made in the past—by Snow[1] first of all, by the French school of physiologists, Paul Bert,[2] Grehant,[3] Dubois,[4] and others, more recently by committees of medical societies and of the British Medical Association[5]—to determine what may be designated as the physiological arithmetic of chloroform; but partly by reason of the difficulty in the way of measuring percentages of chloroform in the air and in the blood, partly by reason of the facility with which chloroform can be administered without any reference to percentages, the results obtained produced very little impression upon clinical practice, and deaths that could not have occurred if the principles laid down by Snow and by Bert had been properly appreciated and acted upon, were and still are regarded by the medical profession and by the public as the normal incidents of medical practice, and attributed to any but their true cause—an overdose of chloroform.

I shall not venture to guess at the number of avoidable deaths that have taken place from this cause, but I place before you a diagram constructed from the annual returns of Somerset House and giving the number of deaths officially classified under the heading "Anæsthetics" during the last fifty years. I do not wish to use the diagram in an alarmist sense, so I hasten to call your attention to the fact that the numbers are not percentages, but absolute figures, which may in your opinion be sufficiently accounted for by the fact that the absolute number of cases has augmented in which anæsthetics have been employed, and that official returns of fatal cases may have become more complete.

Indeed, I do not myself base my judgment of the matter so much upon statistics, which are notoriously apt to be imperfect and misleading, as upon the common experience of most members of the medical profession and of many persons outside that profession; I have rarely met a well-informed person who was not personally acquainted with at least one accidental death by chloroform. Nevertheless I have presented to you the above statistical diagram because I consider that with due reservation this outcome of unprejudiced observation gives a by no means exaggerated picture of an actual fact, and because I believe it is an avoidable fact and will be diminished in future years by the wider knowledge of the physiology of anæsthesia.

I hope I shall not tax your attention too severely if I ask you to follow me through a short arithmetical argument in order to convince you that accidental deaths by chloroform must of necessity be expected to occur in the ordinary way of administration if the administrator is not fully alive to the physical and physiological properties of chloroform, and to outline in your minds a definite picture of some very simple and important measurements.

By ordinary methods of administration the percentage of chloroform vapour in the mixture of chloroform and air inhaled may be anything between 1 and 10 per cent.: let us say that it is 4 per cent.—*i.e.*, that an inhalation of, say, 500 c.c. carries 20 c.c. of chloroform vapour into the lungs. Of this 20 c.c. it is no exaggerated estimate to take one-half, or 10 c.c., as absorbed by the pulmonary blood, the other half being expelled in the expired air. If the subject breathes twenty times per minute 500 c.c. at each inspiration, his blood absorbs 200 c.c. of chloroform vapour in one minute—*i.e.*, one gram of fluid chloroform. He may, of course, absorb less than one gram per minute; but he may also absorb more. Snow estimated that 17 minims of chloroform in the blood (*i.e.*, about one gram) was sufficient to produce anæsthesia, while double the amount was fatal.

Grehant found that after death by chloroform the blood contained half a gram of chloroform per litre of blood—*i.e.*, five litres of blood, which is the normal amount in an average man, would contain two and a half grams. Buckmaster and Gardner find from numerous experiments results that may be summarised as follows:—

Quantity of chloroform (in grams) contained in 100 grams of blood:

	Min.	Mean	Max.
Taken during deep anæsthesia	0·020	0·030	0·040
Taken after death by anæsthesia ...	0·040	0·050	0·060

[1] Snow, "On Chloroform and other Anæsthetics," 1858.
[2] Paul Bert. [3] Grehant. [4] R. Dubois. [5] B.M.A.

These results signify in five litres of blood between one and two grams as the anæsthetic amount, between two and three grams as the lethal amount.

Consider, then, what might happen if a patient were to absorb chloroform at anything like the rate of one gram per minute, and what might happen if by mischance he should absorb two or three grams in a fraction of a minute. This is a mischance that can occur in the ordinary method of inducing anæsthesia: a few deep gasps by a struggling patient, a few moments' inattention on the part of an administrator, and the blood almost at once be fatally overloaded with chloroform.

In the early days of chloroform anæsthesia it used to be considered admissible to administer chloroform vapour of 4 and 5 per cent. strength in air; but at that time the means of estimating percentage were very imperfect, and the figures quoted were little better than guesswork.

The dictum of the Edinburgh school was "plenty of chloroform with plenty of air by continuous administration."

Some ten years ago, at a meeting of the Society of Anæsthetists,[1] I pleaded for the continuous administration of chloroform vapour at a strength (in air) of not below 1 per cent. and not above 2 per cent., which amounted to a translation into figures of the Edinburgh dictum, with justification of the figures by quantitative observation. Perhaps I may briefly explain the method[2] by which the percentages of chloroform and air are obtained:—

	Grams
A litre, or 1000 c.c., of chloroform vapour weighs	5·333
A litre, or 1000 c.c., of air weighs	1·288
The litre weight difference is therefore	4·045

The weight difference of 1 c.c. is approximately 4 milligrams.

So that a 100 c.c. flask in which 1, 2, 3, &c., c.c. of air are replaced by 1, 2, 3, &c., c.c. of chloroform vapour is 4, 8, 12, &c., milligrams heavier than the same flask filled with air.

So that added weights of 4, 8, 12, &c., milligrams indicate 1, 2, 3, &c., per cent. of chloroform vapour present.

Thus, by simply counterpoising a 100 c.c. flask (or, preferably, a 250 c.c. bulb, so as to give weight increments of 10, 20, 30, &c., milligrams as indications of 1, 2, 3, &c., per cent.) filled with air against a similar bulb filled with chloroform mixture, the percentage of the mixture is read directly by the number of centigrams required to counterpoise. For instance, a bulb full of mixture being, say, 18 milligrams heavier than when it is full of air, the chloroform vapour percentage is known to be 1·8 per cent.

Evidently, with a ready means of estimating percentage, one is entitled to talk about the percentages that one considers from experiment to be necessary and sufficient and excessive.

My argument up to this point comprises one or two tacit assumptions that ought to be briefly dealt with, or, at any rate, mentioned.

In the first place, I have assumed that the great majority of accidents by anæsthetics are caused by chloroform.

This is accounted for by the fact that chloroform is the most powerful, the most convenient, and the most extensively used of all anæsthetic vapours. I hasten to add that, in my opinion, this fact is an argument not so much for the substitution of other less dangerous anæsthetics as for the more careful administration of chloroform itself.

In the second place, I have assumed that chloroform is a remarkably uniform and certain reagent, producing its physiological effects in strict conformity with the quantity of vapour administered, and by no means irregular in its action by reason of irregularities or impurities of manufacture. Pure chloroform is more powerful than impure chloroform.

I do not dwell upon these two points now; nevertheless I should like to say that these are not gratuitous assumptions, but, more properly speaking, results of observation

[1] Waller, *British Medical Journal*, April 23, 1898.
[2] Waller and Geets, *ibid.*, June 20, 1903.

and experiment, of which I can offer some evidence. I have tested purified chloroform against the concentrated residue of its impurities, and have found the former to be far more powerful than the latter. And I have compared with each other chloroform or trichlormethane, $CHCl_3$, dichlormethane, CH_2Cl_2, monochlormethane, CH_3Cl, tetrachlormethane, CCl_4, as well as many anæsthetics of the ether group, Et_2O, EtCl, EtBr, EtI, and several anæsthetics belonging to the series of chloroethanes, members of which have at various times been recommended as substitutes for chloroform—*e.g.*, ethylene chloride or "Dutch liquid," $CH_2Cl—CH_2Cl$, and ethyledene chloride, $CH_3—CHCl_2$. The conclusion I have drawn from this study is that of all these more or less powerful anæsthetics chloroform is the most powerful, the most certain, the most convenient, and the most trustworthy.

But I would repeat the statement that the safe administration of chloroform consists in its continuous administration at a strength of between 1 and 2 per cent. And if anyone now objects that it may be safe to go up to 3 per cent., or sufficient to go down to ½ per cent., I am content to accept the objection as being possibly well founded, because it carries with it the all-important admission that the question of safe anæsthesia is in first instance a question of quantity, and in second instance a question of idiosyncrasy and of clinical conditions.

Admitting, then, that the primary condition of the safe administration of chloroform consists in the continuous administration of an atmosphere in which chloroform vapour is between the limits of 1 and 2 per cent., the question is how best to secure this essential condition. It can be secured by many methods. Given the requisite care, skill, and experience on the part of the administrator, anæsthesia may be properly carried out by any method, empirically or otherwise. But some methods demand more skill and care than other methods, and the task of the anæsthetist may be lightened (or it may be aggravated) by various mechanical appliances. A folded towel drenched with chloroform may be safely used by an anæsthetist whom previous experience has rendered fully alive to the extreme danger of two or three deep inspirations of a concentrated vapour, and whose attention is never distracted from the paramount necessity of "plenty of air" with the "plenty of chloroform." On the other hand, a person unmindful of the physiological elements of chloroformisation is a dangerous administrator if he is content with the empirical use of any apparatus, however faithfully he may carry out the instructions of his instrument maker.

Methods and apparatus are legion, and it would be futile or invidious on my part to attempt to describe or criticise in detail any one method or apparatus. But I may usefully invite your consideration of certain principles and ask you to recognise that for their trial by experiment the chief necessity is a simple method, such as I have just described, enabling us to test percentages quickly. Thus, by the use of this method, Mr. Symes[1] has determined what are the usual percentages of chloroform vapour offered to inspiration by an ordinary Skinner's mask, and found them to range between the desirable limits of 1 and 2 per cent., with occasional fluctuations up to about 3 or 4 per cent.

All apparatus designed for the delivery of chloroform vapour of definite and controllable percentage is based upon one or other of two principles. On the first or vacuum system, of which the best known examples are the apparatus of Snow and that of Harcourt, the patient inspires air through a vessel containing liquid chloroform by a broad inlet tube and a closely fitting face-piece.

On the second or plenum system, of which the examples best known to me are the apparatus of Dubois and that to which I have given the name of the "wick vaporiser,"[2] the patient inspires from a freely open face-piece in which an excess of chloroform and air at required percentage is maintained by a pump.

In my opinion, if apparatus is to be adopted, the plenum is preferable to the vacuum principle: for in the latter case it is more difficult to secure uniformity of administration, which requires a perfect fit of the face-piece, stillness of the chloroform over which the inspired current of air is drawn, and which causes of necessity a considerable added resistance to inspiration. By the plenum system there is a more uniform percentage of supply, and the patient breathes freely from an open loosely fitting face-piece, the cavity of which is kept filled to overflowing by an excess of mixture of controllable strength.

But, whichever of these two systems be followed, the choice is obviously one that can only be determined by experience, both clinical and of the laboratory. Equally obviously the so-called accurate percentage afforded by any method can only be approximately accurate under the sometimes difficult conditions of practical administration, and it is therefore of principal importance to ascertain by a simple and ready method of estimating percentages such as I have described above what is the degree of accuracy or, if you prefer to say so, the range of inaccuracy to which any method or apparatus is subject under the ordinary conditions of its application.

You may indeed sometimes hear it said that the percentage can be judged of by the sense of smell, which therefore affords the readiest means of estimating the strength of a mixture, to which I should like to add yes certainly, provided the observer by previous experience of known percentages has formed some standard of comparison on which his opinion is based.

I have finished what I set myself to say to-day concerning the physiological problems involved in the question of safe anæsthesia by chloroform.

But I have reserved for my conclusion certain considerations by which it is customary to introduce the particular subject under review. May I briefly trespass further on your attention to say something about the conditions under which physiological inquiry is pursued in London?

Physiology, in the technical and restricted sense commonly received in this country, has become so closely associated in the public mind with vivisection, and, as dealt with in the medical curriculum, is so narrowly reduced to what is strictly necessary and practicable, that its real scope and value as a general science have been altogether lost sight of.

I do not propose on the present occasion to deal with the question of vivisection either on its ethical or on its utilitarian aspect. All I wish to do is to bring distinctly before your minds two considerations that may, I hope, contribute to a broader and truer conception of the place of physiology among the sciences, though they assuredly will not justify the claim of Dubois-Reymond that physiology is the queen of the sciences.

The first of these two considerations is that the province of vivisection, essential as it is, is a very narrow and restricted province indeed in the domain of physiology. In the ordinary routine of the physiological laboratory experiments involving vivisection are infinitely less numerous and infinitely less exacting than experiments that involve no vivisection. Vivisection is, in fact, an infinitesimal fraction of experimental physiology, whereas in the minds of many who should know better experimental physiology always means vivisection: the two terms are taken as synonymous, and an odium that should not have been attached either to physiology or to vivisection has been directed through vivisection upon the whole of physiology. Yet do not mistake my meaning. I do not for one moment surrender the claim that upon ethical and utilitarian grounds vivisection is lawful; I deprecate the perverted picture of vivisection that is presented to public opinion by sensational agitators and the perverted notion of physiology that is one of the evil results of the anti-vivisection crusade. But I do not desire to dwell on the vivisection question; I do not consider that it can be usefully considered by the general public without an intimate knowledge of the subject, itself possible only to the specialist. An ordinary normal person who should say he approved of vivisection would be, in my opinion, even more objectionable than an ordinary normal person who should express a detestation of vivisection, for the bare idea of vivisection is repugnant to every humane person. To bring dispassionate argument against such natural repugnance seems to me hardly less mischievous than to fan repugnance into hatred by passionate appeals to the

[1] Symes, *Lancet*, July 9, 1904.
[2] Waller, Proc. Physiol. Soc., August 19, 1904.

imagination. The surgeon to whom an ignorant crowd should impute cruelty would fail to serve the cause of humanity by the technical descriptions to them of the operations he is required to perform.

There are two great principles involved in the welfare of any applied science—in the welfare indeed of any living thing—the conservative principle and the progressive principle.

Any organised living mass—let it be an animal or an organised body of men—by virtue of the conservative principle of heredity, of repetition of like by like, of imitation of action that has proved to be successful, works more economically than it could have done if each individual mass had perforce to work out its own salvation, evolve for itself its own suitability to and temporary mastership of surrounding circumstances.

But the child that can only imitate and repeat the actions of its ancestors brings no positive addition to the excellence of the race the upward progress of which requires to be fed by the costly process of initiative efforts, by the sports of talent and of genius, by the cumulative effect of innumerable hits among innumerable misses of innumerable multitudes of individuals.

Transfer this thought to education—to medical education in particular. An educated person—a competent physician or surgeon—must in the first place learn at the feet of his masters, believe and learn what he is told, imitate what he sees done by his instructors, be the apprentice and follower of the experienced craftsman who shows him tried and approved ways of working.

But the apprentice who is to contribute to the commonwealth of knowledge and power has to be something more than the faithful imitator of his teacher; he must initiate, and he must make a hit among, it may be, his many misses. He will then have contributed to the advancement of knowledge and power.

In all provinces of human activity we may distinguish the result of our two complementary principles—imitation, the conservative principle; initiation, the progressive principle. But while in all provinces the conservative factor, being, so to speak, the means of wholesale economy, bulks the larger, the progressive factor, as the means of retail economy, is relatively insignificant.

Between the two extremes—imitation on the one hand, initiation on the other—there is room for numberless variations; and, by reason of the vastness of area of even the minutest province of human activity, the aim of education, even the most technical, is perforce more and more directed to teach the pupil to use his own mind in presence of the task set him rather than to copy minutely and to reproduce perfectly the model facts shown or described to him by the master.

But in every province, and in particular in that of education, the power of imitation is easier to exert and easier to develop than the power of initiation, which is a rare and costly ingredient, since at any given juncture the odds must be heavily in favour of the success of the time-honoured fact or method as compared with its yet untried competitor.

There are of necessity many misses and few hits among the novelties that come to trial.

The genius of our nation is admittedly a practical genius that looks upon the conservative way as the better way, and makes its changes by as small steps as can be from precedent to precedent. This is the safe and easy way, the way of nature; and to this predominance of fact copied over fancy realised may fairly be ascribed our own prolonged constitutional prosperity. We have found by long experience that it is very long odds indeed against any dark horse without a good pedigree of precedents, so we prefer to back the field; old methods are the safe thing and the good thing.

But one may have too much of a good thing, and in education I think we have had too much of the old methods, in which the keynote is imitation and examination of copy, and too little of that expensive and dangerous ingredient—so dangerous that to some authorities it appears in the light of a poison—initiative and originality of thought. I admit all the danger; I grant to the old authorities that there is a good deal of trash current under the label of original research. But I do not think we can have wheat without chaff, and I am convinced that the adherents of original research, as against the *clientèle* of the examiner and of the crammer, bring to the educational commonwealth the scanty and much needed ingredient of initiative. We want education still further urged in the direction of teaching the pupil to use his own mind upon unseen translation of new facts into effective conduct, and one of the best ways of obtaining that the teacher shall guide his pupils to use their own minds is that he should himself use his own mind, and not suffer himself to drop into the jog-trot of routine. We want our teachers to be learned men, but we also want them to continue to be learning men; and that is why, in spite of its defects, I want to urge that greater encouragement be given to original research.

I hope I shall not have taxed your patience too far if I bring these considerations to their natural conclusion by telling you as briefly as may be of an effort that is now being made in the University of London to strengthen and organise that spirit of initiative which is, I am convinced, of capital importance in all teaching, the most elementary no less than the most advanced. We have formed ourselves into a school of physiology, including every teacher of physiology in London, each of whom undertakes to give at the headquarters of the University lectures upon those portions of the science with which his own previous study has rendered him specially conversant. The teaching offered is of an advanced character, and is addressed more especially to post-graduate and to Honours students; and, in pursuance of the principle that such teaching is the immediate consequence of learning, the University has provided a research laboratory in which teachers and other post-graduate students find the necessary facilities for work. We believe that the experience of the last five years has sufficiently proved that a "college of learning" thus constituted renders valuable assistance to the teachers and students of the schools of London, and that it is helping to draw to a focus resources and efforts that are at present scattered and wasted among the several schools. I cannot do better in this connection than quote the words of the Chancellor of the University (Lord Rosebery):—"We hope to make this laboratory the central spot for medical research in London . . . an institute of studies ancillary to medicine, which may develop and complete the work of the University in that direction." And I think that you will agree with me that any movement that contributes to the good health of the University of London contributes to the good health of every university in the Empire, and of every school the teachers of which are animated by the university spirit—the love of learning for its own sake as well as for the sake of the mental and material power that is required of us.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The mastership of Downing College has been offered to Prof. Howard Marsh, who has, it is understood, given a favourable reply, but the election cannot take place until October.

Mr. Augustine Henry has been appointed reader in forestry for five years.

A university lectureship in botany will be vacant at Michaelmas in consequence of the resignation of Mr. Hill. The annual value of the post is 100*l*. Applications for the lectureship, accompanied by testimonials, should be sent to the Vice-Chancellor on or before October 11.

LONDON.—Dr. E. A. Westermarck has been appointed to one of the two professorships of sociology founded by Mr. Martin White—the one for five years; the appointment to the permanent professorship has not yet been made.

Dr. A. C. Haddon, F.R.S., has been appointed university lecturer in ethnology for the session 1907–8 under the Martin White benefaction. The teaching in these subjects will continue to be given at the London School of Economics, and the courses will be treated as intercollegiate courses.

Manchester.—Mr. J. L. Simonsen, Schunck research fellow, has been appointed a junior demonstrator in chemistry.

Oxford.—The professor of human anatomy has notified the Vice-Chancellor that the Welsh prize, 1907, has been awarded to Mr. Wathen E. Waller, of University College.

An election to the Philip Walker studentship in pathology will take place in October next. The studentship, which is of the annual value of 200*l*., is tenable for three years, is open to either sex, and the holder need not necessarily be a member of the University of Oxford nor be legally qualified to practise the profession of medicine, but while holding the studentship he or she must be devoted to original pathological research. If the work done by a student be of exceptional promise, the studentship may be extended for a second period not exceeding two years. Applications, accompanied by three testimonials, must reach the registrar of the University by September 14 next.

At the Convocation to be held on September 30 it will be proposed to confer the honorary degree of D.Sc. upon Dr. Ludwig Mond, F.R.S., who was unable to be present and receive the degree at the late Encænia.

Prof. W. Baldwin Spencer, F.R.S., the holder of the chair of biology in the University of Melbourne, has been elected to an honorary fellowship at Exeter College.

Dr. Norman Moore will deliver the first Finlayson lecture in Glasgow in February next. The lectureship was founded in commemoration of the late Dr. James Finlayson. The subject and actual date of the lecture will be announced later.

Mr. W. Erlam Smith, who is at present acting as temporary professor of natural science at Government College, Rangoon, has been appointed to succeed Dr. W. H. Wilson as professor of chemistry in the Presidency College, Madras, when the latter retires in October next.

For work carried on in the cancer research laboratories of the Middlesex Hospital, the Walter Emden research scholarship and the Richard Hollins scholarship have been awarded respectively to Dr. Victor Bonney and Mr. L. Courtauld.

The Joule studentship of the Royal Society has been awarded to Dr. T. H. Laby, of the University of Sydney, now of the Cavendish Laboratory, Cambridge, for the investigation of the conditions of condensation and supersaturation of vapours other than steam.

Mr. Richard Henry Curtis, principal assistant in the observatories branch, has been appointed superintendent of the instruments branch at the Meteorological Office. The observatories branch will in future be incorporated with the instruments branch. Mr. Richard Corless, of Sidney Sussex College, Cambridge, has been appointed special assistant to the director.

A fellowship in agriculture has been awarded to Mr. W. Dawson by the executive committee of the Carnegie trust for his thesis entitled "Production of Seed by Forest Trees," and a scholarship in agriculture has been awarded by the same committee to Mr. F. S. Marr for his paper on "The Stimulus of Phosphoric Acid on the Early Development of Plant Growth."

The following appointments have been made in connection with the Rothamsted Experimental Station:—Dr. E. J. Russell, lately of the South-Eastern Agricultural College, Wye, as the Goldsmiths' Company's assistant for the investigation of soils, and Dr. H. B. Hutchinson, of the Midland Agricultural and Dairy College, Kingston, Derby, as bacteriologist.

Mr. Murray has published at 5*s*. net a handsome memorial volume of the visit in June, 1906, to the University of London of representatives of the University of France, the Collège de France, and the French provincial universities. We published in our issue of June 14, 1906, an article on the visit, so do not need to say more about the volume than that it contains the names and particulars as to the standing of the guests, verbatim reports of the various addresses delivered, and accounts of the numerous receptions, luncheons, &c., arranged in honour of the distinguished visitors, concluding with the conversazione held at the University of London, South Kensington, at which about 2000 guests were present.

The council of the Institution of Civil Engineers is prepared to consider applications for a nomination to a Palmer scholarship. The annual value of the scholarship, which will be vacant at the end of next month, is 40*l*. Sons of civil engineers alone are eligible for nomination, and they must be desirous of matriculating, and subsequently graduating, at the University of Cambridge, and their circumstances must be such as to need the help afforded by the scholarship. Copies of the regulations may be obtained from the secretary of the Institution of Civil Engineers.

The following appointments in universities abroad are notified in *Science*:—Dr. G. L. Streeter, professor of anatomy in the University of Michigan; Dr. J. Heath Bawden, professor of philosophy in the University of Cincinnati; Dr. F. R. Noll, of the Agricultural Academy at Poppelsdorf, professor of botany at Halle; and the following appointments at Syracuse University have been made:—Joseph E. Kirkwood, professor of botany; W. M. Smallwood, professor of comparative anatomy; and George D. Babcock, professor of practical mechanics.

The most recent report of the U.S. Commissioner of Education deals with the year ending June 30, 1905, and has just been published. The growth of facilities for higher instruction as recorded in the report is remarkable. The total value of property possessed by the institutions for higher education increased during the year with which the volume deals by 10,000,000*l*. At the date mentioned the total value reached approximately 103,000,000*l*., of which 47,000,000*l*. represents endowment funds, the remainder being the value of the material equipment used for instruction purposes. Forty-one institutions have endowment funds of more than 200,000*l*. each. The rate of increase per year in the endowment funds was 41·3 per cent. during the five years 1900–1905. The total income for the year of these institutions for higher education, excluding benefactions, amounted to 8,355,000*l*., an increase of 289,200*l*. over the preceding year. Of this amount 23·6 per cent. was from endowment funds, 23·6 per cent. from State appropriations, and 6·9 per cent. from Federal appropriations. It is interesting to note that Harvard and Columbia had incomes exceeding 200,000*l*. each, eight other institutions had over 150,000*l*. each, three over 100,000*l*., and twelve more over 60,000*l*. The total amount of benefactions reported by all institutions during 1904–5 was 3,335,790*l*., of which 71 per cent. was received by thirty-three institutions which each obtained 20,000*l*. or more. Harvard received gifts amounting to 466,000*l*., Yale 279,000*l*., and Columbia 236,000*l*. The total number of men students in these institutions of higher education increased during the year under consideration from 86,006 to 92,161, and of women students from 32,023 to 34,243.

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 27.—"On the Velocity of the Kathode Particles emitted by Various Metals under the Influence of Röntgen Rays, and its Bearing on the Theory of Atomic Disintegration." By P. D. **Innes**.

(1) The velocity of the electrons emitted by lead, silver, zinc, platinum, and gold under the influence of Röntgen rays has been measured, both for soft and hard rays.

(2) The values found are as follows, the accuracy being within about 3 per cent.:

	Soft rays		Hard rays
Lead	$6 \cdot 3$ to $7 \cdot 6 \times 10^9$	...	$6 \cdot 3$ to $8 \cdot 3 \times 10^9$
Silver	$6 \cdot 0$ to $7 \cdot 2 \times 10^9$	...	$6 \cdot 1$ to $8 \cdot 0 \times 10^9$
Zinc	$6 \cdot 0$ to $6 \cdot 4 \times 10^9$		
Platinum ...	$6 \cdot 1$ to $7 \cdot 5 \times 10^9$	...	$6 \cdot 4$ to $8 \cdot 1 \times 10^9$
Gold	$6 \cdot 1$ to $7 \cdot 5 \times 10^9$	...	$6 \cdot 2$ to $8 \cdot 1 \times 10^9$

(3) The velocity of the fastest electrons emitted from each metal is completely independent of the intensity of the primary rays, but increases with the hardness of the tube.

(4) The velocity decreases with the atomic weight, the difference between the speed of the fastest electron with hard rays and that with soft rays being practically the same for the various metals, if the variation in hardness of the rays is the same.

(5) A minimum velocity is necessary to enable the electron to emerge, and the minimum velocity is nearly the same in the different metals.

(6) The number of electrons given off decreases with decreasing intensity of the rays, as well as with increasing hardness.

(7) The number emitted also decreases with decreasing atomic weight and density.

(8) The conclusion is drawn from calculation and discussion of other theories that the most probable theory is that of atomic disintegration. It is shown that the velocity of the emitted electron is too great to be that acquired under the influence of the electric force in the X-ray pulse. The other theory of ejection is discussed and objections to it pointed out. A possible explanation is given of the increase of the velocity with increasing hardness of the rays, and this fact is shown not to be inconsistent with the disintegration theory.

EDINBURGH.

Royal Society, July 8.—Dr. Robert Munro, vice-president, in the chair.—The plant remains in the Scottish peat mosses, part iii.: F. J. **Lewis**. The third part dealt with the peat mosses of the east and north-west Highlands, Shetland, and the Outer Hebrides. All the Scottish peat mosses show a definite succession of plant remains. The oldest in the south of Scotland and the Shetland Islands have an Arctic plant bed at the base. This is succeeded by a forest of birch, hazel, and alder containing temperate plants. A second Arctic plant bed occurs above the lower forest, and is overlaid in all districts except the Hebrides, Cape Wrath, and the Shetland Islands by the upper forest, covered by several feet of peat bog plants. While it is difficult to reconcile the several stages in the peat with the theory of a single glaciation, the peat beds as a whole agree very closely with the scheme of classification proposed by Geikie in "The Great Ice Age."—Note on the abyssal temperature of fresh-water lakes: E. M. **Wedderburn**. Observed distributions of lake temperatures were brought forward as illustrations of the author's view that the surface current set up by wind action produces a back current at a moderate depth, with a slow movement of the bottom layers parallel to the surface current.—The action of sodium ethylate on trichloromethylsulphonic chloride: Prof. A. Crum **Brown** and T. F. **Cowie**.—A hybrid between Prejvalsky's horse and a Highland pony: Prof. J. C. **Ewart**. In most respects the hybrid differed little from an ordinary cross-bred pony. In its mane, however, it afforded striking evidence of its mixed origin. The front part of the mane projected forward, but failed to form a forelock. The rest consisted of hairs which were either erect or arched outward, some falling towards the right, others towards the left. The experiment gave further evidence in favour of the theory that our modern horses are descended from several distinct stocks, of which the Prejvalsky horse is one.—A note on a reflected mirage: Dr. C. G. **Knott**. This was an account of a curious mirage observed in South Africa by members of a cadet corps who were camping out to the south-east of Worcester. With the town at their back the observers saw about four miles off, apparently on the back of the river, a recognisable image of the town itself.—The system sulphur-iodine: Prof. Alex. **Smith** and C. M. **Carson**. The freezing points of mixtures of iodine and sulphur show that these elements neither combine chemically nor form solid solutions.—Precipitated sulphur: Prof. Alex. **Smith** and R. H. **Brownlee**. Sulphur precipitated from polysulphides by means of acids is almost wholly composed of soluble rhombic sulphur. The fluid droplets of which the precipitate is at first composed crystallise to monoclinic sulphur, and the masses of the latter afterwards turn into rhombic sulphur without change in their spherical form. The sulphur precipitated from sodium thiosulphate by means of acids is wholly soluble when acetic acid is used. With hydrochloric acid the precipitate is viscous. The amount of insoluble sulphur is proportional to the concentration of the acid, and varies from 6 per cent. to 96 per cent.—Preliminary note on the optical rotations (throughout the spectrum), the electrical conductivities, and the densities of mixtures of sodium-potassium-tartrate and ammonium molybdate in aqueous solutions. The essential feature of the method lay in the measurements being made for all kinds of light. Interesting results were obtained with respect to the influence of non-active substances when added to active solutions.

July 15.—Dr. Robert Munro, vice-president, in the chair.—The Pycnogonida of the Scottish National Antarctic Expedition: T. V. **Hodgson**. The main interest of the *Scotia* collection lay in the problem of distribution to which it gave rise. Antarctic and sub-Antarctic regions were distinguished, being separated provisionally by the sixtieth parallel south. Of the fifteen species recorded from the *Scotia* the most striking was the *Decolopoda australis*, a species discovered and accurately described some seventy years ago, but forgotten, and when first noticed despised as a monstrosity or as a sample of defective work.—The marine mollusca of the Scottish National Antarctic Expedition: J. C. **Melvill** and R. **Standen**. The collection is interesting because of the number of deep-sea forms brought for the first time from unusual depths, and because of the extension of the geographical range of certain species already known. A second example of the hitherto unique *Guivillea alabastrina*, Watson, was dredged from a station not far from the original *Challenger* locality. Of the ninety-five species described, the gastropods claim fifty-nine with eleven new species, the scaphopods two with one new species, and the pelecypods thirty-four with nine new forms.—Preliminary note on the internal structure of *Sigillaria mamillaris*, Brongt., and *Sigillaria scutellata*, Brongt.; and description of a new species of Lepidodendron (*L. pettycurense*) from Pettycur: Robert **Kidston**.—The periods of the elliptic functions of Weierstrass: R. T. A. **Innes**. The paper gave a new method of calculating the periods when the invariants of the cubic were given.—Hydrachnidæ collected by the Lake Survey: W. **Williamson**. Among the various forms described there was a species of Whitfeldtia, which until now had not been found outside Norway.—Degenerations following experimental lesions in the motor cortex of the monkey: Drs. W. A. **Jolly** and Sutherland **Simpson**. Lesions were made in the motor cortex of the monkey, *Macacus rhesus*, involving portions of the leg, arm, and face areas. The fibres of the pyramidal tract arising from these areas were traced by the method of secondary degeneration from their source to their termination. It was found that the fibres from these areas begin to intermingle soon after they leave the motor cortex. In the internal capsule there is already a good deal of overlapping, and this is more marked still in the pes pedunculi. Throughout the pons, medulla oblongata, and spinal cord the intermixture is practically complete, so that below the level of the mid-brain there is no localisation or grouping of the fibres within the pyramidal tract as there is of the cells from which they take origin in the motor cortex. Above this level some localisation of fibres does take place, but it is only partial, the degeneration from one area encroaching upon that from the neighbouring areas to a considerable extent.—Classification of igneous rocks according to their chemical composition: Dr. H. **Warth**.—Note on quaternion integrals: Dr. H. **Hermann**. This was an improved demonstration of the generalised quaternion form of the theorems which include those of Green, Gauss, and Stokes.

PARIS.

Academy of Sciences, August 5.—M. H. Poincaré in the chair.—M. A. Lacroix announced the death of J. F. C. Klein, correspondant for the section of mineralogy, and gave an account of his work in the field of mineral crystallography.—Report presented by the committee charged with the scientific control of the geodesic operations on the equator: H. **Poincaré** (secretary). The last report was presented in April, 1905. A summary is given of the work done at seventy-four geodesic stations. Three base lines were measured, and magnetic and pendulum observations were also carried on throughout. The provisional calculations are well advanced. The triangulation and the concordance of the bases measured and calculated appear to be of the same order of accuracy as those used in the revision of the meridian of France.—The law of the velocity of hæmolysis of the red blood corpuscles under the action of light, of heat, and of some hæmolytic bodies: Georges **Dreyer** and Olav **Hanssen.** The decrease of the corpuscles after treatment with light or heat can be expressed by the monomolecular formula, and examples of this are given in three tables.—The heat of combustion and formation of gaseous hydrogen phosphide: P. **Lemoult.** This measurement has hitherto been made by indirect methods only. The author has carried out direct measurements by exploding hydrogen phosphide with oxygen in the calorimetric bomb. Observations were made with a Mahler enamel lined bomb and with a Berthelot platinum lined bomb, the results agreeing to about 0·5 per cent. The molecular heat of combustion of phosphoretted hydrogen is 310 calories at constant volume, 311·2 calories at constant pressure.—The silicide of platinum, SiPt, and on a double silicide of platinum and copper: Em. **Vigouroux.** Referring to a recent publication concerning this silicide SiPt by M. Lebeau and A. Novitzky, the author points out that he recently described the same compound, further details of which are now given.—The use of foreign materials modifying the forms of a crystal in course of growth to determine its crystalline symmetry: Paul **Gaubert.** Crystals of nitrate of urea have been variously ascribed to the monoclinic and rhombic systems. By utilising the effects of the presence of methylene blue or picric acid in the mother liquor from which the urea nitrate crystals are separating it has been found that the crystals of urea nitrate are monoclinic, and it is by an association following a plane perpendicular to the base that the groups appear to show a rhombic symmetry. This macle presents the curious property of not being noticeable from the optical behaviour.—Concerning two notes of M. Gerber, on the ferment of the Cruciferæ and the ferment of the Rubiaceæ: M. **Javillier.**

NEW SOUTH WALES.

Linnean Society, June 26.—Mr. A. H. Lucas, president, in the chair.—New Australian species of the family Calopterygidæ (Neuroptera: Odonata): R. J. **Tillyard.** *Diphlebia lestoides*, Sélys, is the only species of this exceedingly beautiful and interesting family so far described from Australia. Two additions are now made, one a common East Indian species (*Rhinocypha tincta*, Ramb.), and the other a beautiful new Diphlebia from northern Queensland.—A contribution to the geology of Viti Levu, Fiji: Dr. W. G. **Woolnough.** This paper comprises the results of the author's second expedition to Fiji in 1905. The granitic rocks met with in 1901 were shown to occur at intervals over an area of at least 400 square miles; evidence is now adduced to prove that their surface represents an ancient peneplain. The sections at Nasaqo and Nadrau previously described, and new and very instructive ones at Rewasau and Nukuilau, were examined. These prove conclusively that the granite is very much older than the volcanic series which builds the bulk of the island. The slaty rocks associated with the granites are shown to be, in part at all events, altered eruptive rocks. Their geological relationship to the granites has not yet been definitely proved. The earliest stage of the Cainozoic history of the island is marked by extensive submarine eruptions, later stages by terrestrial eruptions of andesites; and a probable sequence of eruptive rocks is suggested. The causes which led to the separation of the Fiji mass from the continental land to the west were assumed to be faulting, but no definite evidence of such a phenomenon was cited. Now fairly definite evidence is adduced to show that heavy faulting has taken place along a N.N.W.-S.S.E. axis. It is suggested that a second faulting has taken place along a W.S.W.-E.N.E. axis, parallel to the long axis of the Viti Levu-Vanua Levu *massif*. Extensive movements of elevation have taken place, causing a maximum uplift of nearly 5000 feet on the north-west with a marked tilt towards the south-east. River development affords scope for very interesting speculations, and several theories are dealt with in the paper. The marked rectangular network arrangement of the rivers is commented on, and is explained as chiefly due to earth movement. River capture has subsequently modified the original drainage in some particulars, and adjustment of drainage is proceeding very rapidly under almost ideal conditions. All the evidence obtained up to the present confirms the opinion formerly expressed that Fiji at one time formed part of a great Austral-Papuan continent.—Revision of the Australian Curculionidæ belonging to the subfamily Cryptorhynchides, part viii.: Arthur M. **Lea.** In this contribution the revision of the genera allied to Cryptorhynchus is continued.

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THURSDAY, AUGUST 22, 1907.

APPLIED OPTICS.

A System of Applied Optics, being a Complete System of Formulae of the Second Order, and the Foundation of a Complete System of the Third Order, with examples of their Application. By H. Dennis Taylor. Pp. xvi+334, with 24 plates. (London: Macmillan and Co., Ltd., 1906.) Price 30s. net.

THAT branch of geometrical optics which deals with the properties of lenses and lens systems has unfortunately been shamefully neglected in England during recent years. This neglect has extended from the theory to its practical applications, and the design and construction of lenses has, to a great extent, been relegated to other countries, notably Germany; although in the time of Dollond, M. Anthéaume was obliged to send to England in order to obtain lenses to carry into practice the theory of achromatism devised by M. Clairaut. Before the publication of the book which forms the subject of this review, there was no work, in English, by the guidance of which an ordinary photographic lens could be worked out in all particulars; and the fact that there has been practically no demand for translations of the numerous books on applied optics which have been published in Germany, shows how completely the subject has been neglected. If we seek for a reason to explain this state of affairs, it is not far to seek. The books on geometrical optics which have appeared in England during recent years have, for the most part, been written by mathematicians who could boast little or no acquaintance with the practical design of lenses; and as the formulæ which can be obtained for the correction and elimination of errors in lenses do not possess that "elegance" which is dear to the heart of the pure mathematician, practically no progress has been made since the time of Airy and Coddington: almost the only modern work which exhibits originality of treatment is a small volume [1] by Mr. Blakesley, published in 1903.

In these circumstances we cannot feel too grateful to Mr. Dennis Taylor for the volume before us. In this, everything which could aid the student in mastering the subject in the easiest and most pleasant way has been done, and done well. The numerous diagrams (drawn to scale, or as nearly to scale as is practicable), which are included in the twenty-four plates, must alone have entailed many hours of tedious labour. The principles underlying each problem that is attacked and solved are clearly and fully explained, while the steps in the analysis which have been omitted can easily be supplied by a reader with very moderate mathematical acquirements. But the chief interest of the book lies in the fact that it is the outcome of a successful attempt to design lenses for practical purposes. Finding that the formulæ arrived at by Coddington, for the curvature of the image formed by a lens, were not quite satisfactory, an attempt was made to solve the problem by some method not dependent on the calculus; and after several disappointments, Mr. Taylor was successful.

In this investigation the formulæ relating to "coma" or "side flare" were arrived at; it is significant that there is scarcely a book in English which even mentions this defect of lenses—a defect which is often of greater importance than those due to spherical aberration or astigmatism. As a practical outcome of the investigation, the Cooke lens was designed; and, finally, Mr. Taylor has embodied his investigations in the book before us.

It is, perhaps, a pity that Mr. Taylor has not adopted the usual convention as regards the signs of the quantities u, v, and r. In the end, one convention (when mastered) is as good as another; therefore, it would appear that the most suitable one is that which is most generally adopted. The convention adopted by Mr. Taylor makes u positive or negative (for a particular position of the object), according as the lens is collective or dispersive, while the signs of v, and the radii of curvature are determined in a similar manner. There appears to be no advantage in this procedure that is not shared equally with the one generally in use; and the reader accustomed to the latter is likely to experience some unnecessary difficulty in following Mr. Taylor's reasoning. This is, however, a detail of no vital importance.

The first chapter of Mr. Taylor's book is devoted to a brief recapitulation of the ordinary formulæ, of the first order of approximation, applied to mirrors and lenses. In the second chapter the "theorem of elements" is explained: a thick lens is shown to be equivalent to two thin lenses (called "elements"), and a plane parallel sheet of glass. The theory of thick lenses, and lens combinations, is discussed in chapter iii.; this theory, as explained by Mr. Taylor, is much simpler than that usually given in books on geometrical optics, although a further simplification is possible and desirable. At this early stage the reader is brought into touch with practice by using the formulæ that have been evolved, to calculate the focal lengths of some well-known lens combinations, including the Cooke process lens. Such calculations occur at short intervals throughout the book, and add much to its value.

Spherical aberration is discussed in chapter iv. The ordinary formula to the second degree of approximation is obtained, and is simplified by the aid of a device due to Coddington; a formula to the third degree of approximation is also worked out, but the reader may omit the investigation leading to this on a first reading, as it is somewhat complicated, though presenting no difficulty other than those generally met with in dealing with unwieldy formulæ. A geometrical device [1] due to Mr. Blakesley, might have been mentioned here with advantage. It can be easily proved that if all rays proceeding from a point on the axis of a lens pass through the lens in such a manner that the deviation of each is a minimum, then the spherical aberration is a minimum also; and Mr.

[1] "Geometrical Optics" By T. H. Blakesley. (London: Whittaker and Co., 1903.)

[1] "Geometrical Optics." By T. H. Blakesley, pp. 94-111.

Blakesley has given a simple geometrical means of designing a thin lens to comply with these conditions. Of course, spherical aberration is not the only, or even the most important defect of a lens; but the simplicity of the geometrical construction leads one to wish that expert mathematicians would devote some attention to the subject to see whether graphical methods could not be used in other cases.

Central and eccentric oblique refractions are discussed in chapters v. and vi. respectively. Eccentric oblique refraction is answerable for the phenomenon of "coma" or "side flare," which is discussed in great detail in chapters viii. and viii*a*. It would be impossible, in the short space of an article such as the present, to deal with the author's treatment of this interesting subject in detail; it must suffice to say that it has now for the first time been brought within the reach of any reader possessing ordinary mathematical attainments who will devote the necessary time and attention to the subject. Some of Mr. Taylor's results are similar to those obtained by Von Siedel, but many are novel. The most important advance effected by Mr. Taylor is the investigation of the foci of oblique and eccentric pencils of large aperture.

The distortion of the image formed by a system of lenses is very fully investigated in chapter ix., where it is shown that Coddington's method is defective in not carrying the spherical aberration of the first lens through to all succeeding lenses, a considerable error being thus introduced. The distortion produced by several combinations of lenses is worked out numerically, and it is shown that, in the case of an eye-piece of a telescope or microscope, an image which is really distorted *may* appear to be undistorted, owing to a peculiarity of the eye. Achromatism is dealt with in chapter x. In reading this, and, indeed, most other chapters of the book, one cannot help being struck by the care with which the author has experimentally tested the results obtained, sometimes finding that an extension of the theory is necessary (see, for example, p. 309). A brief sketch of the errors of the third order is given in chapter xi.

On closing Mr. Taylor's book, we are left to reflect on the living interest which he has given to mathematical investigations, essentially of a somewhat clumsy nature. Throughout the book, theory and practice go hand in hand, and we feel that the labour of solving the complicated problems which arise is well worth the while, for something tangible and useful is gained in the end. It would be well if the examining bodies of the various universities were to attach greater importance to geometrical optics, *studied from an essentially practical point of view*. At present the startling discoveries which have been made during recent years in other branches of physics absorb so much attention that many students who sit for advanced examinations in physics are culpably ignorant as to even fundamental properties of lenses. Questions on geometrical optics are rarely set by examiners; and when they are, they are too often merely mathematical exercises. Since accurate experimenting so often involves the use of lenses and other optical appliances, this state of things is greatly to be regretted.

EDWIN EDSER.

A THEORY OF THE ÆTHER.

Æther: A Theory of the Nature of Æther and of its Place in the Universe. By Dr. Hugh Woods. Pp. xii+100. (London: *The Electrician* Printing and Publishing Co., Ltd., n.d.) Price 4*s*. 6*d*. net.

THIS book is a more elaborated presentation of the views as to the nature of æther set forth by the author in a pamphlet published in 1808. The æther is "regarded as possessing properties such as might justify its being described as a gaseous fluid, composed of atoms almost indefinitely small as compared with recognised chemical atoms." Again, "Æther is a fluid whose ultimate particles, or atoms, are so small that they pass into the minute crevices of spaces in the most solid bodies." This view has much in common with some of the older theories of the æther, and is almost identical with that proposed by Mendeléeff in his tract, "An Attempt towards a Chemical Conception of the Æther" (1902), and which is referred to by the author in support of his views. No attempt is made to overcome the objection first urged by Maxwell to any theory as to the nature of the æther which postulates a discrete structure for it—that all the energy of the universe would have been transferred to it—and the same objection applies even if the æther is regarded as a limiting case of a medium possessing such a structure.

The theory proposed by the author cannot, therefore, be accepted as an ultimate theory of the æther. There remains the question whether this idea of the æther affords a satisfactory working model which could be used to give a concrete representation of physical and chemical phenomena, and enable their course to be definitely followed. The theory is applied to a wide range of phenomena, including gravitation, chemical changes and reactions, heat, light, electricity and magnetism. Many of the explanations that are claimed as consequences of the particular theory would follow from any theory of the æther that assigns to it the fundamental properties of a moving system. The reasoning is in general vague, and the argument is never pushed far enough to enable a quantitative comparison to be made. A few examples will suffice to show the character of the reasoning. On p. 3 the following argument is given:—

"The solar system appears to move through space, borne along in an enormous volume of swiftly flowing æther. Now the resistance offered to the free flow of the æther by the partially impervious bodies floating in it is evidently greatest in the line of greatest thickness of each body, and less as the thickness becomes diminished. Accordingly a difference of momentum is thereby caused in the mass of æther, dashing against the body, and there results a current in the æther from places of higher momentum to places where the momentum is lower, with the effect that a whirl, such as occurs in the air under similar circumstances, is produced. These whirls, then, by their continual action, make the bodies more or less spherical, and set them rotating, each on its largest axis, while the whirls, spreading out in ever widening circles, influence the movements of other bodies floating in the same medium." "In this way, the movements and mutual influence of the heavenly bodies may be explained, in a perfectly rational manner, and without imagining any occult power of attraction."

The reasoning here appears to be scarcely conclusive; there is some unexpressed assumption as to the nature of the action between æther and matter; and that whirls (by which some kind of vortex motion appears to be meant) would necessarily result wants demonstration. These whirls have, at a later stage in the book, to do duty in explaining terrestrial magnetism as well as the relations of the heavenly bodies and their gravitational attraction. Again, p. 11:—

"It has long ago been proved that in æther all bodies fall with equal rapidity towards the centre of the earth, and it may, therefore, be reasonably assumed that all atoms which displace equal amounts of æther have equal weight. There are, however, many and convincing reasons for believing that the atoms of different chemical elements have widely different weights." "The explanation, then, which suggests itself as accounting for this difference, according to the present theory, is the very simple one that the heavier atom is of larger bulk, and displaces more æther than the smaller atom. From this it follows that the sizes of chemical atoms are in the same ratio as their weights."

From this, Gay-Lussac's law and Avogadro's law are derived. Boyle's law and the deviations from it are treated much in the same fashion, and the author then finds it necessary to introduce another factor (p. 15), the *shape* of the molecules. A table of the chemical elements arranged with their atomic weights in ascending order of magnitude (the character—gas, liquid or solid—of each being stated) is given. Arguing from this table, the statement is made:—

"It must hence be admitted that elements with a low atomic weight are much more disposed to be gaseous than those of higher atomic weight, at ordinary temperature and pressure. This quite accords with the theory that their ultimate particles are smaller than those of elements with higher atomic weights."

The difficulty that there are so many solid elements of low atomic weight is got over by invoking the influence of shape. For example, the liquidity of mercury is explained by supposing the atom of mercury to be spherical. A curious reader might wish to know the approximate shapes of the atoms of argon or lithium, but on this point the author is silent. After some pages of the same kind of reasoning, two laws are enunciated: —

(1) "The condition of chemical elements or of chemical compounds, at similar temperature and pressure and under similar conditions generally, depends on their atomic or molecular weights (that is, on the size of their atoms or molecules) and on the shape of their atoms or molecules." (2) "The relative chemical activity and chemical properties of chemical elements or chemical compounds, at similar temperature and pressure and under similar conditions generally, depends on their atomic or molecular weights and on the shape of their atoms or molecules."

The term law appears to be used here in a somewhat unusual sense, as these statements do not constitute laws; to make them such, the laws of dependence should be known. Another good example of the author's mode of reasoning is to be found on pp. 53, 54, where the fact that glass is transparent to light but opaque to heat is explained by the peculiarities of the interstices filled with æther in the case of glass, the nature of these being inferred from the way in which glass fractures.

It will appear from these examples of the author's treatment that his theory cannot even make good a claim to be considered a reasonable working model. A great number, however, of the better known physical and chemical phenomena are brought together, and on this account the book may perhaps prove interesting to readers who have not sufficient leisure or inclination for the perusal of treatises and memoirs that have greater pretensions to scientific accuracy.

FOUNDRY PRACTICE.

General Foundry Practice. By A. McWilliam and P. Longmuir. Pp. vii + 383. (London: Charles Griffin and Co., Ltd., 1907.) Price 15s. net.

THE opinion is generally held among metallurgists that with the rapid progress made of recent years in Great Britain in the metallurgy of iron the foundry has hardly kept pace. Mr. McWilliam and Mr. Longmuir take a more optimistic view, and believe that advances have been, and are being, made of a magnitude commensurate with those of other industries. Certainly signs of progress are apparent in this important branch of metallurgy. The empirical method of charging the cupola is giving place to the system of weighing all materials in proportions determined by the chemist. High-temperature measurement is being practised in the core and drying stove. The field for machine moulding is extending. Permanent moulds made of carbon or similar material are being tried; and the founder is just realising the fact that micrographic analysis has a commercial value. In short, in all branches of his work he is showing a praiseworthy desire to emerge from the slipshod ways of the past. The literature of the subject has, however, remained meagre, and not of a strikingly scientific character. Scattered through the pages of the Journal of the Iron and Steel Institute and of the iron trade journals there is much information of permanent value; but the special treatises on the subject are mostly of an elementary character. The exhaustive work by Mr. McWilliam and Mr. Longmuir may therefore fairly be regarded as marking an epoch in the history of iron founding, and should help greatly in effecting a clear understanding of the subject. The authors possess special qualifications for the work they have undertaken. Mr. Longmuir has held the position of foundry foreman, and is a Carnegie research medallist of the Iron and Steel Institute, while Mr. McWilliam, a distinguished Associate of the Royal School of Mines, has at the University of Sheffield had ample opportunity of ascertaining the needs of students. They have therefore been able to draw upon experience gained under normal foundry conditions and under the conditions of experimental laboratories, and the operations they describe have been personally followed.

The subject-matter is dealt with under the following heads: General properties of matter; moulding sands; facing sands; foundry tools; moulding-boxes; handling material in the foundry; open sand moulding; cores; elementary aspects of moulding; green-sand moulding; securing cores in moulds; moulding from guides; bench, outside, and plate moulding; machine moulding; dry sand moulding; loam moulding; chill casting; casting on to other metals; weighing and binding moulds; shrinkage, contraction, and warping; dressing castings; common faults due to mould and pattern; wrought iron; cast iron; refractory materials; fuels and furnaces; mixing by analysis; further treatment of cast iron; high-temperature measurement; steel; metals other than iron; alloys; mechanical testing; micrographic analysis; common faults due to the metal; and foundry management. The illustrations, of which there are 246, have been carefully chosen, and, like the letterpress, are exceptionally well printed. From this enumeration of the contents it will be seen that, although bearing the comprehensive title of "General Foundry Practice," the work is almost entirely devoted to iron and steel founding. Metals other than iron are disposed of in some twenty pages, brass founding receiving chief attention. The ingenious *cire perdue* process of bronze casting is not mentioned, nor is the modern method of casting in sections bronze statuary of heroic size, such as Bartholdi's "Liberty" at New York and Schwanthaler's "Bavaria" at Munich. The plaster moulds used for this purpose might have been added to the green sand, dry sand, loam, and chilled moulds described by the authors. A few lines, too, might have been devoted to the moulds used for metals with low melting points, brass, slate (for toy soldiers), wood, and even paper (for stereotype plates) being employed.

As the eye of the metallurgist wanders up and down the authors' well-filled pages, it will be arrested by that section which deals with the influence of the various impurities in cast iron. Phosphorus, it is shown, increases the fluidity of cast iron and renders the metal suitable for art castings, such as those for which the Russian works at Kyschtym are famous. Sulphur tends to make castings harder and brittle. Silicon, by tending to throw the carbon out of the combined form and to make it appear in the metal as graphite, has a beneficent influence. Manganese, on the other hand, has a tendency to keep the carbon in the combined form. These facts have to be borne in mind in mixing by analysis, a method which, it is gratifying to find, is steadily replacing mixing by fracture, by guesswork, or by trial. As the underlying science of the founder's art becomes more and more clear, well-marshalled knowledge is increasingly helpful. As the authors point out, the real theoretical knowledge of the man of science is built on experiment, and his theories are tested by further experiment. The practical man constantly meets with difficulties in his work; and he also must, in a truly scientific way, devise a remedy by testing the results of his former experience. The apparatus may be cruder than that of the laboratory, but it will be used with a subtle judgment of the needs of the case. The man who combines a scientific training with practical experience is gradually, but surely, becoming the dominant type of industrial captain in the best equipped foundries.

The book is unusually free from typographical and other errors, and there is little in the arrangement of the material to which exception can be taken. It might perhaps have been well to have carried the subject a stage further, and to have given the student some information regarding the galvanising, nickel-plating, lacquering, and porcelain enamelling of castings, and regarding the repairing of faulty castings by melting in iron by means of the electric arc or the oxyhydrogen blowpipe. Pattern making is altogether ignored. It is true that it is a distinct trade involving the skill of the joiner and the turner. A practical founder should nevertheless have a general knowledge of the construction of foundry patterns; and the elaborate patterns, sharply chased in a tin-lead alloy, used for ornamental castings present many features of interest to the foundry managers and foremen for whom the work is primarily intended.

OUR BOOK SHELF.

Eversley Gardens and Others. By Miss R. G. Kingsley. Pp. x+280. (London: George Allen, 1907.) Price 6s. net.

It is always stimulating to meet with enthusiasm, and Miss Kingsley is not only an enthusiast with regard to individual plants, but possesses a keen eye for their artistic setting and arrangement. Eversley is situated on the Bagshot beds in a part of Hampshire that has received the *sobriquet* of "the rubbish-heap of the world"; and as much of Miss Kingsley's experience was gained in laying out and cultivating the garden of Keys House, in Eversley, her success may serve as a help to other amateurs whose energies are also concentrated on poor soil.

It would appear that roses have been Miss Kingsley's chief delight, especially the teas, hybrid teas, and climbers. She presents a lengthy choice, arranged in colour groups, containing besides such universal favourites as G. Narbonnand, Frau Karl Druschki, and Caroline Testout, others less generally known, as Madame Ravary, Coquette de Lyon, and Monsieur Trillier. The list of rhododendrons, a plant that finds a congenial home on the Bagshot soil, is especially noteworthy, and the plan of growing bulbs in peat fibre in bowls is recommended as a clean and rapid method for producing fine flowers. While it is probable that most gardeners will find many hints and references to species unknown to them, it is certain that all can learn much from the artistic combinations described by the author, some produced in her own garden, others in her friends' gardens.

The Friendly Stars. By Martha Evans Martin. With introductory note by Prof. Harold Jacoby. Pp. ix+253; illustrated. (London and New York: Harper and Brothers, 1907.) Price 5s. net.

Evidently written by one who for years has been in the habit of looking upon the stars as companions, rather than as conglomerations of known and unknown elements, this volume will appeal to the beginner in astronomy and to the general reader quite as much as to the astronomer.

After dealing generally with the apparent movements and with the brightest stars, the author proceeds to thirteen chapters containing causeries on particular stars, describing the relative position of each, its seasonal apparitions, its diurnal path, and its colour, &c., adding a few words as to the distance and physical conditions of each star.

More general problems are then discussed, such as the numbers, distances, and light of the stars. A brief chapter on double stars gives an excellent first idea of multiple systems, and is followed by nine chapters dealing with the constellations, frequent diagrams illustrating the text. By those who simply wish to recognise the individuals of the starry host, and to be *au fait* with sufficient characteristics of each to mark its individuality, the volume will be found a useful companion. W. E. R.

On the Evolution of Wound-treatment during the Last Forty Years. By Sir Hector C. Cameron, Professor of Clinical Surgery in the University of Glasgow. Pp. 96. (Glasgow: James MacLehose and Sons, 1907.)

THE appearance of this book at the present time is opportune, for the lectures deal very largely with Lord Lister's researches on antiseptic treatment, of which they form a brief history. Lister's treatment was founded on Pasteur's demonstrations and writings, and no man ever acknowledged an indebtedness more often and more unequivocally. At the commencement of the first lecture the procedure adopted in 1860, or thereabouts by Mr. Syme, the period immediately preceding the introduction of antiseptics, is detailed. In 1868 or so Lister's first method of treating wounds antiseptically was being tested by its author. This consisted in swabbing the wound with undiluted carbolic acid (a crude and impure preparation at that time) and covering it with lint saturated with the same substance, over which a piece of sheet-lead was placed; each day the lead was removed and the lint painted over with the carbolic. By such treatment, crude and simple as it may now appear, it was abundantly demonstrated that wounds, even the dreaded compound fracture, would heal without suppuration. Subsequently, a putty consisting of whiting and carbolic acid was used, and step by step carbolic gauze, corrosive sublimate, mercuric iodide, and the cyanide gauzes were evolved. The author holds that no mere dressing with dry sterilised wool or gauze, apart from germicidal solutions, will suffice to prevent suppuration in dirty wounds, and with this pronouncement many will cordially agree.

Vortex Philosophy: or the Geometry of Science Diagrammatically Illustrated. By C. S Wake. Pp. 36. (Chicago: Published by the Author, 1907.)

"As negation is the expression of energy and position is the expression of force, the elements of undulation, which is the dynamic aspect of the molar energy light, are expansion in the atomic field and ionisation in the molecular field; and the elements of spiralisation, which is the dynamic aspect of molar force (gravitation), are contraction in the atomic field and convergence in the molecular field" (p. 20). This extract shows that Mr. Wake has an extensive vocabulary. and a fund of unconscious humour. His pamphlet has no scientific value. but is amusing in its way as an attempt to classify all human knowledge on principles ostensibly scientific and logical. but really vague and æsthetic. Even from this point of view the coloured diagrams vii. and xii. are unsatisfactory.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The August Draconids—Perseid Fireballs.

IMMEDIATELY after coming out to watch the northern sky on August 15 at 9h. 23m., I observed a second-magnitude meteor appearing stationary at the point $288° + 61°$, near *o* Draconis. Four other meteors were seen directed from precisely the same position during a watch of forty minutes later on the same night, but clouds came over before 10h. 30m., and though the sky cleared at a later hour I did not look out again.

This radiant point in Draco is nearly identical with that of a brilliant shower of fifty-six slow-trained meteors which I observed on 1879 August 21 to 25. I also recorded it in several other years, but it was very feebly represented. It appears to be visible both in July and August, but though I have often eagerly awaited it, the striking activity it displayed in 1879 has never been repeated. Possibly this year it may have returned more richly than usual, and I trust other observers recorded it while watching the later stages of the Perseid shower.

The following are the positions I have obtained for the Draconic radiant in past years:—

(1)	1888, July	8-13	... $290° + 59°$ ...	4	Slow.
(2)	1885, ,,	9-13	.. $290 + 60$ ...	5	Slow.
(3)	1900, ,,	24-30	... $291 + 59$ ...	6	Rather slow.
(4)	1899, Aug.	12-16	... $293 + 60$ ...	8	Medium.
(5)	1901, ,,	15	.. $290 + 60$ ...	3	Rather swift, suspected.
(6)	1900, ,,	16-18	... $291 + 60$ ...	5	Slow.
(7)	1887, ,,	20-24	... $289 + 60$ ...	5	,,
(8)	1879, ,,	21-25	... $291 + 60$ ...	56	,,

Of all the meteors seen during the recent Perseid display, one of the finest appeared on August 12 about 11h. 12m. It was recorded at Bristol and at Stockport, and at the latter place Mr. J. P. Kenyon estimated that it burst out so brilliantly as to give a flash equal to the light of the full moon.

The object fell from a height of seventy-nine miles over Donington, Lincolnshire, to forty-four miles over Market Harborough, Leicestershire. Its length of visible course was fifty-two miles, and observed velocity forty-one miles per second. Other observers probably noticed this fine meteor, and I will be glad to receive further descriptions of its apparent path with a view to determine its real course more accurately.

There was another magnificent Perseid which gave a flash like lightning as it descended in the Milky Way north of Aquila, on August 13 at 14h. 10m., but the only account of this is one from Mr. W. Lucking, of Manuden, near Bishop's Stortford. W. F. DENNING.

Bishopston, Bristol, August 19.

The Heating of a Balloon Wire by Lightning.

THE following account of the heating of a balloon wire by a lightning discharge is interesting as furnishing approximate limits for the energy of the discharge.

Report by Mr. S. F. Cody on Striking of a Balloon by Lightning on July 22, 1907.

"At about 11 a.m. on Monday, July 22, a captive balloon, carrying meteorological instruments, was in the air. Some 4500 feet of 19 S.W.G. tin-plated piano wire was between the balloon and the winch. The balloon was probably about 3500 feet high. The winch was exceedingly well earthed, standing on a large solid iron plate, which was also buried about $1\frac{1}{2}$ feet in the earth.

"I was trying to locate the balloon, which was hidden by clouds at the time, when a flash of lightning came crossing horizontally, and then a quick stroke to the earth.

"Being unlike anything I had ever seen before, I set about inquiries to find out whether the wire had been struck or not. No smoke appeared from the flash. There was a deep hissing noise, followed by the natural crash of the thunder some seconds afterwards.

"The hissing noise was probably the wire falling, as it was in many cases driven 2 or 3 inches into the earth. I was about 180 yards from the winch in the same direction as the wire, and about forty yards from directly under the wire to the left, looking from the winch.

"The balloon went away free, carrying the instruments, and was watched for several minutes, as it happened to pass through a clear portion of the sky where no clouds were at the time. It has not since been recovered.

"On investigation of the wire I found that near the winch, say about 250 yards from it, the wire became less tempered; in fact, it would stand bending quite well in the portions found near the winch. It was fused right off at the first wheel of the winch, and was undamaged at the drum of the winch.

"The weather was sultry; there had been some rain. The wind was light but squally, W.N.W. There had been no lightning previously.

"The following are some observations taken on the ground about an hour before the wire was struck:—

Dry bulb	18° C.
Wet bulb	15°·8 C.
Barometer	29·85

Wind, N.W. to W.N.W.

"Specimens of the wire enclosed."

It appears from the specimens of wire that the heat developed was sufficient to melt the tin but not to fuse the wire. If then we assume that the process is too rapid for loss of heat by conduction, we get for the limits between which the heat energy must lie $6\times1400\times200\times0{\cdot}11$ and $6\times1400\times1300\times0{\cdot}18$ in gram degree units, the wire weighing about 6 grams per metre, and the mean specific heat of steel from 0° C. to 1300° C. being taken to be 0·18.

In ergs the limits become $7{\cdot}12\times10^{12}$ and $8{\cdot}28\times10^{13}$, or, assuming the height of the cloud to be 100 metres, the energy was sufficient to raise 73 kilograms, but not sufficient to raise 840 kilograms, to the cloud level.

The fact of the wire being less brittle in the lower portion points to a diminution of the energy developed, but no reasonable explanation of this is apparent unless it is due to an induction effect.

In the case of a similar discharge on April 11 of this year, the wire was completely fused from the balloon to the winch; the length of wire out was half a mile, and the height of the balloon 2000 feet. The balloon was in the clouds at the time. The discharge in this case also took place by a cross flash from cloud to balloon. An account of the occurrence is given in a paper by Colonel Capper, read before the Royal Meteorological Society in May. E. GOLD.

Meteorological Office, 63 Victoria Street, London, S.W., August 19.

The Origin of the Domestic Striped Tabby Cat.

IN the Proceedings of the Zoological Society for February of this year I attempted to prove that English domestic cats are to be referred by their patterns to two distinct kinds, which were described as the blotched and striped tabbies; and in discussing the possible origin of these two cats, I set the blotched tabby aside as of unknown descent, and stated it as my conviction that the striped tabby was to be traced to the interbreeding of two well-known wild species, namely, the European wild cat (*Felis sylvestris*) and the so-called Egyptian or African wild cat (*Felis ocreata*). There were living at that time in the Zoological Gardens a male example of *F. sylvestris* from Scotland and a female example of *F. ocreata* from Uganda. The latter was captured as a kitten near Nairobi in March, 1906, and had never been put to a male. To test the truth of my belief that the progeny of these two species would resemble our domestic striped tabby, and also to discover if there was any foundation for the theory some authors had put forward previously that the blotched tabby was the result of such a cross, the two cats in question were placed in the same cage this summer. They took to one another at once, and last week the female produced a litter of kittens resembling in every respect a typical striped tabby such as may be seen any day in the streets of London. R. I. POCOCK.

Zoological Society's Gardens, August 18.

A Fossil Tsetse-fly in Colorado.

AMONG the interesting materials obtained this year in the Miocene shales of Florissant, Colorado, is a large "biting" fly, with a remarkably long and strong proboscis, very well preserved. A very superficial examination was sufficient to show that it was no ordinary Tabanid or Muscid, and it at once occurred to me that it was a tsetse-fly. Having no specimen of the latter at hand, I turned to the admirable coloured figures in the second report of the Wellcome Laboratories at Khartoum, and, as was expected, it matched so nearly that it might well go in Glossina. There is a slight difference in the venation which may or may not be of generic value, but if the insect is not a Glossina it is at least closely allied. Curiously, it is not new, for it appears to be the species described by Scudder in 1892 as *Palocstrus oligocenus*, a supposed new genus of Œstridæ. The new specimen, practically complete, and with the mouth-parts, shows that it has nothing to do with Œstridæ, and anyone who will refer to Scudder's figure will see how closely the venation resembles that of Glossina.

The specimen obtained this year was found by Mr. George N. Rohwer, a member of our party from the University of Colorado. It is an obvious suggestion, following some remarks lately published by Prof. Osborn, that the existence of such flies may have had something to do with the extinction of some of the Tertiary Mammalia of America. T. D. A. COCKERELL.

University of Colorado.

PHYSICS AND CHEMISTRY.

"ONE of the penalties of devotion to a progressive science is the constant feeling of being left behind." So says the president of Section B, in his address from the chair, at the recent meeting of the British Association; and although he adds that he does "not think there is any occasion for panic," yet the concluding portion of his address seems to indicate that something approaching fear accompanies the impression that the progress of science at the present time is almost too rapid. There were some other indications, also, at the meeting, that physics at the present time is mistrusted by some chemists, to an extent perhaps beyond ordinary and necessary caution.

With a great part of the address agreement is easy. The plea that chemists should continue chemists, and that accurate manipulation and careful experimenting should be strenuously cultivated, is so reasonable as to be almost trite: for who would have it otherwise? That an atomic theory of matter, which has proved so useful in the past, should be adhered to as a guide in the future is also a natural desire against which no physicist has a word to say. Indeed, very much the contrary: the atom of matter is as useful a conception as ever, and has become even more real and concrete owing to the actual counting and measuring of individual atoms by physicists. But that physicists and mathematicians should leave the atom alone, and refrain from discomposing examination into its probable internal structure, should cease to break it up and otherwise modify it by appropriate agencies, and should turn a blind eye to any spontaneous explosions of energy whenever they have the bad taste to occur; also that no element shall be discovered and named which has zero chemical affinity, or which cannot be obtained in weighable amounts—all that is surely more than Section B has any right to expect, nor do I suppose that it seriously makes such a demand.

But the worst of a pessimistic outcry about the over-rapid development of science is that it is taken up by the general public, one section of which is always hoping that what is unintelligible is really meaningless, and may be safely ridiculed or ignored. So it has happened that a strange sentence in Prof. Smithells's address, which I will quote directly, is made the text for a singular attack by a leading article writer in the *Times* of August 6 apparently against the Cambridge school of mathematical and experimental physicists, which for a long time now has been in the eyes of the world one of the scientific glories of this island. The quotation is as follows:—

"There is never more cause for anxiety than when we see a mathematical theory awaiting the delivery of the confirmatory facts; and there is nothing more important for chemistry than the continual recruiting of that old guard which will be ever ready to stand to arms on the appearance of an eager theorist."

Now it is an old and recognised tradition that mathematical prediction of a fact to be subsequently confirmed by experiment is the highest achievement of science. The clearer the prediction, and the more rigorous the subsequent verification, the greater should be the joy among all those who wish for the advancement of natural knowledge.

That the theory should be completely intelligible to those comparatively ignorant of mathematics, until the fact has been arrived at experimentally, is not to be expected; and that a few should suppose that the prediction is only really forthcoming after the event—which is when they first hear of it—is also not unnatural. But the preparation of a theoretical niche for a fact, either just discovered or just on the verge of being discovered, is a piece of work involving the highest faculty of scientific insight; and it is to be hoped that the public are not going to be misled into a depreciation of the work of all except those who, very rightly, collect an assemblage of facts.

There is room for workers of all kinds towards the progress of science, and the encouragement and countenance of the public is one of the conditions; for often enough the difficulties of the work itself are more than discouraging, and if uncertainty as to its reception or appreciation by the contemporary human race is to be added, then it is to be feared that the discouragement may in some cases become complete. Such a catastrophe actually happened in the case of Thomas Young; but it was not the outcome of a meeting of the British Association for the Advancement of Science.

Probably the real intention of the president of Section B was to caution certain physical chemists, and perhaps to restrain or rebuke some of the Ostwald school in his own section; a matter well within his jurisdiction. Indeed, if he only wishes to express dislike at an attempted replacement of ordinary dynamics by a vaguer "energetics," he will find sympathisers among the physicists; as witness the following quotation from an article by the late G. F. FitzGerald in NATURE for March 12, 1896 (reproduced in his collection, "Scientific Writings," p. 387), with reference to an article by Prof. Ostwald called "Emancipation from Scientific Materialism." I must add, however, that FitzGerald was a keen admirer of the work of Prof. Ostwald in general, though in this particular doctrine, especially on its negative side, he did not consider that he was on a hopeful path. The quotation is as follows:—

"There are so many vague fallacies underlying it, that it would hardly be worth answering, only that there is considerable risk that others, chemists especially, may be carried away by the arguments of one whom they rightly value as a leader in their own domain, when he descants positively about the realm of mechanics."

For the present purpose I need not enter upon a discussion of this matter: there is doubtless much that can be said on both sides. If the president of Section B had so expressed himself as to drive home this kind of caution among the members of his own section, without appearing to refer to better known and more immediately prominent subjects of debate, I should have said no word; and I desire it to be clearly understood that I am not now expressing any opinion on this subject. But, unfortunately, that is not how his address has been regarded from outside, nor is it the interpretation to which certain phrases, such as "chemistry of phantoms," "exuberance of mathematical speculation," readily lend themselves. It is in the hope that damaging misunderstanding may be avoided that this article is written. OLIVER LODGE.

A TRIAD OF SPORTING BOOKS.[1]

TO the author of the volume standing first on the list given below, the wilderness from time to time calls with such persistence and force that to hear is practically to obey; and, whether to shoot wild goats in the Taurus, to collect vultures' and eagles' eggs in Asia Minor or Spain, or to track the lordly moose and the branching-antlered caribou in the wilds of the far North-West, Mr. Selous returns year after year with unabated zest to the roving life of his earlier South African days. That the public benefits from this restless disposition can scarcely be denied, for although he cannot be credited with anything special in the matter of literary style, the author of "Recent Hunting Trips" writes with that freshness and *verve* that almost transports the reader to the very scenes of his adventures and triumphs. Nor is this all, for Mr. Selous is essentially of a generous nature, and it is but seldom that he returns from one of his sporting trips without some important addition accruing to the national museum.

In the volume now before us, the author gives an account of his experiences during several shooting trips to British North America, undertaken between the years 1900 and 1906 (inclusive) in search of moose, caribou, and wild sheep; these, which include two visits to Newfoundland, comprising the whole of his hunting in this portion of the New World. In the preface, Mr. Selous records his opinion with regard to the closure to the sportsman of the central districts of American Alaska—an opinion worth quoting, as it has a bearing on so-called game-preservation in other parts of the world. Although the sportsman, who would be content with a few good trophies of male animals to add to his collection, is completely shut out, the game is by no means protected. The Indians, for instance, armed with modern weapons, can apparently shoot as they will, and spare no animals of either sex or of whatever age which come in their way, while meat-hunters of European blood are no less destructive. Although the Indian doubtless has the justification that he shoots, in part, at any rate, for his own maintenance, yet it is he and his white fellow-countrymen who, in the author's opinion, will ultimately bring about the extermination of the game with which the land now abounds, unless the whole system of game legislature is altered, and that speedily.

[1] "Recent Hunting Trips in British North America." By F. C. Selous. Pp. 400; illustrated. (London: Witherby and Co., 1907.) Price 16s. net.
"Game and Game Coverts." By John Simpson. Pp. 83; 15 plates. (Sheffield: Pawson and Brailsford.) London: County Gentlemen's Association, Ltd., 1907.) Price 15s.
"How to Fish: a Treatise on Trout and Trout-fishing." By W. E. Hodgson. Pp. xii+377. (London: A. and C. Black, 1907.) Price 3s. 6d. net.

Although from the point of view of bodily stature the moose (or elk, as it is commonly called in England) is undoubtedly the finest animal in this part of the world, the various races of caribou (or reindeer) are calculated to attract the interest of naturalists to a special degree on account of the incredible numbers in which they occur, not only on the mainland, but also in the almost untrodden heart of Newfoundland; while their periodical migrations in certain districts are among the most wonderful phenomena in big-game life. Not the least marvellous feature in these "treks" is the manner in which whole herds sometimes swim in company, so as to form in certain cases, as described by a recent traveller in Labrador, a veritable living bridge. In other cases, however, they travel in small parties, or even in pairs, lying down to rest or pausing to feed as their inclinations prompt.

FIG. 1.—Caribou on migration. From "Recent Hunting Trips in British North America."

"On one occasion," writes the author, "herd after herd of caribou passed the end of the lake in full view from where we were sitting. These herds were all small, consisting of from three or four to ten animals. They were all following the same trail, and were evidently migrating from the north-east to the south-west. Although they kept stopping to feed they travelled fast, often trotting as if alarmed."

With the assistance of various friends, the author has been able to illustrate his book with a number of striking photographs of migrating caribou, some showing the animals as they traverse the scrub in well-beaten tracks, and others their appearance when swimming lakes or rivers. As a permanent memento of the latest trip, reference may be made to the two magnificent caribou shot by the author and presented by him to the British Museum (Nat. Hist.), where they are now set up in the mammal gallery, one of these representing the large dark-coloured *Rangifer tarandus osborni*, and the other the smaller and whiter *R. t. terrae-novae*. Special interest, it may be added, attaches to the mention (p. 73) of the manner in which the spreading feet of the caribou enable the animal to traverse boggy ground, where horse, ox, or ass would be helplessly mired. Lack of space prevents mention of a number of interesting points in this fascinating book of adventure and sport, but we must refer to the author's measurement of his finest bull moose (p. 215), the height of which is given as 6 feet 11 inches. Reference must also be made to an interesting opinion in connection with wild sheep, namely, that the white *Ovis dalli* probably grades into the grey *O. fannini*, and the latter into the black *O. stonei*. The view that these sheep are but local races of the Kamchatcan *O. nivicola* is supported; the true *O. canadensis*, like the true grizzly bear, having departed further from the northern type owing to its having travelled further south, and perhaps having entered the country at an earlier date than the others.

The second (like the third) work on our list is entirely for the stay-at-home sportsman, and is intended to emphasise the importance of much greater care being exercised by game-preservers as to the culture of covert suitable for different kinds of game. Hitherto the general practice has been to let coverts grow more or less as they will; but the author, who has had great practical experience of the subject, shows that this is altogether wrong. Not only is one kind of tree or bush specially suited to particular species of game, but care is needed in order that such trees or bushes may have proper opportunities for full development. A case in point is afforded by the blackberry bramble, which needs open space and sun, when it affords not only excellent covert, but also a valuable food-supply. In this connection it may be mentioned that in Mr. Simpson's opinion gamekeepers err in over-feeding their charges; which, to say nothing of economical considerations, would be far better in many ways if left to get their own living in properly planted coverts. Game-preservation, according to the author, is likely to become more and more profitable to English landlords; and special attention is directed to the economic value of rabbits on estates. The special feature of the book, which should be in the library of every landowner and game-preserver, is the beauty of the illustrations of different kinds of covert, when properly developed; the most exquisite of all being the photograph of a mound of blackberry bramble in fruit.

Sometimes we venture to think that authors do not select sufficiently comprehensive titles, but in the case of Mr. W. E. Hodgson's book, standing third on our list, the main title seems to err in the opposite direction. For in place of instructing the angler in the art of alluring river-fish of all kinds, this volume, as, indeed, is indicated in its supplementary title, tells him only how to capture the wily trout. Since, however this is, *par excellence*, the sporting fish of English rivers, there may be some justification for the designation. The author has already published a more ambitious work on trout-fishing, which has, we believe, been well received by anglers; but that volume is intended mainly for the benefit of those who are already experts in the gentle art, whereas in the one now before us it is sought to instruct the beginner in the elementary principles of trout-fishing.

Mr. Hodgson is evidently one of those who believe that salvation is to be found otherwise than by "dry-fly" fishing; and a considerable portion of his work is accordingly devoted to other methods, inclusive of spinning with minnows, and luring with the luscious wasp-grub. That the author will not please every angler in all details may be regarded as a matter of course; but, speaking generally, he seems to have treated his subject in a manner which ought to satisfy those who are making their first essays at trout-fishing. The book is well illustrated, and likewise contains a number of observations on the natural history of the subject, and, indeed, on nature-study generally.

R. L.

GENETICS.[1]

THE last contribution to the fast-increasing pile of Mendelian literature is unique. It is at once the bulkiest, within the limits of two covers, that has been made to this subject, and at the same time the most condensed, the most varied, and the most valuable.

The third International Conference on Genetics, held under the auspices of the Royal Horticultural Society, and under the presidency of Mr. Bateson, was a veritable Mendelian orgie. The history of all new theories is the same. They are judged not so much on their own merits as on the number and variety of natural processes, previously unintelligible, which they explain. The result of the publication of the "Origin of Species" was, as Mr. Bateson has pointed out, the distraction of the attention of biologists from the process of evolution itself and its diversion into the hitherto dry channels of palæontology, classification, embryology, comparative anatomy, and distribution. It was not until the end of the nineteenth century that men returned to the study of evolution. The relation between man and a new theory is the same as that between a child and a new toy. When we first get the toy we are occupied in playing with it in every possible way, and as often and as much as we can. But when all legitimate sources of interest have been tapped, we tire of playing with the toy and begin to wonder how it works; and to satisfy our curiosity, we pull it to pieces. The result of the attempt to satisfy this curiosity in the case of Darwin's theory was the growth of a conviction that natural selection did not provide a sufficient explanation of the diversity of organic forms. The history of Mendelism has been like that of Darwinism. The flood of energy let loose by the re-discovery of Mendel's papers has spent itself rather in work based on the assumption that the interpretation which Mendel put on the facts he discovered was true than in the attempt to discover whether that interpretation were true or not; and in our opinion it is right that this should be so. The merely critical spirit is a barren one. The enthusiasm of the kind which follows the birth of a new theory such as Darwin's or Mendel's has been as productive of discovery in the case of the latter as it was in that of the former. At the same time, we should not forget that Mendelism is now in the stage in which Darwinism was before it was subjected to the process of being overhauled; and though we may perhaps be right in holding that criticism is barren of discovery, we should guard against the possibility of entering that frame of mind which regards criticism as blasphemy. Mendel's peas have already been called classical; and it is a very remarkable fact that no one has repeated Mendel's experiments with the deliberate intention of testing the Mendelian interpretation of the results. People speak as if Mendel got to the bottom of the inheritance of roundness and wrinkledness, yellowness and greenness, and as if there was nothing more to be said on the subject. On p. 88 of the report before us there is a table exhibiting the result of crossing a yellow with a green pea to the fifth generation. The proportion of pure yellows, impure yellows, and greens is given both for the fourth and for the fifth generation as 1 : 2 : 1, and it is stated on the bottom of p. 88 that this process of segregation "will be continued "practically for ever." It is highly probable that the three categories do form respectively 25, 50, and 25 per cent. of generations four and five; but Mendel never published any figures which prove this to be so. All he said was: "The proportions in which the descendants of the hybrids develop and split up in the first and second generations presumably hold good for all subsequent progeny. Experiments one and two have already been carried through six generations, three and seven through five, and four, five, and six through four, these experiments being continued from the third generation with a small number of plants, and no departure from the rule has been perceptible."[1]

We offer no apology for adopting this critical attitude towards Mendelism. There is plenty of admiration for "Mendel's incomparable achievement," and we share it; but we do not find it impossible to combine it with a suspicion that Mendel's interpretation of his results may not have been right after all.

The report is, of course, absolutely indispensable to every student of genetics, whether his interest is purely scientific or purely horticultural, or both. The keynote of the conference was struck by a pealing of the marriage bells of Science and Practice. We could have no better guarantee that their union will be fertile than that their hands were joined by the Rev. W. Wilks, who has earned the gratitude of every student of heredity by editing this report, and of every lover of flowers by creating the Shirley poppy.

NOTES.

PROF. H. LE CHATELIER has been officially nominated professor of chemistry at the Paris Faculty of Science in succession to the late Prof. Henri Moissan.

IT has been decided by the Paris Municipal Council to perpetuate the memory of Prof. Berthelot by renaming the Place du Collège de France the Place Marcelin Berthelot.

WE regret to have to record that Prof. Karl Vogel, director of the Astrophysical Observatory at Potsdam, died on August 13.

WE regret also to have to announce the death of the Rev. Dr. John Kerr, F.R.S., formerly lecturer on mathematics in the Glasgow Free Church Training College.

[1] Report of the Third International Conference, 1906, on Genetics. Edited by Rev. W. Wilks. Pp. 486. (Printed for the Royal Horticultural Society by Spottiswoode and Co., Ltd., n.d.) Price 15s.

[1] This is Bateson's translation in Mendel's Principles, p. 57. The original may be consulted most accessibly at p. 26 of No. 121 of Ostwald's Klassiker der exakten Wissenschaften, Versuche über Pflanzenhybriden. Price 1 mark.

THE death, from heart failure, of Sir William Robertson Copland took place at Glasgow on Monday last. Sir William Copland made a special study of drainage and of water supply, and took great interest in promoting technical and university education, being chairman of the governing body of the Glasgow and West of Scotland Technical College, and a member of the Glasgow University Court. He was knighted last year.

DR. WILLIAM THOMSON, who died at Philadelphia on August 3 at the age of seventy-four, had not only written largely on medical and surgical subjects, but had introduced several reforms in field service. At the battle of Antietam, in the American Civil War, he abandoned the old practice of bringing all the wounded into one hospital, and improvised a number of smaller hospitals in various parts of the field. The success of this innovation led to its adoption during the rest of the war, and later in the Franco-German War. Dr. Thomson will be further remembered for adopting the local application of carbolic acid as a disinfectant in the treatment of wounds, and for the introduction, in connection with the Pennsylvania Railroad, of the testing of engine-drivers for colour-blindness.

A REUTER telegram states that the instruments of the chief seismographical station at Hamburg registered several earthquake shocks in the afternoon of Saturday last. Slight shocks were recorded at about 1.22 p.m. and shortly after 2 p.m., while at 6.40 p.m. the instruments began to record a series of distant shocks of medium strength, which lasted nearly two hours. The disturbance reached its height shortly before 7 p.m., and ceased at about 8.45 p.m. It is estimated that the earthquake occurred at a spot 8000 kilometres south-east of Hamburg; a seismic shock was also recorded at Grenoble at 5h. 43m. 40s. on the same day.

IT is announced in *Science* that the yearly sum of 5000 dollars has been voted by the Minnesota Legislature towards the maintenance of a Pasteur institute at Minneapolis.

A CIRCULAR letter has been distributed by the president and general secretaries of the second International Congress on School Hygiene concerning the important new departure made by the congress in the matter of school hygiene. Arising out of the question of whether it would not be advisable to establish a bureau, with a permanent staff, library and museum, &c., in some central but neutral spot, such as a Swiss or Dutch town, it was decided that it would probably lead to greater progress if such bureau was not localised, but if each country had its own centre for the diffusion of knowledge, and to act as a clearing-house in the matter of school hygiene, statistics, laws, and regulations. Finally, to supervise in scientific matters and generally to do all that is possible at all times or places to forward the human interests which are bound up in the special lines of knowledge included in school hygiene, the International Committee has formed a small council, consisting of the president of the past congress, the president of the one lately held, the president of the next congress, and nine other members to be elected, which will have all the powers of an ordinary committee. The following questions will come under the consideration of the council almost immediately:—How medical inspection of schools can best be carried out with the maximum of efficiency and minimum of cost; how far the laws of health can best be imparted to the coming generation, so that later they will know how to care for themselves and those dependent on them; the best systems or methods of physical training for both sexes at various ages; and the feeding of children requiring proper nutrition, so that it shall be done without developing pauperism and with regard to those upon whom the cost falls.

IN reply to an inquiry put to him in the House of Commons as to whether, in view of the work already accomplished by the Liverpool School of Tropical Medicine in combating tropical diseases, he could arrange for an increased grant to be made in order that the work might be further extended, the Under Secretary for the Colonies said that a further grant will be made, of which the Secretary of State will be able to specify the amount after consultation with the Treasury.

THE Keith prize (consisting of a gold medal and 50*l.*) has been awarded by the council of the Royal Society, Edinburgh, to Dr. T. H. Bryce for his two papers on "The Histology of the Blood of the Larvæ of *Lepidosiren paradoxa*," published in the Transactions of the society.

THE seventh International Physiological Congress met in Heidelberg last week, with Prof. Kossel as president. About 300 members were present, and 200 communications were made in the four sections into which the congress was divided. At the opening meeting Prof. Kronecker paid a glowing tribute to the late Sir Michael Foster. Prof. Dastre, of Paris, gave a short biography of the late Sir J. Burdon-Sanderson, while Prof. Sherrington spoke of the loss sustained by the congress through the deaths of Prof. Errera, of Brussels, and Prof. A. Herzen, of Lausanne. By order of Grand Duke Friedrich of Baden each member of the congress was given a bronze medal in memory of the meeting. The medal bears on one side an impress of "Helmholtz—MDCCCLVIII–MDCCCLXXI."

THE French Congress of Medicine will be held in Paris under the presidency of Prof. Debove from October 14 to 16. It is proposed to hold discussions on, among other subjects, the question as to the origin of pulmonary tuberculosis; acid-resistant bacilli; the therapeutic action of radium; ionic medication; the use of collargol; the therapeutic value of tuberculin; and the serumtherapy of dysentery and cutaneous sporotrichoses.

THE third International Sanitary Convention is to be held in the city of Mexico from December 2 to 7 next. Each delegate attending is expected to bring a paper relating to the nation represented by him, with a report on the existence of any transmissible diseases—especially bubonic plague, yellow fever, cholera, malaria, beri-beri, and trachoma—that may prevail within its boundaries. Among the questions to be discussed are the transmission of yellow fever, the means to be used in combating the *Stegomyia fasciata*, tuberculosis, and various administrative measures.

THE eighteenth annual general meeting of the Institution of Mining Engineers will take place in the Firth Hall of the University of Sheffield on September 4, when the following papers will be read, or taken as read:—The sinking of Bentley Colliery, by Messrs. J. W. Fryar and Robert Clive; roof-weights in mines, by Mr. H. T. Foster; and deep boring at Barlow, near Selby, by Mr. H. St. John Durnford. A number of visits to collieries, works, &c., have been arranged.

THE recent opening of the medical academy at Düsseldorf was, according to the Berlin correspondent of the *Lancet*, an event of some importance, and was attended with considerable display. The academy and that at

Cologne have a two-fold object. In the first place they import a new feature into medical study by introducing newly qualified men to the practical side of medicine more than is done at the universities. After the university medical curriculum has been completed and the State examination has been passed, the practical year which is required by recent regulations may be spent at the academics. Their second purpose is to supply the medical practitioners of the district with opportunities for post-graduate study. The Düsseldorf Academy is the first for which clinics and lecture-rooms were specially built, because at Cologne the existing municipal hospitals were adapted for teaching purposes. The structural and other arrangements are described as excellent, and the clinical material will be abundant. Prof. Witzel, formerly of the University of Bonn, is the director of the new academy, while the teaching staff includes Prof. Schlossmann in the subject of pædiatrics and Prof. Lubarsch in the subjects of pathology and pathological anatomy.

THE Paris correspondent of the *Chemist and Druggist* states that the committee on analytical methods has defined the programme for the competitions for the prizes offered for alcohol-denaturation in connection with the law of November 29, 1905. This Act instituted two prizes, one of 800*l.* for the discovery of a "denaturator" more advantageous than those now used while safeguarding the revenue against frauds, and a second (value 2000*l.*) for a system of utilising alcohol for lighting in the same manner as paraffin. The denaturator must have a taste and smell which will effectually discourage any desire to use the alcohol as a beverage; wine or date must, oil of thyme and rosemary, and similar flavours are thus eliminated. The denaturant should not be sufficiently objectionable in smell to prevent its domestic or industrial use—thus acetylene, asafetida, and garlic are excluded. No soluble substance which could leave a deposit on lamp-wicks, and thus render combustion difficult, may be used, such as sea-salt, sodium sulphate, alum, ammonium chloride, potassium ferrocyanide, picric acid, tobacco-juice, and aloes. It must not consist of a substance much more or less volatile than alcohol, and which could thus (besides other disadvantages) be removed by fractional distillation, as ether, carbon bisulphide, light fractions of petroleum or turpentine, cresyl, carbolic acid, camphor, or naphthalene. It should contain no substance which might injure the metallic part of lamps or motors (ammonia, nitrobenzene, sulphuric acid). It should not be poisonous (as mercuric chloride, methyl cyanide, sodium arseniate, and aniline) or contain poison (hyoscyamus, aconite, or digitalis). It should be sufficiently inexpensive, should not normally exist in commercial alcohol, and its presence in alcohol should be capable of easy and certain detection.

A PRIZE of 150*l.* is offered by the German Colonial Society for a method to produce an extract from mangrove bark that will impart as light a colour as possible to leather, and such as will only slightly darken by exposure to light. The mangrove bark contains a large amount of tannin, and also a red colouring matter that prevents the bark and its extract from successfully competing with other tanning agents. The problem to be solved is the practical removal of this red colour. Competitors are invited to send in particulars of their methods by July 20, 1908, to Deutsche Kolonialgesellschaft, Schellingstrasse 4, Berlin.

THE Board of Agriculture is considering the terms of an order prohibiting the importation of plants and bushes bearing edible fruit, except by a licence to which conditions will be attached, with the object of preventing the introduction of the gooseberry mildew and other pests injurious to horticulture.

ACCORDING to *Engineering*, an Australian record in wireless telegraphy has been achieved by the successful transmission of messages from H.M.S. *Challenger*, one of the Australian squadron at present stationed in Hobson's Bay, to the flagship *Powerful*, which at the time was moored in Farm Cove, Port Jackson. The *Challenger* was in communication with the flagship by means of wireless telegraphy the whole of her voyage. The longest message was one flashed over a distance of 410 miles in a direct line, and this constitutes an Australian record, as previously never more than 240 miles had been achieved by warships on the Australian station.

ACCORDING to *Science*, an equatorial telescope has been given to the Nantucket Maria Mitchell Association, and plans of an observatory to house the instrument are being considered. An appeal has been made for funds properly to equip the observatory that it may be available for astronomy classes in the near future.

A MEMORANDUM, dated August 5, issued by the Director-General of the Egyptian Survey Department, on the meteorological conditions of the monsoon season and the prospects of the Nile flood, is far from encouraging. The rains in June and July have been exceptionally weak, and some 16 per cent. of an average flood volume may be considered as deficient at the above date. On the whole, Captain Lyons thinks it more probable that this deficiency will be increased in August than that it will be diminished.

IN the *Meteorologische Zeitschrift* (part iv., 1907) Dr. V. Conrad gives an epitome of an interesting lecture delivered by him on the formation and constitution of the clouds. The author points out that to obtain a clear idea of the subject we require to know (1) the size of the separate fluid drops, (2) the rate of their descent, and (3) the number contained in a cubic centimetre. An idea of the pains bestowed upon the inquiry may be formed from the fact that sixty-nine references to authorities are quoted in the paper. The size appears to have been first microscopically measured by Kratzenstein, who published the results at Halle in 1746; recent measurements by Assmann, Dines, and others give their mean diameter as about 20 μ, or 10^{-3} cm. radius. The vesicular theory was not displaced until A. Waller published his paper in the Phil. Trans. in 1847, and subsequent investigators showed that the optical phenomena observed in clouds could only be explained by the existence of complete drops; much information upon this subject will be found in Dr. Pernter's "Meteorologische Optik." The researches of Stokes and others have shown that a droplet of 10^{-3} cm. radius would fall 1 cm. per second in calm air; with increasing radius, up to a certain limit, V increases with r^2, so that a drop of 10^{-2} cm. radius would attain a velocity of 1 metre per second. From independent investigations the author found the number of drops ($r=10^{-3}$ cm.) in a cubic metre of dense cloud to be 10^9 (a thousand millions), or 1000 in a cubic centimetre. The question of the formation of the first condensation elements is one of great difficulty, since it has been shown by Aitken and others that the presence of some nucleus in the atmosphere is necessary; possibly observations made in balloons may eventually elucidate the matter.

The important position occupied by the electric spark in wireless telegraphy will account for the many attempts which have been made in recent years to obtain some knowledge as to its effective resistance. The principal methods used fall into two groups, based either on the original resonance arrangement of Bjerknes or on the substitution process of Simons. Unfortunately, the two groups give different results, and Dr. W. Eickhoff has rendered valuable service by his examination of the validity of the various methods which appears in the *Physikalische Zeitschrift* for August 1. He comes to the conclusion that deductions as to the most suitable arrangements for telegraphic purposes cannot legitimately be made from results obtained by the method of Simons.

The memorandum of the Manchester Steam Users' Association for the year 1906 consists mainly of a report on the tests of pressure gauges carried out at the National Physical Laboratory and the remarks of the chief engineer of the association on these tests, and on pressure gauges in general. The ten gauges tested were all by trustworthy makers and of first-class workmanship, and the report of the tests states that, as regards freedom from friction and backlash, they leave little to be desired. Greater agreement between the records at different temperatures ought to be aimed at, and for gauges subject to vibration some form of balancing should be adopted. The whole report will be of great value to pressure-gauge makers, and may be taken as a typical illustration of the way in which improvements can be brought about by the cooperation of manufacturers and an institution like the National Physical Laboratory.

Dr. C. Nordmann, of the Paris Observatory, published several years ago in the *Annales de l'Observatoire de Nice*, vol. ix., a theory of the diurnal variation of terrestrial magnetism, according to which the convection currents of the upper atmosphere, crossing the lines of magnetic force, generate electromotive forces which, in a region rendered conducting by solar radiation, produce electric currents and so affect the magnetic needle. In the March number of *Terrestrial Magnetism* he shows that the observations he made in Algiers during the total solar eclipse of August 30, 1905, confirm a deduction from his theory, namely, that during an eclipse the magnetic needle should tend to return from its normal position at the time of occurrence of the eclipse towards its mean position for the day.

Parts i. and ii. (comprising 335 pp. and 18 plates) of vol. lxxxvii. of the *Zeitschrift fur wissenschaftliche Zoologie* are occupied by an elaborate paper on the comparative developmental history of sexual individuals in the hydroid polyps. The author, Mr. A. Goette, of Strassburg, formulates some important conclusions with regard to this development, which are, however, too complex to be summarised within our limitations of space.

In a paper on the navicular of the tarsus of man and monkeys, published in vol. xli., part iv., of the *Journal of Anatomy and Physiology*, Mr. T. Manners-Smith describes and illustrates the remarkable variations obtaining in that bone in the human subject. In some degree, at any rate, these variations appear to be connected with the degree of mobility of the foot, certain features being more constantly developed in this bone in the skeletons of ancient Egyptians than among modern Europeans. The occasional existence of a separate element in the tuberosity of the navicular is also noticed.

From the astounding feat accomplished by Prince Borghese in his wonderful journey in a motor-car from Pekin to Paris, many lessons may be drawn. The greatest, the *Engineer* of August 16 points out, is the wonderful adaptability of the power-driven vehicle. The distance traversed is estimated at 7000 to 8000 miles, and the time occupied was sixty-two days, the daily average being about 121 miles. When the time is taken off for pulling the car through loose sand and for extricating it from morasses, the speed seems almost incredible, considering that for half the journey there were practically no roads. Serious obstacles were encountered. Overwhelmed in a cyclonic sandstorm, dragged through rivers, precipitated from a weak bridge into a fast-running river below, immersed in bogs, the wood-work of the car on fire, and being nearly run into by a train on the Trans-Siberian Railway, were a few of the experiences of the intrepid traveller, any one of which would be sufficient to stop most people from continuing such a perilous journey.

On August 17, 1807, Robert Fulton's steamer, the *Clermont*, ran her trial trip from New York to Clermont, and in order to commemorate the centenary of steam navigation, an interesting account is given in the *Engineer* of August 16 of the events that led up to this development. Illustrations are given of the paddle-wheel steamboat *Clermont* and of her machinery.

The prospects of the Indian manganese ore industry are discussed by Mr. A. Ghose in the Journal of the Society of Arts (August 2). The demand for Indian manganese ore has grown with great rapidity. In 1905 the export to Great Britain amounted to 71,600 tons, whilst last year the total amounted to 490,612 tons, valued at 865,443*l*. India supplied most of the manganese ore used in the British furnaces, Brazil with 127,257 tons being second, and Russia following with 103,270 tons.

An interesting account of the Museum of Traffic and Engineering at Berlin is to be found in the August number of the *Engineering Magazine*. The museum is located in the old Hamburg passenger railway station, which has, however, been thoroughly reconstructed for the purpose so far as its basement is concerned. The museum has three main departments, devoted to railway, naval, and civil engineering respectively. Explanatory notes are added to many of the exhibits, and in some instances a cross-section is given to illustrate the internal arrangement. Some of the models may be worked by visitors, and to these a special notification is attached. Models of plant of exceptional interest are to be demonstrated and explained from time to time by officials of the institution. In addition to models, the museum possesses many diagrams, photographs, statistical tables, a reading room, and library, all of which should make it of real service to engineers.

The extension section of the Manchester Microscopical Society has sent us its new list of lectures arranged for delivery by members of the society during the coming winter in Yorkshire, Manchester and district. The work of lecturing and demonstrating is entirely voluntary and gratuitous on the part of the members, but a charge is made for the hire of slides, travelling, and out-of-pocket expenses. The purpose of the section is to bring scientific knowledge, in a popular form, before societies unable to pay large fees to professional lecturers, but in all cases where lectures are given before societies which are commercial undertakings, or are subsidised out of Government or public grants, a fee is charged in addition to the out-of-pocket expenses. All fees paid for lectures are devoted to the working expenses of the section.

In a paper by Mr. W. F. Allen on the subcutaneous vessels of the head in certain fishes, published in the Proceedings of the Washington Academy of Sciences (vol. ix., p. 79), we regret to observe that Lepidosteus, the well-known name of the bony pike, is changed to Lepisosteus. Even if the latter be the original rendering, the former is grammatically correct, and should be maintained. We have also received copies of two papers on Mendelism, one by Mr. C. B. Davenport and the other by Mr. O. F. Cook, published in the same series. Variation and correlation in the crayfish, by Messrs. Pearl and Clawson, and researches on North American Acrididæ, by Mr. A. P. Morse, form the subject of papers issued by the Carnegie Institution of Washington, of which copies have reached us.

ACCORDING to the report in the July number of the *Victorian Naturalist*, Mr. F. C. A. Bernard selected as the subject of his presidential address to the last annual meeting of the Field Naturalists' Club of Victoria the increased facilities for the study of natural history in Australasia since 1880. After a well-deserved compliment to the Linnean Society of New South Wales, which he believed to be the only organisation existing at that date in Australia devoted solely to promoting the interests of natural history, the president traced the origin and progress of the numerous bodies which now exist for the same purpose.

IN an illustrated pamphlet entitled "The Brent Valley Bird Sanctuary" (published, at the price of sixpence, by the local branch of the Selborne Society) Mr. W. M. Webb gives a picturesque account of an attempt to encourage and protect the bird-life of the district. A wood of some nineteen acres in extent has been secured and put in charge of a keeper, and it is satisfactory to learn that it has afforded nesting sites for twenty-seven species of birds.

AN addition to the fauna of the British Isles is recorded by Mr. J. W. Taylor (in the *Irish Naturalist* for August) in the shape of *Vitrina elongata*, a land mollusc inhabiting the mountains of many parts of the Continent. The Irish specimens were discovered in 1904 and 1905 near Collon, county Louth.

THE contents of vol. xl. of *Neue Denkschriften der allg. schweiz. Gesellschaft* (1906) include an article by Dr. Theodor Studer on additional remains of the ground-sloth, *Grypotherium listaei*, from the well-known cavern of Ultima Esperanza, S. Patagonia. Separate copies of this article were issued in 1905. The author confirms the opinion that this ground-sloth inhabited the cave contemporaneously with aboriginal man, by whom it appears to have been kept in a semi-domesticated state. These aborigines seem to have been identical with the ancient Patagonians. Grypotherium appears to have been a stouter-built animal than Mylodon, with the orbital region of the skull smaller. Stratigraphists will find much to interest them in an article in the same volume by Dr. E. Gerber, of Bonn, on the geology of the Alps to the eastward of Kienthal, embracing the district between that valley and Lunterbrunnen.

A BULLETIN (No. 4) from the Agricultural Research Institute, Pusa, indicates the preliminary arrangements in connection with a series of fruit experiments initiated under the direction of Mr. A. Howard. The planting, pruning, and manurial experiments are in the main similar to those at Woburn. In addition, weathering experiments are proposed, which consist in removing the soil from round the stems and laying bare the roots for a period after the close of the rains; the object is to check vegetative growth, especially before the flowering period. The largest plots are planted with citrus fruits, peaches, mangoes, litchis, and figs.

IN plant experiments to test Mendelian principles several apparently anomalous results have been obtained by crossing white-seeded strains with plants having coloured seeds. In papers published in *Science*, vol. xxv., Nos. 646 and 647, Dr. G. H. Shull refers to results obtained by crossing the flowers of white flageolet beans with those of black-, brown-, and yellow-seeded forms in which the hybrids showed purple and mottled characters. The author adopts the explanation offered by Cuénot that in such a case there are three characters, the pigment character P, the purple modification B, and the mottling M. The black beans show PB dominant, M recessive, the white beans show all three characters dominant. Therefore, instead of considering the *allelomorph* or distinguishing character as necessarily single, Dr. Shull holds the view that it may be compound.

SEVERAL important contributions to the study of the proteins of the wheat grain have been made from time to time by Dr. T. B. Osborne in conjunction with other collaborators. The results have been brought together in Publication No. 84 of the Carnegie Institution of Washington, in which is given a full account of the experimental work, as well as a brief review of the literature. It is found that ***gliadin***, a protein soluble in 70 per cent. alcohol, and ***glutenin***, which together constitute the substance ***gluten*** obtained by washing the dough, form nearly the whole of the proteins in the endosperm; in the embryo the proteins are much smaller in amount, and consist chiefly of globulin, an albumin termed ***leucosin***, and a proteose.

AN article by Mr. H. A. Smith entitled "Saving the Forests" appears in the *National Geographic Magazine* for the present month, and deals with the work of the United States Forest Service, which has charge of Government resources valued at 1,500,000,000 dollars. The U.S. national forests contain more than 150,000,000 acres. In economic usefulness the forests increase in importance almost day by day, and they are fast becoming self-supporting. In the year ending June 30, 1904, the national forests yielded a total revenue of 60,000 dollars, while for the year 1906–7 the sum realised amounted to 1,600,000 dollars, and it is thought that by 1910 the receipts from this source will be equal to the appropriations for the forest service.

ON account of a remarkable discovery of reptilian footprints, the Higher Bebington sandstone quarry at Storeton, Cheshire, has been visited by many geologists during the past year. From time to time Cheirotheroid, Rhynchosauroid, and Chelonoid footprints have been found at this quarry, but since the present owner introduced a stone-channelling machine much more work is being done, and the slabs are got out with less breakage. The quarry, which is worked in the Keuper Sandstone, has a vertical face of 130 feet, and at two horizons half-way down the face occur two thin beds of marl on which the interesting footprints are found, and casts of them occur on the layer of sandstone immediately overlying the marl. Photographs, by Mr. G. J. Williams, of the face of the quarry and of some of the footprints are reproduced in the report of H.M. Inspector of Mines for the Liverpool district for 1906 (Cd. 3449, vi.).

THE *Journal of Hygiene* for July (vii., No. 4) contains a number of interesting articles. Among others, Castellani shows that human yaws is transmissible to monkeys, and that in the lesions, spleen, and glands the same spirochæte (*S. pertenuis*) is present as in man.

AN interesting account of the evolution of the steam turbine and a sketch of the career of its inventor—the Hon. C. A. Parsons, F.R.S.—by Mr. A. A. Campbell Swinton, appears in the current issue of the *World's Work*. Other articles of scientific interest in the number are "Lobster Farming," by Mr. F. A. Talbot, dealing mainly with the work carried on at Mill Cove, Wickford, Rhode Island, by Dr. A. D. Mead, and "Scientific Taxidermy," by Mr. H. J. Shepstone. The two last-named contributions are strikingly illustrated.

WE recently published a review of part i., vol. i., of "Research in China," dealing with descriptive topography and geology (NATURE, August 8), and have now to record the receipt of part ii. of the same volume of the work. The bulk of the section before us treats of petrography and zoology, and is the work of Mr. Eliot Blackwelder, but there is also a syllabary of Chinese sounds by Dr. Friedrich Hirth, professor of Chinese at Columbia University. The work is issued by the Carnegie Institution of Washington.

A SECOND edition of "Impianti Elettrici a Correnti alternate semplici, bifasi e trifasi" has recently been received from Mr. U. Hoepli, Milan. The book forms one of the very practical series of Manuali Hoepli, and will be of service to students and electrical engineers able to read Italian.

MESSRS. A. AND C. BLACK announce a book entitled "The Norwegian Fjords," which is to be written and illustrated by Mr. A. H. Cooper. The work will describe the home life, domestic industries, religion, superstition, and folk-lore of the peasants of Norway.

THE Patent Office has just published a subject list of works on military and naval arts, including marine engineering, in the library of the Patent Office.

OUR ASTRONOMICAL COLUMN.

DANIEL'S COMET, 1907*d*.—This comet is now at its maximum brightness, and with a clear sky and good horizon may be seen quite easily by the naked eye for some time before sunrise. Its naked-eye magnitude on August 12 was estimated to be equal to that of μ Geminorum, about 3·5.

The comet rises about 25° north of east, in London, at about 2 a.m., and on August 22 will be some 12° 11′ directly south of Pollux.

Two excellent photographs of this object were secured by M. Quenisset, at Juvisy, at 2 a.m. on July 19 and 20 respectively, and are reproduced in the August number of the *Bulletin de la Société astronomique de France*. On the former date the photograph showed five tail streamers, but on the latter seven were to be seen on the plate. The longest tail extended some 4° from the nucleus, representing at least some 12,000,000 kilometres (7,500,000 miles); on July 20 the diameter of the nucleus was about 4′, or 173,000 kilometres (about 108,000 miles).

SEARCH-EPHEMERIDES FOR COMETS 1894 IV. AND 1900 III. —No. 4195 of the *Astronomische Nachrichten* (p. 319, August 7) contains two sets of search-ephemerides, one by Prof. Seares for the De Vico-E. Swift comet (1894 IV.) discovered in 1894, but not seen on its return in 1901, the other by Herr Scharbe for Giacobini's comet, 1900 III.

The former was referred to in these columns on August 1, and the comet's brightness on August 25, according to the ephemerides, will be either 0·61 or 0·86, its brightness when its magnitude was 13·1 (November 21, 1894) being taken as unity.

Ten alternative ephemerides are given for comet 1900 III.

MARS.—In a telegram published in No. 4195 of the *Astronomische Nachrichten* (p. 323, August 7), Prof. Lowell announces that the Martian double canal Gihon has been photographed as double both by Mr. Lampland and himself.

In Bulletin No. 30 of the Lowell Observatory the same observer discusses the results of the observations of the North Polar Cap of Mars during the period March–June, 1907. It appears that the cap commenced quite suddenly and in an extensive manner just as it did in 1903 and 1905, and on practically the same date, the Martian August 22–23. Further, the first frost melted again on the succeeding days and was followed by another fall a little later, again as it did in 1903 and 1905.

This striking fact led Prof. Lowell to investigate mathematically the problem of the daily insolation upon a planet, and he shows that the Martian phenomenon is in accordance with his deductions.

Among other points he demonstrates the existence of an atmosphere sufficient to retard the general deposition of frost by some nineteen days. He also states that the arctic and antarctic regions of Mars are actually warmer in the Martian summer than are ours, although the mean temperature of the planet, 48° F., is some twelve degrees less than the mean temperature of the earth.

THE TOTAL ECLIPSE OF JANUARY, 1908.—From No. 114 (p. 167, vol. xix., June 10) of the Publications of the Astronomical Society of the Pacific we learn that arrangements have been made for an expedition from the Lick Observatory to observe the total solar eclipse of January 3, 1908.

Only two islands are crossed by the shadow-path, and of these the Lick expedition has selected Flint Island (long. 151° 48′ W., lat. 11° 26′ S.), which lies in the central Pacific Ocean some 390 miles north-west of Tahiti.

Under the existing conditions the eclipse will occur at 11h. 18m. (local mean time), with the sun 15° from the zenith. The duration of totality, according to the American ephemeris, will be 4m. 6s.

The expedition, the sending of which has been made possible by the generosity of Mr. William H. Crocker, will leave San Francisco on November 22, journeying thence to Tahiti, and will be conveyed from the latter island by a U.S. gunboat.

At the instigation of Prof. Campbell, Prof. Abbot, of the Smithsonian Institution, will accompany the Lick expedition in order to secure bolometric observations of the corona. The two expeditions will be independent scientifically, but will be united in the travelling and subsistence arrangements.

In the August number of the *Observatory* (p. 333, No. 386) it is tentatively suggested that it may be possible for some European astronomer, who could not otherwise see the eclipse, to obtain some assistance from the Lick expedition.

THE LEEDS ASTRONOMICAL SOCIETY.—The fourteenth annual Journal and Transactions of the Leeds Astronomical Society contains some interesting papers communicated by the members during 1906.

An observatory, in connection with the University and the city council, was opened on May 4, 1906, on Woodhouse Moor, and contains an 18¼-inch Newtonian reflector and a transit instrument. These instruments are to be used by members of the University staff, certain university students, teachers and selected students from the Education Committee's schools and by members of the astronomical societies.

Among the papers published in the Journal, one may mention a discussion of the existence of an intra-Mercurial planet, an illustrated description of the immense Jai Singh observatories located at Benares, Delhi, and Jaipur, and a lengthy discussion of Tennyson's astronomy.

THE MAKING OF MOUNTAINS.

THE profound impression made on contemporary geological thought by what is known as the Schardt-Lugeon theory of overfolding is well seen in Herr H. Hoek's last paper on "Das zentrale Plessurgebirge" (*Berichte d. Naturforsch. Gesell. zu Freiburg i. B.*, Bd. xvi., 1906, p. 367). In this he completely modifies his reading of the district, published three years ago, in favour of one that brings it into structural harmony with recent views as to the existence of "Ueberschiebungsdecken," "Nappes de recouvrement," or overlapping and overthrust recumbent folds. The region south-east of Chur has received a good deal of geological attention, and Herr Hoek claims that it now falls into its place as a structural link between the overfolded areas of Switzerland and the Austrian Alps. His paper is written in a considerately argumentative spirit that provides cheerful reading, and concludes with a tilt at Rothpletz, who has sprung into the same field of inquiry. Both writers agree, however, that the overlying rock-sheets of the Plessurgebirge have been brought into the area from a distance; and that is the point which interests the watchers of the tourney.

Dr. W. Hammer, in a review of the above paper (*Verhandl. d. k.k. geol. Reichsanstalt*, 1906, p. 383), evidently regards it as an attempt to put an old wine of good quality into new and uncertain bottles. But Herr G. Steinmann adopts Hoek's typical landscape of the four overthrust sheets above Parpan in his "Geologische Probleme des Alpengebirgs" (p. 40), and he has had ample opportunity of discussing the structure with the author. Steinmann's paper, published by the Deutscher und Österreichischer Alpenverein at Innsbruck in 1906 (Bd. 37 of their *Zeitschrift*), is a delightful exposition of the older and later views, beginning with the Juras and ending in the east of Switzerland, and is written for the ordinary traveller as well as for the geologist. The landscapes, in which the beds are duly labelled, are accompanied by an admirable series of sections, often showing the two rival readings, and gathered from various authors. Steinmann's own sections show clearly the stages of growth which are held to have culminated in the system of overfolds in Switzerland. This lucid paper seems to us perfect for its purpose, and the author is able, in his separately issued copies, to reproduce Dr. von Seidlitz's panorama from the Künihorn, which was published in part only in the *Zeitschrift des Alpenvereins*.

Herr Schardt himself has furnished, in the *Verhandlungen der Schweizerischen Naturforschenden Gesellschaft*, St. Gallen meeting, 1906, p. 308, a welcome account of "die modernen Anschauungen über den Bau und die Enstehung des Alpengebirges." Already this distinguished author suffers from an extremist group of followers, and he humorously characterises some of Termier's work as an exhibition of "Ultranappismus." The coloured sections illustrating Schardt's paper supplement this very clear exposition of his views. On p. 343 he emphasises the importance of gravitational sliding in producing certain features of steeply elevated and compressed folds, and points out that this influence has been too often underestimated.

Travellers in the most familiar part of Europe will also profit greatly by Herr A. Baltzer's "Das Berneroberland und Nachbargebiete" (Berlin: Gebrüder Borntraeger, 1906, pp. xv+347). The price of this handy book, 12.50 marks, includes a general volume, which has not yet reached us, though it was announced to appear during last winter. Rothpletz's work on the overfolded area of the Rhætic Alps, to which Hoek refers in the paper above noticed, has been published in the same "Sammlung geologischer Führer." Baltzer's volume starts in the Bernese Juras, among the romantic *cluses*, guides the pedestrian of geological tastes to the typical sections around Grindelwald, and brings him back by the St. Gothard railway and Lucerne. The illustrations are not always so neat as those of Steinmann, but cover a great amount of detail. The transparent sheets on which the names of the rock-layers are printed, which are used as indexes to several of the photographs, strike us as a little awkward in a book that must be used in all weathers in the field. Among the many useful diagrams is one (Fig. 69) showing the folded strata as viewed from the steamer on both sides of the lake of Uri.

Dr. C. Sandberg (Transactions of the Geological Society of South Africa, vol. ix., Johannesburg, 1906, p. 82) gives a new reading of the folded structure underlying "the innocent looking, softly undulating Karroo Formation" in the Prince Albert district of Cape Colony. The country, with its bare kopjes and its abundance of rock-exposures, lends itself to stratigraphical investigation. The Tygerberg shows on its south side the Witteberg series resting on the Dwyka conglomerate, which properly overlies it, while the Dwyka series occurs again on the north side of the hill. This can be explained by fan-structure, the Witteberg series coming up along a local anticline, which has expanded southward as an overfold. Though various authors show various dips, the anticlinal view has been generally accepted. Dr. Sandberg, however, quoting the magic names of Schardt, Lugeon, and Termier, reads the structure as the downward-turned, or, shall we say, pseudo-synclinal, end of an overpushed anticline, the root of which lies away in the Zwartebergen to the south. Mr. A. W. Rogers, who is invoked by the writer, points out that a section quoted from him in support does not touch the Tygerberg, and he evidently prefers the older view for the present (Proceedings to accompany the above volume, 1907, p. liii.). But Dr. Sandberg's paper serves as a fresh indication of the keenness and vitality that prevail in South African geology.

It is evident that very few geologists now doubt that overfolds occur in the earth's crust, whereby strata are moved from their place of deposition over distances amounting to even 100 kilometres. If we grant ten miles for such movements in the north of Scotland, we do not find it unreasonable to allow seventy miles of overthrusting in the more crumpled region of the Alps (see Sir A. Geikie's remarks, Abstracts of the Proceedings of the Geol. Soc. of London, April 10, p. 67). But the admission raises serious questions as to what happens in the foundations underlying these compressed areas of the crust. Dr. Ampferer, in a lengthy and closely reasoned paper on "Das Bewegungsbild von Faltengebirgen" (*Jahrb. der k.k. geol. Reichsanstalt*, Bd. lvi., 1906, pp. 539–622), rejects the theory that localised crumpling is due to the approach of great earth-blocks in the contracting crust. He urges, moreover, that there is nothing in any complex group of rocks, such as we ordinarily find folded together in a mountain-chain, to account for the folding in that particular locality. The local structure determines the details of the architecture (p. 607), but the position of the chain on the earth must be referred to the nature of the plastic foundation, the "Untergrund." The composition of the earth's interior is by no means uniform (pp. 608 and 609), and both physical and chemical changes in it may produce considerable alterations of volume in one portion or another. These alterations are manifested at the surface, in the sensitive skin of the earth, as local subsidences or elevations. The vertical movements of the foundation lead to gravitational sliding, which affects the overlying skin (p. 601), and it is suggested that the folded mountain-chains are formed along lines of more or less intense vertical upheaval, from which the fundamental masses then flow away sideways, producing the overfolds and crumplings that we perceive upon the surface. The underflow, the "Unterströmung," is thus Ampferer's main cause of surface-folding, and changes in the living and mobile "Untergrund" determine where "Unterströmung" shall occur.

We trust that in these few words we have correctly represented Dr. Ampferer; for the paper is not an easy one, and the absence of references to the details shown in many of the diagrams renders these of little help as illustrations. Fig. 41, however, on p. 611, shows suggestively how the irregularities of the foundation or "Untergrund" may be ascertained by a comparison of the geological history of areas on the earth's surface. Areas with similar foundations may be expected to subside together or to be elevated together during geological time. It is easier to estimate the amount of subsidence that took place during any epoch than the amount of elevation, the latter being marked by no characteristic sediments; but we may hope eventually to represent the history of an area by a curve rising or falling in reference to a datum-line, the time-scale being indicated on the latter. Prof. Steinmann, in the paper above noticed, has employed similar curves for various regions in the Alps. Dr. Ampferer holds that a similarity in the curves for two or more areas would imply a general similarity in the foundation. This seems to leave out of count Mr. Osmond Fisher's suggestion of convection-currents in a liquid interior, which might produce considerable local differences in the curves; but the absence of all reference to previous workers, except a passing one to Schardt's and Lugeon's theory of over-folding, makes it uncertain how far Dr. Ampferer wishes to link himself with his predecessors. While admitting (p. 620) that his criticism has been largely of a destructive order, he feels hopeful that future research may make us better acquainted with the "Untergrund."

Dr. Ampferer's paper was written in March, 1906, but was not issued until December. Meanwhile, Mr. R. A. Daly had published a paper on abyssal igneous injection as a causal condition and as an effect of mountain-building (*American Journ. of Sci.*, vol. xxii., September, 1906, p. 195). Ampferer does not believe in geosynclinals and subsequent lateral compression; but it is precisely these that Daly sets out to explain. He urges that the underlying molten magma, which he believes to be of basaltic composition, is always ready to leap into any cracks that arise in the plastic layer above it and in the "shell of tension" in the lower portion of the crust. Cracks may arise in the plastic layer by the effects of tidal torsion on the crust, and in the shell of tension by the general contraction due to cooling. The igneous mass in the great dykes thus produced, so long as it remains liquid, exercises a hydrostatic pressure on its walls, and forces them further apart. Here we have a cause that may close up other cracks in the shell of tension, and the total lateral creep "involves a strong downward pull exerted on the shell of compression," *i.e.* that part of the crust above the level of no strain. The resulting geosynclinal area finally becomes weakened, as sediments accumulate in it and its underlying rocks are bent down into hotter regions; and then, in some way which is rather lightly dealt with, an "orogenic collapse" takes place, and a mountain-chain begins to rise. The increase in bulk of the crust by magmatic injection, which was, by the by, well pointed out by Mr. Osmond Fisher, is urged as an additional cause of its crumpling, and the hydration of its minerals gives similar assistance. The shearing apart of the shell of compression and the shell of tension "during the orogenic revolution releases the tensions still unrelieved in the underlying shell," and allows of further abyssal injection on a large scale. The location and elongation of mountain-chains and geosynclinals are all (p. 216) related to special zones of abyssal injections from the substratum. Here we see Mr. Daly looking, like Dr. Ampferer, for final causes in the "Untergrund," and with this point of agreement we must for the moment rest content.

Still more recently (March, 1907), Dr. L. Waagen publishes in the *Verhandlungen der k.k. geologischen Reichsanstalt* a general review of the relations of ocean-basins and mountain-chains. He finds the origin of folding in the subsidence of continental masses, and the continued sinking of the moving *Hinterland* of a chain may bring this region below sea-level, and so promote an interchange between continental and oceanic areas. Marine transgressions (p. 121) are thus the natural accompaniments of epochs of considerable mountain-building.

G. A. J. C.

THE SOUTH AFRICAN ASSOCIATION.

The report of the South African Association for the Advancement of Science (Cape Town, 1907), a handsome volume of 640 pages, affords striking evidence of the large amount of attention that is being devoted to scientific research in South Africa. The report includes the presidential address delivered by Mr. T. Reunert at Johannesburg in 1905, in which year the usual sectional meetings were not held, and minutes of the proceedings of the fourth meeting of the association at Kimberley in 1906. The address of the president, Mr. G. F. Williams, who was unable to attend the Kimberley meeting in 1906, contains an interesting historical sketch of the settlement of the Cape, of the adventurous spirit of the Portuguese, of the influence of the Dutch pioneers, and of the rush of adventurers from almost every part of the world, who laid the foundation of the mining industry of to-day.

The president of Section A, Mr. J. R. Sutton, gave a valuable summary of our present knowledge of the diurnal variation of barometric pressure, which may be considered as the fundamental problem in meteorology—the rise and fall of the barometer twice a day, the precise cause of which has never been satisfactorily explained. After referring to the efforts of Herschel, Dove, and others, the author pointed out that Dr. Buchan made a material advance in distinguishing between the weight and elasticity of the air. Perhaps the most important contribution to the subject is due to Prof. J. Hann, who by classifying and generalising the harmonic elements for a great number of stations succeeded in establishing some noteworthy results. Among the various papers read in this section, some of which have been published elsewhere, we may specially mention:—(1) Anticyclones and their influence on South African weather, by Colonel H. E. Rawson. An examination of the charts published by the London Meteorological Office, and of other data, showed that the weather in South Africa is under the direct influence of the movements of two great anticyclonic systems lying to the west and east. (2) The barometer in South Africa, by Mr. R. T. A. Innes. The author states that the annual variation of the barometer consists of a well-marked single oscillation, pressure being greatest in winter and least in summer. (3) Variability of temperature in South Africa, by Mr. J. R. Sutton, as represented by three typical stations, showing the mean difference between the temperatures of one day and the next. Prof. J. Milne contributed a paper on the observation of earthquakes and other earth movements, and Prof. R. A. Lehfeldt one on accelerations of gravity at Johannesburg.

At the various sectional meetings sixty papers were read, which are published in full or in abstract. Among these, noteworthy papers dealing with matters of local interest are, in addition to those already mentioned:—Rev. H. A. Junod, on the theory of witchcraft among South African natives; Rev. F. Reuter, on northern Transvaal ethnology; Mr. A. W. Rogers, on the glacial beds of the Griqua Town series; Mr. R. H. Rastall, on the petrography of the Kimberley district; Mr. F. P. Mennell, on the Somabula diamond field of Rhodesia; Mr. J. P. Johnson, on the Stone age of South Africa; Mr. F. A. Hurley and Mr. C. D. H. Braine, on irrigation in South Africa; Mr. K. A. H. Hought, on native education in its higher branches; and Mr. T. Lowden, on the place of manual training in South African education.

Of the sectional presidential addresses, that by Mr. Sidney J. Jennings, on wastes in mining, waste of thought, waste of labour, and waste of material, should be mentioned. Nothing has proved so efficacious for the prevention of waste of thought as the free interchange of ideas made possible by the numerous societies and associations. Centralised management can also be made to perform a valuable function in preventing thought-waste. In preventing waste of labour, the fundamental difficulties lie in the untrained condition of the Kafir for manual labour, and in the ineptitude of many white overseers for transforming a semi-savage population into an industrial one. The best prevention of waste of stores is the continued thought of the management combined with the loyal and interested cooperation of the men.

An account of a discussion on university education in South Africa is contained in the report. The discussion was opened by Prof. Lyster Jameson with a brief survey of the past history and present position of university education in South Africa, followed by a summary of the more obvious remedies for the present unsatisfactory state of affairs. There is a single university, the University of the Cape of Good Hope, an examining body pure and simple. In addition to the University, several institutions calling themselves colleges have arisen. In the Transvaal the only institution seriously doing university work is the Transvaal University College, which was founded as a full faculty of mining and engineering, adding its arts department at a later date. However great the disadvantage of federation or of separation, the greatest peril to university education in South Africa lies in the excessive multiplication of institutions with poor endowment and small, underpaid and overworked staffs. The discussion was well sustained; and, in summing up, the chairman, Mr. S. J. Jennings, pointed out that in Germany and England a population of a million could support a university. Roughly speaking, a population of a million in South Africa would correspond in fee-paying capacity with a population of two millions in Germany or England. It therefore seemed within the range of possibility that South Africa could support two universities.

INTERNATIONAL MARINE INVESTIGATIONS.[1]

THIS summary of the results so far obtained by the international investigation of the North and adjacent seas is drawn up by the executive committee of the Swedish Hydrographic-biological Commission, and is the second of its kind. Being well written, illustrated by good charts and plates, and demanding no great previous knowledge from the reader, it is one of those accurate yet popular accounts which, by educating public opinion in the utility of research, possess a real public value. Its slight unevenness is probably inevitable in the rapid survey of so wide a field, and it is to be regretted that the language in which it appears will restrict so narrowly the number of its readers.

The introduction patriotically reminds us that Sweden took the initiative in cooperation in marine research when King Oscar issued invitations to the conferences of Stockholm (1899) and Christiania (1900), and states the aim of the work to be, in the terms of a resolution of the latter meeting, "to prepare for the rational exploitation of the sea on a scientific basis." The aim is thus practical; the writers proceed at once to discuss the urgent practical question which played a considerable part in securing British participation in the international scheme, namely, the over-fishing question.

The belief that the catch of fish (mainly trawl-caught fish) was greater than nature replaced had arisen, declined, and revived when the international work began. Remedies had been proposed, and, being based on insufficient knowledge of the sea, had failed. The authors unreservedly include among the failures the closure of areas to trawling and the replenishment of the sea by fish-hatcheries; they speak hopefully of the value of market statistics, recognise the recent improvements in English methods of collection, and pass to the biological attack on the problem. This section is a little disappointing. Much has been ascertained concerning intensity of fishing, migration, &c., the bearing of which on over-fishing is not clearly brought out in the text. Since, for instance, over-fishing is stated to affect plaice mainly by reducing the average size at which they are caught, any experimental evidence of a possibility of increasing the rate of growth deserves close consideration; yet the promising results of transplanting plaice from crowded "nurseries" to good feeding-grounds where growth is more rapid are very briefly dealt with.

To make any proposal for restrictive legislation before the International Council has fully sifted the evidence collected on over-fishing seems premature, and, from the representatives of a country not greatly interested in trawling, even a little out of place. The writers, however, advise that each country fix an inshore size limit independently, while no plaice should be landed from offshore grounds of less length than 28 cm., that limit to be gradually increased to 33 cm. As to the practicability of enforcing this rather complicated scheme they are silent; possibly wisely.

Numerous biological researches are described, but by far the greatest detail is accorded to hydrography. Even Prof. Petterssen's theory of the effect of ice melting is included, although, as Nansen's "Northern Waters" has shown, it is still controversial. The Baltic hydrography is perhaps the freshest section for English readers. Hydrography gained much from cooperation; the standardising of instruments and reagents removed one frequent source of wasted opportunity in earlier voyages, by making all observations more strictly comparable, while the periodic cruises of the numerous vessels employed ensured regular observations over the whole great area involved. The main result has been the discovery that European seas are flooded every autumn by Atlantic water (of 35 per mille salinity or more) which withdraws in spring, and that many fisheries depend on these movements. Such a fishery is that of the Swedish "winter herring"; the fish is abundant, and the fishery prosperous when southern bank-water, of characteristic salinity, temperature and plankton, forms a thick layer in the Baltic entrances, while in years of exceptional abundance of Atlantic water this displaces the overlying bank-water, and a "bad herring year" results. These years occasion considerable distress.

The summary closes with appendices, some of which, semi-diplomatic documents now apparently published for the first time, are worth careful perusal by all interested in fishery legislation and research. One, written by Prof. Petterssen in reply to a question from the English Board of Agriculture and Fisheries, as to the probability of practical results shortly appearing, is especially interesting. Prof. Petterssen mentions the confusion of ideas and opinions that, owing to lack of knowledge of the sea, prevailed before the international work began, describes the results attained and the value set on cooperation by the investigators, and, speaking of the protection of immature fish, he makes the noteworthy remark, "International measures of this kind must be founded on strong and indisputable evidence. . . . Such evidence can only be the outcome of a joint investigation of the total area in question, executed by the best specialists of every nation concerned." These words constitute now, as they did three years ago, a weighty defence of international cooperation in fishery research.

[1] "Resultaten af den Internationella Hafsforkningens arbete under åren 1902–1906, och Sveriges andel därfuti. By G. Ekman, O. Pettersen, F. Trybom. Pp. 164. (Stockholm: Isaac Marcus, 1907.)

THE TRANSVAAL DEPARTMENT OF AGRICULTURE.

WE have received from the director a copy of the annual report of the Transvaal Department of Agriculture for the year 1905–6. The department was formed soon after the close of the war, and was placed under the charge of Mr. F. B. Smith, who had been trained at Cambridge and had gained experience as an agriculturist at Wye College, of which he was for some years the vice-principal. On his arrival in the Transvaal, Mr. Smith gathered round him a band of zealous and competent workers, and organised the new department on American lines, assigning the work to a number of "divisions." Each of these, while independent and under the charge of separate heads, was kept in close touch with the work of the other divisions through the director of the department and his office staff.

The report for the past year gives a *résumé* of the work on which the new department is now engaged, which should prove of interest not only to those directly concerned, but to many in our own country who may wish to know what the trained agriculturist can do to assist the development of the colonies. The most obviously beneficial work of the department is that of the veterinary division, which was formed partly to investigate the numerous diseases which threatened the live stock of the colony at the close of the war, but chiefly to check the spread of disease by treating diseased animals and by administering acts regulating their movements. The need for this type of work may be inferred from the fact that during the year 726 outbreaks of contagious disease were dealt with, 140,000 animals inspected, and 660,000 examined for soundness at the ports or on the borders of the Transvaal before being admitted into the country.

The acts regulating the movement of diseased animals have caused stock-owners some inconvenience and have been the subject of occasional complaints, but they have succeeded in a remarkable way in improving the health of the live-stock. For example, the disease known as East Coast fever, which at the close of the war was a serious menace to the cattle of the colony, has been overcome, and large areas have been altogether freed from it. In 1904–5 about 8000 cattle died of this disease; in 1905–6 the number was reduced to 800. As an instance of the protective measures adopted by the department, we may cite the case of rabies. The Transvaal is free from this disease, but it is found in Rhodesia, and in the hope of preventing its introduction a strip of country fifty miles wide, along the northern border of the Transvaal, has been entirely cleared of dogs.

A large part of the time of the chief of the division of botany is taken up by consultative work. Information upon new crops, weeds, poisonous plants, forest trees, &c., is in constant demand, and, apart from interviews and attendances at shows, this work alone involves the writing of some 3000 letters per annum. A herbarium is being formed. Some progress has been made in crossing and selecting maize, but it is remarked that, owing to the pressure of other work, plant-breeding has not hitherto received the attention it deserves. An important section of the work of the division is that which deals with plant pathology. A pathologist was recently appointed by the department, and the number of diseases which he has already observed is referred to in the director's report as "amazing." Special attention has been directed to the rusts, and five have been so far identified, viz. *Puccinia graminis* on wheat and barley, a second form of *P. graminis* on oats, *P. triticini* on wheat, *P. coronifera* on oats, and *P. maydis* on maize. Some attention has been directed to disease-resistant varieties, and stress is laid on the fact that a cereal which may be immune to the attacks of one rust may be very susceptible to infection by another; the practical conclusion is drawn that every effort should be made to obtain disease-resisting varieties, and that the continued growing year after year of the same variety of any cereal should be avoided as much as possible.

The chemical division has been engaged in an examination of soils, and attention is directed to the fact that the soils of the Transvaal are generally well supplied with potash, but are deficient in phosphoric acid, lime, and organic nitrogen. In conjunction with the veterinary division, the chemist has carried out an investigation into the composition of the bone of animals suffering from osteo-porosis, and he finds that affected bones are deficient in total ash, lime, and phosphoric acid. The normal proportion of nitrogen to total ash is about 1 : 14; in diseased animals the proportion is approximately 1 : 11.

The "division of publications" issues a quarterly journal, each number of which extends to some 300 pages; there are two editions, an English of some 8000 copies, and a Dutch of about 2000 copies. The journal contains original articles, notes from the various divisions, extracts from foreign journals and Government circulars, market prices, customs returns and other figures of interest to farmers. In addition to the journal, this division publishes leaflets and bulletins; among the latter, those written by members of the veterinary division upon the common diseases of the live stock of the colony have been of most importance.

It is satisfactory to learn that the work of the department commended itself to the Public Service Commission which inquired into the working of all branches of the Civil Service. The commissinn report emphasises the importance to the Transvaal of agricultural research, and goes on to state that it "has been impressed by the zeal, devotion, and business-like methods which characterise the Department at present, and that it finds itself unable to suggest any improvements in the organisation, or in the distribution of the business."

THE ARC AND THE SPARK IN RADIO-TELEGRAPHY.[1]

THE discovery by Heinrich Hertz between 1887 and 1889 of experimental means for the production of electric waves, and Branley's discovery that the conductivity of metallic particles is affected by electric waves, form the foundation on which, in 1896, Signor Marconi built up his system of wireless telegraphy.

Many of the early investigators certainly had glimpses of a future system of being able to transmit messages without connecting wires, for as early as 1892 Sir William Crookes predicted in the *Fortnightly Review* the possibility of telegraphy without wires, posts, cables, or any of our costly appliances, and said, granting a few reasonable postulates, the whole thing comes well within the realms of possible fulfilment.

Two years later Sir Oliver Lodge gave his memorable lecture on the work of Hertz, and carried the matter a step nearer the practical stage.

There will not be time to dwell to-night on the early history of the art and its development. It will be necessary, however, to explain some of the fundamental properties of signalling by means of Hertzian waves in order to be able to bring out clearly the relative advantages and disadvantages of the two rival methods now in practical use for producing Hertzian waves for wireless telegraphy.

The fundamental part of the transmitting apparatus may be said to consist of a long conductor generally placed vertically, in which an alternating or oscillating current is set up by some suitable means. Such a conductor radiates energy in the form of Hertzian waves at right angles to itself into space, in very much the same way that an ordinary candle sends out light in all directions. This radiation, though it is strictly in the nature of light, is invisible to our eyes, as the frequency is too low.

If we set up any other conductor approximately parallel to the first, there will be produced in this second conductor alternating or oscillating currents having the same frequency as those in the first conductor, and which can be detected by suitable instruments.

The simplest and one of the earliest methods for producing Hertzian waves for use in wireless telegraphy consisted in charging up, by means of an induction coil, a vertical insulated conductor, which was allowed to discharge itself to earth by means of a spark taking place between its lower end and another conductor which was connected to earth. To detect the Hertzian waves Marconi employed an improved form of the Branley filings tube, which is known as the coherer.

In order to transmit messages the radiation is started and stopped so as to form short and long signals, or dots and dashes of the Morse code, out of which the whole alphabet is built up in the well-known way.

As I have already stated, the radiation takes place round the vertical conductor approximately equally in all directions. Suppose that I set up my transmitting apparatus here in Leicester, a receiving station set up either in Nottingham, Derby, Rugby, or Peterborough would be able to receive the message equally well. Should I wish to send a message from here to Nottingham at the same time that Derby wishes to speak to Rugby, then the receiving station at Nottingham would receive both the message from Leicester which it should receive, and the message from Derby which it was not required to receive.

To get over this difficulty, known as "interference," a large number of devices have been patented. The most successful in practice is syntony, or tuning; in this method each station has allotted to it one definite frequency or tune, and the apparatus is so arranged at each station that it will only be affected by messages which are radiated by other stations on its own frequency or tune, and not by any other radiations. To take a musical analogy, supposing I had somebody who was either deaf to all notes of the piano except, say, the middle "C," or had such a musical ability that he could tell at once when I struck the middle "C," then I could transmit to that person a message in the ordinary Morse code by playing on the middle "C," and that person, whom I shall call Mr. C., would not take any notice of the fact that I might also be playing on the notes D, E, F, G, &c., but Mr. C. would confine his attention entirely to what is being done with the middle "C." It is conceivable that I might find a series of persons or train them so that they could each pick out and hear one note only of the piano, irrespective of what was being played on the other notes or of any other noises that were taking place. Taking an ordinary seven-octave piano, and neglecting for a moment the black notes, this would give me fifty-six distinct notes on which I could transmit messages; so that, transmitting from Leicester, I might send messages simultaneously to fifty-six different towns.

[1] Discourse delivered at the Leicester meeting of the British Association on Friday evening, August 2, by Mr. W. Duddell, F.R.S.

The number of possible simultaneous messages depends on the number of octaves there are on the piano used, and on how close together the different notes are which can be used without producing confusion. For instance, it might be quite easy to train someone to distinguish with certainty between "C" and "E," and pick out signals on "C" at the same time that signals are being sent on "E." It is certainly more difficult to do this with two notes that are closer together, say "C" and "D," and still more difficult if the half-tones are used as well. The problem, therefore, in wireless telegraphy is to arrange the receiving apparatus so that it can hear, or perhaps I should say, more accurately, so that it can only see, notes of one definite frequency or pitch, and not be affected by any other notes, even though of but slightly different pitch. Another requirement to obtain good working is that we should use as little power as possible at our transmitting station consistent with obtaining enough power in our receiving instruments to work them with certainty.

I have a mechanical model to illustrate how we are able to make our receiving instruments very sensitive to one frequency, and only slightly affected by frequencies which differ but slightly from its proper frequency.

The transmitter in the model consists of a disc that can be rotated slowly at any speed I like, with a pin fixed eccentrically on its face. This pin can be connected to a vertical wire which moves up and down as the disc rotates. I shall assume that the movement of this wire corresponds with the movement of the electricity in the vertical conductor. As a receiving apparatus I have a pendulum, and representing the ether between the transmitter and receiver I have an elastic thread connecting the pin in the disc to the pendulum.

When I set the disc rotating slowly the elastic thread is alternately stretched out and relaxed, and the pendulum is a little affected. If I gradually increase the speed of the disc at one definite speed it will be found that the pendulum is set into violent oscillation, and by observation it will be found that when this is the case the disc makes one complete revolution in exactly the same time that the pendulum would make one complete swing if left to itself; that is to say that the disc and the pendulum make the same number of swings per second or have the same frequency; in music they would be said to be in tune with each other. If instead of allowing the disc to rotate continuously I allow it to make only half a dozen revolutions, then the pendulum will be affected, but much less strongly. The greater the number of revolutions the disc makes up to a certain maximum number, the more the pendulum will be caused to swing.

Instead of starting and stopping the disc, I can keep the disc rotating, and start and stop the pulls on the elastic thread by moving the pin in the face of the disc in and out from the centre, which produces a movement which much more nearly corresponds with the actual current in the vertical wire as used in spark telegraphy.

It is necessary here to explain the relationship that exists between the wave-length, the frequency, and the velocity of propagation of Hertzian waves. The waves travel with, as far as we know, the same velocity as light, namely, 300,000,000 metres, or 186,000 miles, per second. Between these quantities we have the relationship that the product of the wave-length by the frequency is equal to the velocity of propagation, or, as I have already mentioned, the velocity of light.

The wave-lengths which are of practical use in wireless telegraphy at the present time range between 100 and 3000 metres, though, of course, it is quite possible to use for special purposes wave-lengths outside these limits. The corresponding frequencies in practical use are therefore between 3,000,000 and 100,000 complete periods per second. We require, therefore, to produce in the vertical conductor alternating or oscillating currents of any frequency within this range, and to have a sufficient number of oscillations following one another without interruption to allow of good syntony being obtained.

There are three methods of producing these currents—namely, the alternator, the spark, and the arc methods.

There are great difficulties in the way of constructing an alternator to give such high-frequency currents, and I can best illustrate this by taking an example. Suppose that it is required to build an alternator to work at the lowest frequency, namely, 100,000 periods per second, and let us assume that we can drive this alternator by means of a turbine at the high speed of 30,000 revolutions per minute. This alternator could not have a diameter much above 6 inches for fear of bursting; and, as it makes 500 revolutions per second, it would have to generate 200 complete periods for each revolution, so that the space available for the windings and poles for one complete period will be less than 1/10 inch, a space into which it is quite impossible to crush the necessary iron and copper to obtain any considerable amount of power. In spite of the small space that we have allotted to each period, as there are 100,000 periods per second, the speed of the surface of the moving part works out at more than 500 miles per hour. A small alternator has been built to give more than 100,000 frequency, but the amount of power it produced was extremely small. Several experimenters have stated lately that they have built alternators giving these high frequencies and a considerable amount of power, but, so far as I am aware, there is no trustworthy data available as to the design of these machines.

If it should prove possible to construct alternators for these very high frequencies, we shall be able to obtain a sufficient number of consecutive oscillations of the current in the aërial of definite frequency to enable very sharp syntony to be obtained. Not only will this greatly reduce interference troubles in wireless telegraphy, but such alternators will be of the greatest value for wireless telephony.

The earliest method of producing high-frequency oscillations was proposed by Lord Kelvin, who pointed out that if a Leyden jar or condenser be allowed to discharge through a circuit possessing self-induction or electrical inertia, then under certain conditions the discharge of the jar is oscillatory, that is to say, that the electricity flows backwards and forwards in the circuit several times before the jar or condenser becomes finally discharged. I think that perhaps the best way to make this matter clear is by demonstrating experimentally with an oscillograph the nature of the discharge of a condenser and how it is affected by the resistance and self-induction in the circuit. As a mechanical analogy one may look upon the charged condenser as a weight attached to a spring which has been pulled away from its position of rest. To discharge the condenser we let go the weight, and it begins to oscillate backwards and forwards, and, after making a greater or less number of oscillations, finally comes to rest. The number of oscillations per second will depend upon the strength of the spring and the mass of the weight, which correspond with the capacity and self-induction in our electrical circuit. The number of oscillations before the weight finally comes to rest is determined by the friction which tends to stop the weight, or by the resistances and other losses in the electrical circuit.

In practice the aërial conductor acts as a Leyden jar or condenser. It is charged with electricity and allowed to discharge, the current oscillating backwards and forwards in the aërial during the discharge. In many installations Leyden jars or condensers are electrically connected to the aërial, so that the oscillations taking place in them are transmitted to the aërial. Any remarks, therefore, that I may make as to the oscillations which may be set up in condensers apply equally well to the oscillations in the aërial in wireless telegraphy.

For wireless telegraphy it is usual to charge the condenser or aërial by means of an induction coil or an alternator to a very high voltage, and it is allowed to discharge by means of a spark between the two electrodes which form the ends, so to speak, of a gap in the electrical circuit. As long as the pressure is low the spark gap is a perfect insulator; when the pressure becomes high enough, the air between the electrodes breaks down and a spark passes the gap, becomes conducting, and allows the condenser to discharge. The property of the spark gap of passing almost instantaneously from a condition of being an insulator for electricity to being an extremely good conductor for electricity is of the utmost value in the spark method of wireless telegraphy. The more perfectly the spark gap insulated before the discharge takes place, and the more perfectly it conducts after the discharge has taken place, the better it is for our purpose.

If I take two electrodes sufficiently far apart in air, and gradually raise the electrical pressure between them, the first indication that anything is going to happen is the formation of fine violet aigrettes on the more pointed or rougher parts of the electrodes. This is known as the brush discharge. By gradually raising the pressure, this brush discharge extends further out into the air, until finally the air between the two electrodes becomes so strained that it breaks down and the real spark passes.

The long thin spark that occurs in this case is not very suitable for wireless telegraphy, as its resistance is too high. Ordinary lightning flashes are good examples of long sparks on a very large scale. If instead of working with the electrodes far apart they are placed nearer together, and if the electrical pressure is supplied from a very powerful source, then directly the spark passes it forms a thick discharge having the appearance of a flame in which the nitrogen of the air is actually being burnt; a process which, it is hoped, in the future may have immense importance in the supply of artificial nitrates for agriculture. This flame-like discharge has a low electrical resistance, but has the effect that it so heats or modifies the air that it is difficult to get the air to insulate again, after one discharge, ready for the next.

If a large quantity of electricity is discharged through the spark gap, and if the spark lasts a very short time compared with the interval between successive sparks, then a highly-conducting spark can be obtained, as well as a good insulation between the sparking terminals when no discharge is passing.

In order to help to bring the gap back to its insulating condition after each discharge, many devices are employed, such as subdividing the spark into several shorter sparks, cooling the electrodes, blowing air across the spark gap, &c. When the condenser or antenna discharges through the spark gap, oscillations are set up which radiate Hertzian waves.

In practice in wireless telegraphy it is difficult to obtain a large number of oscillations during each discharge as corresponding with each oscillation; the antenna radiates energy. A large number of oscillations means, if we keep amplitude of each the same, that we are radiating a large quantity of energy. Besides this radiated energy, which is useful for transmitting messages, there is also energy wasted in heat in the spark gap, in the conductors, in the glass or other insulation of the condensers. It is this useless part which we require to make as small as possible.

I have lately had an opportunity to determine how many oscillations actually take place in a certain wireless transmission. The experiment was made by photographing the spark as seen in a mirror rotated at a very high speed, and it was found that each spark consisted of nine or ten complete oscillations.

If all the oscillations had been of equal strength or amplitude, and if the receiving circuit had been similar to my pendulum in my mechanical model, then there would be very little to be gained by increasing the number of oscillations. As the oscillations die away in the spark method, two or three times this number would probably be required for the best effect. As a matter of experiment, very good tuning was obtained with the wireless transmission referred to above.

As an example of the sharpness of tuning obtainable by the spark method, the following test carried out on the Lodge-Muirhead installation at Hythe may be of interest.

The station at Hythe had to receive messages from Elmer's End at a distance of fifty-eight miles over land, in spite of the fact that the Admiralty station at Dover, only $9\frac{1}{4}$ miles distant, was transmitting as powerfully as it could, in order to produce interference, and that the regular communications were going on in the Channel between the shipping. It was found possible with a difference of wave-length of 6 per cent. to cut out the interference from the Dover station.

In the arc method of producing continuous oscillations we employ, as before, a condenser and self-induction; but, instead of charging the condenser to a high voltage and allowing it to discharge by means of oscillations which die away, and then repeating the process over and over again, we actually maintain the condenser charging and discharging continuously without any intermission, so that we practically obtained a high-frequency alternating current in the aërial.

To impress the difference on your minds, I have an incandescent lamp, which I switch on and off rapidly about ten times, and then after a short time I repeat the same flickering of the light, and so on. The flickering of the light corresponds with the oscillations in the ordinary spark method, and the time spaces between the flickers represent the times during which the condenser or antenna is being charged ready to produce a fresh series of oscillations. In practice we may have as many as, say, a couple of hundred discharges of the condenser a second, and during each discharge we may get, say, ten complete oscillations, each oscillation lasting one-millionth of a second, if the wave-length is 300 metres; thus the total time that the condenser is discharging is only one one-hundred-thousandth of a second, or the five-hundredth part of the interval of time between two successive discharges. My lamp here flickers about five times per second, and makes ten flickers before it goes out; the total time that it is flickering is two seconds, and the time before it should start to flicker again to correspond with the practical wireless case is therefore 1000 seconds, or rather more than a quarter of an hour. If now I represent continuous oscillations, such as are obtained by the arc method with this lamp, I shall simply keep the lamp flickering continuously, and there will be no intervals whatever.

The arc method of producing continuous oscillations is founded on my musical arc. In order to explain this I must demonstrate some of the properties of the direct-current arc. If I vary the current flowing through the arc very slowly and note the potential difference corresponding with each value of the current, keeping everything else constant, I obtain a curve generally spoken of as the characteristic of the arc. These curves under different conditions have been very thoroughly investigated by Mrs. Ayrton.

With the carbon arc between electrodes in air the voltage decreases very rapidly when the current is gradually increased, starting from very low values. As the current becomes larger the rate of decrease of the voltage becomes less and less until it is, comparatively speaking, quite small, with a current of ten or twelve amperes. With the arc between metal electrodes similar results are obtained, except that the discontinuity in the curves, called the hissing point by Mrs. Ayrton, takes place at very small currents, generally well below one ampere.

With arcs burning in hydrogen, Mr. Upson has found that the curves are generally much steeper for the larger values of the current than for the corresponding arcs burning in air. This point is of great importance as explaining the value of the hydrogenic atmosphere used by Poulsen and referred to later.

In general, I may therefore say for the above arcs that increase in current through the arc is accompanied by decrease of the potential difference between its electrodes, and *vice versâ* decrease of the current causes increase in the potential difference; on the other hand, certain arcs, such as the arc between cored carbons, behave in an opposite manner, that is to say, current and potential difference increase and decrease together.

I demonstrated in 1900 that if I connect between the electrodes of a direct-current arc (or other conductor of electricity for which an increase in current is accompanied by a decrease in potential difference between the terminals) a condenser and a self-induction connected in series, I obtain in this shunt circuit an alternating current. I called this phenomenon the musical arc. The frequency of the alternating current obtained in this shunt circuit depends on the value of the self-induction and the capacity of the condenser, and may practically be calculated by Kelvin's well-known formula.

Besides the condition that an increase of current must be accompanied by a decrease in potential difference, it is necessary that the relative decrease in potential difference produced by a given increase in current, that is to say, the steepness of the characteristic, shall exceed a certain minimum value which depends on the losses in the shunt circuit. It is also necessary that an increase in current shall be accompanied by a decrease in potential difference, even when the current is varied very rapidly.

Let us consider what takes place when I connect this shunt circuit to an arc. At the moment of connection a current flows from the arc circuit into the condenser circuit, which tends to reduce the current flowing through the arc. This reduction of the current through the arc tends to raise the potential difference between its terminals, and causes still more current to flow into the condenser circuit, and I now have a condenser charged above the normal voltage of the arc. The condenser, therefore, begins to discharge through the arc, which increases the arc current and decreases the potential difference, so that the condenser discharges too much; the reverse process then sets in; the condenser becomes successively overcharged and undercharged, due to the fact that, instead of the potential difference between the terminals of the arc remaining constant and allowing the condenser to settle down with its proper corresponding charge, the potential difference actually decreases when the condenser is discharged and increases when it is charging, so as to help to keep up the flowing backwards and forwards of the current indefinitely.

The oscillograph wave forms show what is going on very clearly, and they show that in general the swing of the current in the condenser circuit attains such a magnitude that when the condenser is charging it takes the whole of the current away from the arc, so as to make the arc, although burning on a direct current circuit, a pulsatory arc. The pulsation of the current through the arc causes the vapour column to grow bigger and smaller, and the light to vary. When the vapour column grows bigger and smaller it displaces the air around it and produces a note the pitch of which is determined by the frequency of the current in the shunt circuit.

The values of the capacities of a series of condensers have been calculated by Kelvin's formula to give the frequencies corresponding with a musical octave, and the nearest values in an ordinary laboratory box of condensers have been taken and connected to a keyboard. The result shows how nearly Kelvin's law is obeyed.

With this apparatus I can demonstrate the importance of tuning in electrical circuits, and perform electrically some experiments which I have already performed mechanically earlier this evening. I use the large coil which forms the self-induction in the circuit shunting the arc as a transmitting circuit for wireless telegraphy by the magnetic induction or Preece method; and I have a receiving circuit consisting of a coil of wire connected to a small lamp, and not connected in any way to the transmitting circuit. At a certain short distance between the transmitting coil and the receiving coils, the indicating lamp lights if I cause my arc to sound *any* one of the notes of the octave, and so produce an alternating current of corresponding frequency in the transmitting coil. If I now tune the receiving circuit, by connecting a condenser in it, the lamp on the receiving circuit will light at about five times the distance; but it will only light when one definite note is sounded by the arc. These are the two distinct advantages of tuning, namely, greater distance and syntony, or responding to only one definite note.

For wireless telegraphy by means of Hertzian waves, based on my arc method, we require much higher frequencies in the shunt circuit. If we attempt to obtain this higher frequency from the ordinary arc burning between solid carbons in air, we find that above a certain limit the oscillations will no longer take place. This is due to the fact that we are varying the current through the arc at this higher frequency too quickly for an increase in current to be accompanied by a decrease in potential difference. I have demonstrated that if I only vary the current through the ordinary current arc sufficiently rapidly, then an increase in current is accompanied by a proportionate increase in the potential difference, and the arc behaves just like an ordinary resistance. If we work with very small current arcs, we can obtain high-frequency musical arcs burning in air either between carbon or metal electrodes.

In a paper read before the International Electrical Congress at St. Louis in 1904, Mr. Poulsen showed that, by placing the arc in a flame, it was possible to obtain higher frequencies than when the arc was burning in air. Following this up, Mr. Poulsen came to the conclusion that the best results were obtained when the arc was burning in hydrogen, or a gas containing hydrogen; and he further added a magnetic field around the arc somewhat similar to that which has been previously used by Elihu Thomson.

The arc burning in coal gas in a powerful transverse magnetic field was used by Poulsen in his early experiments to produce the high-frequency current necessary for wireless telegraphy between Lyngby and Esbjerg, in Denmark. This apparatus has been further improved, and is now employed by the Amalgamated Radio-Telegraph Company in their station at Cullercoats and the other stations that they are erecting.

In both the arc and the spark methods of wireless telegraphy we employ a high-frequency alternating current in the aërial conductor. The essential difference between the two methods lies in the fact that with the spark method our alternating current in the aërial conductor first increased to a maximum value and then dies away rapidly, making only a limited number of oscillations, whereas in the arc method the oscillations are maintained continuously of unvarying amplitude.

With the arc method we are further able to choose the number of consecutive oscillations which make up each signal sufficiently great to obtain the very best syntony. On the other hand, improvement in the arrangement and construction of the apparatus for the spark method has so increased the number of oscillations corresponding with each spark that it may be that we shall be able to obtain a sufficient number in each train to give as good syntony by this method as that obtained with the arc method.

The arc method seems eminently suitable for very high speeds of working. As the oscillations are quite continuous, we can cut them up into groups to form the dots and dashes of the Morse alphabet, just as if we were working with a continuous current such as is used on land lines, so that there seems no reason why as high a speed of working should not be obtained from the arc method of wireless telegraphy as is obtainable by automatic signalling on land lines; for it is to be noted that the dot or shortest signal of the Morse alphabet, even at a speed of three or four hundred words per minute, will last long enough to consist of many hundreds of oscillations of the current in the aërial, so that there will be plenty of oscillations in the group forming the dot to give good syntony.

Turning to the spark method for high working speeds, we find a difficulty in that the dot of the Morse alphabet must at least occupy the average time required to charge the condenser or aërial and produce one spark, and preferably sufficiently long for several. We are therefore obliged in the spark method to use a high rate of sparking for high-speed signalling. This difficulty has not become very serious with the present low speeds of sending. When we come to use considerable amounts of power to transmit messages over long distances, and we also require a high speed of working, the practical difficulty in constructing apparatus suitable for sufficiently rapid sparking will become serious.

Mr. Marconi in 1905 claimed to have already reached a speed of 100 words per minute by the spark method, and lately there has appeared in the technical Press examples of high-speed signalling by the British Post Office over a distance of fifteen miles in which readable signals were received at a speed of seventy words per minute.

Turning to the receiving end, almost all the receivers that have been used in the spark method can be equally well used for the arc method; for it must be remembered that the transmission in either case is affected by Hertzian waves traversing space, and that the only fundamental difference consists in the number of oscillations in each train of waves. It must be noted, however, that in those methods in which a telephone receiver is used it is necessary to break up the continuous oscillations of the arc method into groups succeeding one another sufficiently rapidly to produce an audible sound in the receiver; for in the spark method the sounds we hear in the receiver correspond with the succession of impulses of the diagram, one for each spark at the transmitter. This chopping up of the continuous wave-train so as to produce audible signals in the receiving apparatus can be done either at the transmitting end or in the receiving apparatus. An example of this latter method is Poulsen's ticker.

The question whether receiving apparatus can be arranged so as to receive messages from stations equipped with the spark apparatus and from stations equipped with the arc apparatus is a matter of enormous importance at the present moment in view of the probable ratification of the Berlin Convention, which imposes an obligation on all commercial stations to inter-communicate without regard to the make or system of transmitting apparatus employed. I am of the opinion that there will be no difficulty in carrying this into effect provided that the stations using the spark method send out long trains of waves, as they should do to obtain syntonic working, which is also called for by the Berlin Convention.

An extremely interesting development which is now progressing rapidly owing to the possibility of producing continuous oscillations by the arc method is wireless telephony. Suppose that we can vary the intensity of the oscillations in a manner corresponding with the vibrations of the air which constitute sound and speech, then we should obtain at the receiving stations a train of Hertzian waves the amplitude of which varies in a corresponding way; by allowing these waves to act on a telephonic receiver which is sensitive to the intensity of the waves we shall obtain in the telephone a reproduction of the sounds. This has actually been carried into effect by employing an ordinary microphone to modify the current through the transmitting arc so as to vary the intensity of the oscillation current produced, and by employing what is known as a point-detector and a telephone at the receiving station.

Another method which may be used consists in causing the microphone to vary the frequency of the oscillations of the generator, and by arranging the receiver so that it is more or less strongly affected according to the frequency of the received waves.

I am informed that experiments have been made in wireless telephony in Berlin by the Amalgamated Radio-Telegraph Company between their stations in Mathieustrasse and Weissensee, 6·5 km. apart, with good results, and that it is now proposed to equip the stations at Oxford and Cambridge for the further perfecting of this application.

It is greatly to be desired that wireless telephony may develop rapidly, as it seems to me that for the purpose of communicating with ships wireless telephony will have great advantages over wireless telegraphy.

I am deeply indebted to Mr. Colson for all the facilities that he has placed at my disposal, and to his engineers for their assistance, which has enabled me to carry out the experiments in the lecture; and I have also to thank the Tramway Department for the special supply of current.

THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. J. B. FARMER, M.A., F.R.S., PRESIDENT OF THE SECTION.

CUSTOM has decreed that those who are charged with the responsibilities that to-day fall to my lot should endeavour to address themselves to the consideration of matters such as they may deem to be of advantage to others, or, at any rate, of interest to themselves. It is not, perhaps, always easy to combine these two courses, and if I choose the less altruistic one I experience the smaller compunction in doing so because the undisturbed repose that most Addresses enjoy when they have been decently put away between the covers of our Annual Report seems to indicate that an attempt to express the passing thought, however ephemeral its interest, may not be the worst introduction to the business of the advancement of our science.

Any attempt to give a survey of the progress and present position of botanical science, even were so large a task at all within my power, has almost ceased to be necessary, owing to the enterprise which has so admirably provided for its adequate fulfilment elsewhere. I propose, therefore, to try to put together, in a form as intelligible as I can, the result of reflections on some of the aspects of botany that are often not seriously regarded; perhaps because they belong rather to the nebulous region of speculation than to the hard (and sometimes dry) ground of accepted fact.

I am by no means blind to the risks incurred in venturing on such a course, but I believe that a glance directed, however imperfectly, towards some of the less obvious sides of our science may not be altogether futile, even though the attempts should evoke the criticism:

Dum vitat humum, nubes et inania captat.

The problems that confront us as botanists are far more numerous and far more complex than formerly. We are attached to a science that is rapidly growing, and this rapid advance is carrying with it a process of corresponding differentiation. Some years ago a danger arose, even within this Association, that we might have replaced differentiation, that quality which distinguishes the higher organisms, by a process of fission which is more characteristic of the lower ranks of life.

The products of the threatened fission would doubtless have pursued divergent paths, and the botanist of to-day would have been the poorer for it. He would have been lost to physiology, and all that physiology implies. Happily that danger was averted, and, to our lasting advantage as members of the botanical organism, our science escaped disruption, and physiological investigation still continues both to inspire, and to be aided by, other branches of botanical research. A physiological conception of morphological phenomena is the one that to me seems to afford the broadest outlook over our territory. It serves to check a tendency towards mere formalism on the one hand and to correct the not less baneful effects of a superficial teleology on the other. Both are real dangers, and we have all encountered examples of them.

In rating highly the value of maintaining a physiological attitude of mind towards the phenomena presented by the vegetable kingdom, one is mainly influenced by the logical necessity which such a position carries with it of constantly attempting to analyse our problems, as far as may be possible, into their chemical and physical components. It seems to me that this is the only really profitable method that we can bring to bear on the difficulties that lie before us, because in using it we are constantly forced to consider the *causes* which have led to the final result. Of course I am well aware that to some minds the very attempt to apply such a method beyond a very limited range may appear futile, or at least premature. But the goal of all scientific inquiry lies in the ultimate ascertaining of cause and effect, and only with this knowledge can we hope to get control over the results.

Chemistry and physics each present to their followers problems far more elementary than those with which we have to grapple; but the explanation of the great advances which these two branches have made lies essentially in the fact that an analysis of the factors involved has enabled the investigator intelligently to interfere with, and so to control, the mode of presentation of the reacting bodies to each other. And our own special problems, whether we confine ourselves to the simpler ones, or whether we approach the obscurer matters of organisation, heredity, and the like, are assuredly susceptible of a similar method of treatment. We can never expect to get further than to be able to modify the mode of presentation to each other of the materials that interact to produce what we call the manifestations of life; but the measure of our achievement will depend on the degree in which we are successful in accomplishing this.

Indeed, until we have analysed the nature of the reacting bodies, and also especially the particular conditions under which the reactions themselves are conducted, we are avoiding the first steps in the direction of ultimate success. At present, when we desire to know the taxonomic value of this or that character, we are perforce largely guided by purely empirical considerations. We find, for example, that a particular structure is very constant through a group of species otherwise closely resembling each other, and we rightly (but quite empirically) regard the possession of that character as a valuable indication of affinity within that alliance. But the very same feature in other groups may be highly variable, and lack all importance amongst them for systematic purposes. It may be, and very probably is, optimistic to look forward to the time when we shall know *why* the character is good in one, and worthless in another, alliance. But when we do, I am convinced that the reason will be found to lie in chemical and physical causes. We are very ignorant as yet of the details, but we can nevertheless even now form a fair guess at their general nature.

In this connection I would venture to express the opinion that much real harm is done by the toleration of an uncritical habit of mind, all too common, as to the significance of structures which are regarded as adaptive responses to stimuli of various sorts. It is *not* enough to explain the appearance of a structure on the ground of its utility; properly speaking, such attempts, so far from providing any explanation, actually tend to bar the way of inquiry just where scientific investigation ought to commence.

That many of the responses to such stimuli are of a kind to render the organism "adapted" to its environment no one, of course, will dispute; but to put forward the *adaptedness* as an explanation of the process is both unscientific and superficial. The size and the spherical shape of duckshot are admirably adapted to the purposes for which duckshot is used; but this affords no insight into the necessary sequence of cause and effect, which makes the melted lead assume the characters in question as it falls down the shot-tower.

But many people still find consolation and satisfaction in an anthropomorphic and somewhat slipshod application of a kind of doctrine of free-will to matters that really call for rigorous examination into the causes which, under given conditions, must inevitably and of necessity bring about their definite result.

One of the commonest responses to the stimulus of wounding in the higher plants is the formation of a layer of cork over the injured and exposed tissue. No one can deny that this is a reaction of great utility, checking as it does the undue evaporation of water and the entrance of other parasitic organisms. And yet I suppose that no one would go so far as seriously to maintain that the obviousness of these advantages satisfactorily explains *why* the cork layer is produced. It seems to me that an investigation of the real underlying conditions which govern such a modified reaction would be of immense value, and that the information we might gain therefrom as to the nature of the chemical processes involved would prove to be of first-rate importance in tracking to their sources some of the factors that influence the course of carbohydrate metabolism within the cell. Again, we know how easy it is to produce colour-changes in the leaves of certain plants—*e.g.*, rhubarb—by severing the vascular bundles, and thereby interfering with the process of translocation. Overton has shown how the accumulation of soluble carbohydrates within the leaf of such a plant as Hydrocharis modifies the metabolic processes within the cells. Thus in bright light, under conditions of cold sufficient to arrest starch formation, but not enough to stop photosynthesis, a red-coloured substance makes its appearance in the cell, and this again disappears on raising the temperature, so that the accumulation of soluble carbohydrates diminishes. The red colour which is associated with the change may possibly by absorbing the heat ray aid in restoring metabolism to its "normal" course; but such a teleological explanation is not of general application, and gives no real insight into the nature of the processes involved. The well-known laboratory method, which we owe to Klebs, of inducing Eurotium to enter on a sexual phase by keeping it at a temperature of 26° C. is another example of the same order. The particular reaction that occurs in each of these instances is that which necessarily results under the specified conditions, and no other course of chemical change is possible.

In the last-mentioned example, Eurotium acts in a way similar to that of drought, only the result is more quickly produced. This perhaps indicates that we are dealing with a definite series of changes which are inhibited by the presence of too much available nutriment supplied at a temperature too low to enable it to be sufficiently rapidly altered within the organism so as to give rise to the specific substance, which is more directly responsible for the ascogonial phase of the life-history. Something of an analogous character is probably effective in the formation of "fairy-rings," so typical of the growth of certain agarics. This appearance of fairy-rings may be easily reproduced in artificial cultures of moulds by appropriate means. Thus if the nutriment agar be kept fairly dry, so that the rate of diffusion of soluble materials is slowed down, it is found that concentric zones of sterile and sporiferous hyphæ regularly alternate with each other. An explanation of this behaviour, which seems most probable, is that the hyphæ, after they have been growing over the substratum for a certain distance, have acquired sufficient raw material to provide for the building-up of the substance which stimulates spore-production. When this has taken place the substance so elaborated is used up and spore-production ceases until a fresh supply of material, under the conditions of the experiment, has been formed to act in its turn as a new stimulus. This suggestion is supported by the interference with the circular form of zones that can be brought about by artificially interfering with the rate of diffusion of the supply of nutriment in the jelly. The rhythmical alternation of sterile and fertile zones seems to prove that *quantity* of elaborated material is an essential factor in the process, just as in the stimulation of a motile organ the stimulus itself has to reach a certain minimal intensity in order to cause a movement.

The parallelism between the nutritive, *i.e.*, the chemical, stimulus in the case of the fungus and the minimal time-stimulus required to provoke geotropic movement is very striking. For it will be remembered that there is evidence in the latter instance also of the occurrence of a definite chemical change as the result of the disturbance of normal gravitational relations. This finds expression in the accumulation of homogentisinic acid as the result of the formation of an anti-oxidative substance which arrests the complete disruption of tyrosin in the cells. Whether this is the immediate cause of the geotropic movement, or merely a concomitant of it, we cannot settle at present. But it is of the highest interest to know that chemical change is initiated as a result of the external gravitational impulse, even when the latter is of too short duration to produce an actual geotropic movement. And although we may not at present be able to identify the exact material which is directly concerned in these stimulatory or formative processes, we have, as it seems to me, irresistible evidence in favour of its real existence. It is more than mere analogy that leads us to believe that the various kinds of galls, for example, that may be formed on an oak leaf owe their formation to the specific interference of the secretion of the grub with the higher metabolic processes going on in the cells of the leaf.

I have alluded to the different conditions under which given reagents may interact, and these may in turn very materially affect the final result by modifying the course of the reaction itself. We are coming to realise the fact that the physical conditions of the cellular constituents exercise an important influence on the course of chemical activity manifested within their range. We all know what an important part water plays in ordinary chemical reactions, but the water question assumes a special prominence when the reactions are going on in a colloidal matrix, or rather in a mixture of colloids, such as the various proteins that occur in the cell. Questions of rates of diffusion, physical absorption, and the like have to be taken into account; and beyond all these there remain the series of remarkable electrical relations which the proteins exhibit, as well as those changes in surface-tension that are, in part at least, connected with them.

It is impossible to resist the belief that a closer study of the physico-chemical changes that accompany a nuclear division will yet throw much light on the mechanics of this wonderful process. Indeed, we already possess some data which are serving as starting-points for further investigation, and they have placed some of the known facts in a very suggestive light.

It has often been urged as a reproach against the histological methods employed in the study of the cell that all such investigations can, after all, only give information as to the character of coagulations or precipitations. Of course this is perfectly true; but provided we have sufficiently good grounds for enabling us to feel confident that the precipitation or coagulation faithfully maps out the positions originally occupied by the respective colloids during life, there is no real force in the objection. No one would call in question the accuracy of a photographic negative on the ground that after development it no longer consisted of the actual substances which had been formed in the film by the exposure to the action of light. All that is required is that the deposited silver shall accurately express the limits of, and be proportionate in amount to, the alteration in the composition of the salt which was produced when the plate was exposed in the camera.

Much of the general detail of a nuclear division can be followed even in the living cell, and we therefore possess direct as well as indirect means of testing the degree of accuracy with which the fixed preparation represents the original pattern of distribution of the colloids within the cell. No one who has studied the behaviour of artificially prepared mixtures, the colloidal proteins and nucleins after "fixing" and staining them, can entertain reasonable doubts as to the substantial identity of the structures visible in a well-fixed cytological preparation with those present during life. For the substances, even in these artificial mixtures, keep remarkably distinct, as indeed Fischer showed some years ago.

Few things are more striking than the remarkable series of evolutions passed through by the linin, and by the chromosomes which finally emerge from it during the progress of a mitosis. We have clear evidence that the nucleus at this period is the seat of rapid chemical change. The process of distribution of the nuclein within the linin is sufficient proof in itself of this. But we have also, I believe, evidence of physical disturbances of an electrical nature which accompany, and indeed in a measure determine, the course of mitosis. This is indicated, not only by the movements that proceed within the nucleus, and concern the linin and chromosomes, but also by the remarkable alterations in surface-tension exhibited by the nuclear membrane.

It is well known that at a certain stage of the heterotype division, for example, the chromosomes move to the periphery of the nucleus, and each one is removed as far as possible from every other chromosome. At this stage, to which Haecker has given the name of "diakinesis," the nucleus reaches its maximal size. Diakinesis is not the only stage in which there is an indication of repulsion between the elements of the chromatic linin. Measurements prove that all such periods of repulsion are also marked by an increase of nuclear size which is transitory, and either disappears or alters in a synchronous fashion with them. These phases of enlargement have been generally regarded as directly connected with the intake of liquid by the nucleus, due to a hypothetical change in osmotic conditions. But, so far as I am aware, no satisfactory explanation has yet been given as to why, or how, the supposed increase of osmotically active molecules within the assumed semi-permeable nuclear membrane could be effected. On the other hand, an enlargement of the surface-membrane of the nucleus would necessarily follow on the migration towards it of chromosomes or other bodies carrying similar electrical charges. For the induced charge in the particles of the membrane would of course weaken its coherence, for the same reason that the free chromosomes repel and move away from one another.

There is evidence to show that the proteins *are* able to carry such charges, and this is a matter of the highest importance as affording a clue to many other processes in which changes of surface-tension play a part, besides those connected with nuclear division.

Not the least of the many remarkable properties exhibited by the proteins lies in their capacity of taking on either a positive or a negative charge of electricity. A clear proof of this was afforded by the beautiful experiments of Billitzer, who showed that, when so charged, the colloid moves as a whole towards one pole or the other on sending a current through the liquid in which it was suspended. At first sight it may not be easy to understand how it is possible for a colloid to receive and retain a charge under the conditions which obtain either in the solution or in the cell. It must, however, be remembered that the liquid contains electrolytes in solution also, and any disturbance in the equilibrium of the products of ionic dissociation will be accompanied by corresponding differences of potential. The most reasonable explanation of the phenomenon in question seems to be that the colloids are unequally permeable to the ions, whereby there comes to be a preponderance of one or the other group associated with the proteins. Perhaps this should be connected with the remarkable though still imperfectly understood property of adsorption which is characteristic of many colloids.

Much, however, still remains to be done before a complete survey of the electrical changes that are associated with mitosis can be made. We especially desire more complete information on the nature of the chemical processes which are involved. For it is obvious that the physical changes must ultimately be connected with the transformation of materials which goes on so energetically at these recurrent periods of nuclear activity. We do not yet know how or why the chromosomes that have been dispersed at diakinesis should again congregate on the spindle prior to their final separation. Possibly this is to be connected with the signs of disturbance in the extra-nuclear cytoplasm, which in its turn finds expression in the differentiation of the achromatic spindle. The character of this body has long aroused the suspicion that its existence is to be attributed to electrical causes. The more recent work serves to indicate that this suspicion was well founded.

The more complete study of the chemistry and physics of karyokinesis is certain to prove valuable for another reason. The successive changes which the nuclei of both animals and plants exhibit when they are undergoing division are so remarkably similar that it seems exceedingly probable that the processes actually involved may turn out to be relatively simple, at any rate in their broader features. I mean that they probably belong to what we might term the lower grade of metabolic problems. For the great uniformity of the process as a whole, complex though it undoubtedly is, hardly suggests direct relations as existing between it and those more specialised forms of metabolism on which the properties of specific form, and such like characters, depend. This view of the matter is not in any way weakened by the fact that the materials providing for the multiplication of nuclei have themselves passed through the very highest stages of anabolic construction. There are, indeed, some grounds for believing that the composition of the higher proteins is distinctly specific for different groups of organisms; but apart from this it is difficult to resist the conviction that, in so far as its essential constituents are concerned, the nucleus is the seat of a complex organisation which is superadded to its chemical composition. But this conception of the nucleus does not affect the position of the lower-grade chemical changes, with their physical accompaniments which are periodically rendered apparent during the rhythmical series of changes that culminate in the division of the nucleus. It is true that there are some who refuse to admit the necessity of what I might perhaps call architectural complexity in protoplasm. They prefer to regard all the phenomena of organisation and heredity as the outcome of dynamical, rather than of structural, conditions. It seems to me that it is impossible to reconcile such a view with the known facts respecting the inheritance of characters, and that we are driven to postulate the existence of material units which are to either responsible for the sum of the characters represented in any individual. There are grounds for believing that their entities, whatever be their nature, are doubled, and then equally distributed to the two daughter cells at every ordinary nuclear division; and thus the properties of organisation are preserved and transmitted over and above the flux of chemical change.

Most people who have concerned themselves with cytological studies agree that the salient features of karyokinesis strongly emphasise the probability of a conservation of definite material; and that an extremely accurate distribution of it occurs where two daughter cells arise from a parent cell by division. And this inference is greatly strengthened by what occurs, more or less immediately, in connection with the formation of the sexual cells. The origin of these in all the higher animals and plants, as is well known, can invariably be traced to a nuclear division of remarkable complexity. In this, the so-called heterotype division, the special feature consists in the sorting-out of the nuclear constituents originally furnished by the two parents of the individual. This sorting or distribution takes place in such a way that each of the two daughter nuclei which arise as the result of the division receives only half the total number of chromosomes previously contributed by the two parents. The essential point of interest lies in the fact that the process does not consist in the mere halving of nuclear *substance*, but in the distribution of nuclear *constituents*. When two sexual cells which have been formed in this way unite to give rise to a new individual, the total number of nuclear chromosomes is again made good; but the resulting nuclear constitution will not exactly resemble that of either parent. That such is really the case is borne out by innumerable experiments that have been made by breeders. Furthermore the extensive investigations on the results of crosses, both in animals and plants, have confirmed the view that particular characters can be treated as entities. For they are distributed amongst the posterity of the original parents in proportions that closely approximate to mathematical expectation. In this distribution the separate characters behave independently. For instance, the green colour and round form of peas are two characters which may occur in the same or in different individuals. The numerical proportions in which they *will* appear can be foretold with a considerable degree of accuracy.

With these facts before us—and many others could be adduced, all pointing in the same direction—it is not easy to resist the conviction that within the nucleus there must exist material entities which are severally responsible for the appearance of the characteristic traits of any given individual. The question is, What conception can we form as to their nature, and how are they able to produce the observed results? It is not necessary to discuss the evidence that the chromosomes, or the materials of which they are composed, play a most important part in connection with development. All the work of the last decades has tended to emphasise their importance in the transmission of hereditary qualities, and this is equivalent to admitting that they contain factors that determine the path of development, and are responsible for the production, from the egg, of the form and structure of the adult.

Now it is certain that it is not the *chromosome-substance acting as a whole* which is effective in those processes summed up in the term Ontogeny. It might be, and until recently was, thought that in those plants in which there is a marked alternation of generations a definite relation existed between the number of the chromosomes and the particular stage of the life-history. The double number was supposed to be essential for the sporophyte, whilst the halved number was similarly regarded as causally related with the appearance of the gametophyte or prothallial generation.

But Loeb and others had already shown that the eggs of echinoderms might be stimulated to parthenogenetic development by means other than fertilisation, and Wilson found that such larvæ only contained the half number of nuclear chromosomes, as, indeed, was only to be expected. But the idea of a close parallelism between chromosome number and the alternative phases of the life-history was so deeply rooted that the full significance of Wilson's discovery was not at once grasped. The comparative neglect was, perhaps, partly justified, inasmuch as the larvæ could not be reared. It may, however, be incidentally remarked that no one, so far as I am aware, has yet succeeded in raising the *normal* echinoderm larva beyond the pluteus stage.

The investigation of cases of apospory that occur in the pteridophytes have proved that no causal relation can exist between the number of the chromosomes and the characters that distinguish the gametophyte and the sporophyte respectively. For the sporophyte may give rise to the gametophyte aposporously without any reduction, whilst the various types of apogamy with which we are now acquainted exhibit all gradations between a coalescence of more or less differentiated nuclei and the complete absence of all semblance of nuclear fusion. In the latter case, when the sporophyte springs from a gametophyte that has itself arisen after nuclear reduction, the sporophyte continues to retain the smaller number of chromosomes normally associated with the other generation only.

We thus have a complete proof that a single sexual cell which has undergone reduction in the number of its chromosomes retains, in so far as its architectural configuration is concerned, the capacity of giving rise to a plant possessed of the full complement of characters belonging to the species. But this, after all, is only what the facts of heredity might have led us to anticipate. For, whilst we are ignorant of the fundamental *significance* of the sexual fusion of the gametes, one of its most obvious *results* consists in the duplication of the primordia of the specific characters in the cells of the individual thus produced. This statement is not only in accord with results of experiments in breeding, but it is also in harmony with the essential features of the heterotype mitosis; and no other satisfactory interpretation of the latter series of phenomena has yet been found.

Furthermore, the facts of Mendelian dominance clearly show that each parent, through the gametes to which it gives rise, contributes an independent organisation responsible for at least some of its own distinctive characters, as well as those which distinguish the species. Consequently, when two gametes fuse, the embryo will be provided with a duplicate stock of agents or primordia which determine the appearance of its own specific and individual characters. These will not always be similar in the two parents, and when this is the case it often happens that the offspring resembles one parent only in respect of a particular feature. Nevertheless the results of further breeding show that the corresponding, but apparently lost, character only is latent, for it reappears in a proportion—and often a fixed proportion—of the individuals of the succeeding generations. In such an example, where both agents or primordia are present, one of them lies dormant, whilst the dominant one alone influences the course of metabolic processes, and thus brings about the appearance of the character itself. The dormant primordium can be transmitted as such through many generations, betraying its existence in each by the occurrence of individuals in which it finds its perfect expression. This happens when the opposite dominant agent or primordium has been removed from some of the gametes by the sorting-out process during the heterotype mitosis to which I have already alluded.

The particulate character of inheritance seems, as many writers have pointed out, to demand a structural organisation for its basis; and the units or primordia of which the latter is composed must be relatively permanent, inasmuch as heredity itself is so stable. The agents or primordia themselves probably act by definitely influencing the course of chemical reactions that proceed within the living protoplasm, somewhat after the fashion of the ferments. But whether this influence on the course of metabolism is to be attributed more directly to the chemical or the physical aspect of the organisation must, of course, remain an open question, though I incline to the latter alternative on grounds which I have already indicated.

The processes of the higher metabolism offer suggestive analogies with those reactions for which the ferments are responsible. In contemplating them one can hardly fail to be struck by the orderly way in which ferment succeeds ferment on an appropriate medium. Each one produces its own special change, which it is unable to carry further itself, but it thereby provides a substratum suitable for its successor. Starting, for example, with a complex substance like cane sugar, we see it acted on by a series of ferments, each the result of protoplasmic differentiation, and each one carrying the process of disintegration a little further, but strictly limited in its power to act, and only able to take the change on to a definite stage.

Everyone who has experimented with plants with the view of inducing the formation of some structure foreign to the species or individual by artificial means must have become impressed by the great difficulty of getting into touch, so to speak, with the higher metabolism at all. It is often easy enough to divert the life-history into either the vegetative or the reproductive channel, as every gardener is more or less consciously aware, and as Klebs has conclusively shown in his remarkable series of carefully conducted experiments. But even here it is sometimes difficult exactly to hit off the conditions requisite to ensure the production of one or other of the various phases of the life-history. There are many fungi, for example, which are believed to represent vegetative stages of Ascomycetes or Basidiomycetes, but it has not yet been found possible to ascertain the conditions that would cause them to form the highest fructifications. Even in simpler instances a similar difficulty is sometimes encountered. Thus *Bispora moniliforme*, a mould that often occurs on the wood and stumps of oak or hornbeam, is not readily cultivated as the Bispora form, whether it be grown on wood or on various nutritive media. The usual result of raising it under artificial conditions is to obtain a luxuriant crop of Eurotium-like mould. But the Bispora form can be reproduced from such a culture by growing it in strong solutions of cane sugar under certain conditions, all of which are not as yet understood.

I take it we shall agree that the properties of structure and form are to be interpreted as the necessary result of the action of particular substances on the protoplasm, and that these cause it to assume those definite attributes which we term specific on account of their constancy through a larger or smaller range of individuals. But this constancy of form must then be the result of a corresponding definiteness in the series of changes undergone by the raw materials supplied as food in their upward transformations; each stage in the process limits the possible range of those that follow, as in the case of the ferments to which I have alluded; and thus it becomes increasingly difficult to modify the final result.

In this way we may see, perhaps, an explanation of the circumstance that in amphibious plants the particular structure, whether adapted for land or water, that will arise in conformity with the environment is irrevocably determined long before the organs themselves are sufficiently developed to be exposed to the direct influence of the conditions to which they are supposed to be specially adapted.

Now it is a matter of common knowledge that the formative processes can be, and sometimes *are*, disturbed with the most surprising results. I may again refer to the fungal or insect galls as examples that will be familiar to everyone. It appears to me that these exceptional developments are of extraordinary importance in relation to any endeavour to probe the mysteries of organisation. The very difficulty experienced in imitating the effect of the insect's secretion strongly emphasises the specialised nature of the particular substance which is able to modify the "normal" reactions of the plant. The latter are dependent on the way in which the organic apparatus determines the fashion of the molecular presentations, so that, as I have said, the course of the reactions themselves become increasingly limited in their range. Now as regards the manner in which the secretion of the insect operates, it seems clear that it can produce no permanent change in the organising apparatus of the protoplasm, since the growth is at once arrested on the removal or death of the insect. But whether the influence is one that more directly affects the physical state of the apparatus for the time being, or whether it acts more directly by introducing new substances into the final chemical reactions, are questions which are plainly worth investigation, but at present certainly do not admit of an answer.

Another example of interference with the developmental processes is afforded by the well-known "lithium larva," which was discovered by Herbst to arise when the eggs of some species of sea-urchins are allowed to segment in sea-water that has been altered by the addition of lithium salts. The monstrosity produced under these conditions was just as constant and specific in character as are the different galls which can be induced to develop on an oak leaf by the corresponding species of insect.

Extending these considerations a little further, one sees that what we call disease also falls into the same category. For disease represents the necessary outcome of a disturbance, however introduced, into the course of metabolism, which diverts it from the "normal" channels. Pathology has long recognised that the explanation and the consequent control of disease lies, ultimately, in the correct appreciation of the cellular reactions as the result of their experimental study. We cannot pride ourselves on the advances that have been made in the study of plant pathology as yet. Our remedies are commonly of the crudest kind, and we have only recently begun to take serious count of the facts of organisation in the scientific attempt to breed races of plants immune from the attack of certain diseases. The results that have already been obtained, both abroad and by Biffen and others in this country, are full of hope at the present time. The study of the causes of immunity along scientific lines ought assuredly to form a fruitful field of investigation in the near future.

From what we already know it seems clear that the proximate causes of immunity may be diverse in character, and may consist in very different reactions in different cases. It may be that the response becomes expressed in a modification of the carbohydrate metabolism, leading to the formation of an excluding layer of cork; or it may lie in the direction of those substances, as yet so little understood, the anti-toxins; or, again, it may be due to still other and even less apparent causes. But whatever the true nature of the response, it will have to be investigated for individual cases, and its secrets will only be unlocked when the chemical and physical processes involved in its operation are understood.

In making these remarks I dare say I may be accused of putting forward an impossible ideal, or at any rate one that is impracticable of attainment. I am not very much concerned about that. Progress is only to be made by trying to penetrate further than we can at present see, and I believe we have gained enough insight into the chemistry and physics of the living processes to warrant us in hoping that we shall penetrate a good deal deeper still. But if we are to ever unravel the tangle, it can only be by applying such methods as have been successful in dealing with material things elsewhere.

For the problems that rise up before us are seen, as we become able to get at close quarters with them, to resolve themselves more and more into questions of chemistry and physics. I believe that it is only by the help of these elder branches of science that the accurate formulation, to say nothing of the final solution, of the problems will be achieved. A recent writer has suggested that life is not the cause of the reactions underlying the phenomena of life. Nevertheless the reactions that go on in the living body are obviously guided as to the particular directions they take by the apparatus or mechanism of the individual organism. When the conditions for the manifestation of life, and all that it implies, are satisfied, what will be produced depends partly on the structure of the apparatus itself (*i.e.*, on the hereditary organisation), partly on the nature of the substances fed into the apparatus, and finally on the physical conditions under which it is working. It is probably along the last two lines that investigation will continue to be pursued with more immediate profit; but the goal will not be finally reached until we have solved the problem as to the nature of organisation itself.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY SIR PHILIP MAGNUS, B.Sc., B.A., M.P., PRESIDENT OF THE SECTION.

The Application of Scientific Method to Educational Problems.

NOTWITHSTANDING the fact that the greater part of my life has been spent in educational work, in teaching, in examining, in organisation, and in the investigation of foreign systems of instruction, I have experienced considerable difficulty in selecting, from the large number of subjects that crowd upon me, a suitable one on which to address you as President of a Section of the British Association devoted to educational science.

At the outset I am troubled by the title of the section over which I have the honour to preside. I cannot refrain from asking myself the question, Is there an educational Science, and if so, what is its scope and on what foundations does it rest? The object of the British Association is the advancement of Science, and year by year new facts are recorded in different branches of inquiry, on which fresh conclusions can be based. The progress of past years, whether in Chemistry, Physics or Biology, can be stated. Can the same be said, and in the same sense, of Education? It is true that the area of educational influence is being constantly extended. Schools of every type and grade are multiplied, but is there any corresponding advance in our knowledge of the principles that should govern and determine our educational efforts, or which can justify us in describing such knowledge as Science? If we take Science to mean, as commonly understood, organised knowledge, and if we are to test the claim of any body of facts and principles to be regarded as Science by the ability to predict, which the knowledge of those facts and principles confers, can we say that there exists an organised and orderly arrangement of educational truths, or that we can logically, by any causative sequence, connect training and character either in the individual or in the nation? Can we indicate, with any approach to certainty, the effects on either the one or the other of any particular scheme of education which may be provided? It is very doubtful whether we can say that educational science is yet sufficiently advanced to satisfy these tests.

But although education may not yet fulfil all the conditions which justify its claim to be regarded as a science, we are able to affirm that the methods of science, applicable to investigations in other branches of knowledge, are equally applicable to the elucidation of educational problems. To have reached this position is to have made some progress. For we now see that if we are ever to succeed in arriving at fixed principles for guidance in determining the many difficult and intricate questions which arise in connection with the provision of a national system of education, or the solution of educational problems, we must proceed by the same methods of logical inquiry as we should adopt in investigating any other subject-matter.

In order to bring Education within the range of subjects which should occupy a place in the work of this Association, our first efforts should be directed towards obtaining a sufficient body of information from all available sources, past and present, to afford data for the comparisons on which our conclusions may be based. One of the five articles of what is known as the Japanese Imperial Oath states, "Knowledge shall be sought for throughout the whole world, so that the welfare of the Empire may be promoted"; and it may certainly be said that, as the welfare of our own Empire is largely dependent on educational progress, a wide knowledge of matters connected with Education is indispensable, if we are to make advances with any feeling of certainty that we are moving on the right lines.

There can be no doubt that of late years we have acquired a mass of valuable information on all sorts of educational questions. We are greatly indebted for much of our knowledge of what is being done in foreign countries to the Reports of different Commissions, and more particularly to those special reports issued from the Board of Education, first under the direction of my predecessor in this Chair, Prof. Sadler, and latterly of his successor at the Board, Dr. Heath. But much of the information we have obtained is still awaiting the hand of the scientific worker to be properly coordinated and arranged. A careful collation of facts is indispensable if we are to deduce from them useful principles for our guidance, and unfortunately we in this country are too apt to rest content when we have provided the machinery for the acquisition of such facts without taking the necessary steps to compare, to coordinate, and to arrange them on some scientific principle for future use. Within the last week or two a Bill has passed through several stages in Parliament for requiring Local Authorities to undertake the medical inspection of school children, but, unless the medical inspectors throughout the country conduct their investigations on certain well-considered lines laid down for them by some Central Authority, we shall fail to obtain the necessary data to enable us to associate educational and physical conditions with a view to the improvement of the training given in our schools.[1] On the other hand, although I personally am sceptical as to the results, we have reason to believe that the inquiry recently undertaken into the methods adopted here and elsewhere for securing ethical as distinct from specifically religious training will be so conducted as to give us not only facts, but the means of inferring from those facts certain trustworthy conclusions.

The consideration of Education as a subject capable of scientific investigation is complicated by the fact that it necessarily involves a relation—the relation of the child or adult to his surroundings. It cannot be adequately considered apart from that relation. We may make a study of the conditions of the physical, intellectual, and ethical development of the child, but the knowledge so obtained is only useful to the educator when considered in connection with his environment and future needs, and the means to be adopted to enable him, as he grows in physical, intellectual, and moral strength, to obtain a mastery over the things external to him. Education must be so directed as to prove the proposition that "Knowledge is Power." It can only be scientifically treated when so considered. Education is imperfectly described when regarded as the means of drawing out and strengthening a child's faculties. It is more than this. Any practical definition takes into consideration the social and economic conditions in which the child is being trained, and the means of developing his faculties with a view to the attainment of certain ends.

It is in Germany that this fact has received the highest recognition and the widest application, and for this reason we have been accustomed to look to that country for guidance in the organisation of our schools. We have looked to Germany because we perceived that some relation had been there established between the teaching given to the people and their industrial and social needs; and further, that their success in commerce, in military and other pursuits was largely due to the training provided in their schools. Unmindful of the fact that Education is a relation, and that consequently the same system of education is not equally applicable to different conditions, there were many in this country who were only too ready to recommend the adoption of German methods in our own schools. Experience soon showed, however, that what may have been good for Germany did not apply to England, and that, in educational matters certainly, we do well to follow Emerson, who, when addressing his fellow citizens, declared: "We will walk on our own feet; we will work with our own hands, and we will speak our own minds." Still, the example of Germany and the detailed information which we have obtained as to her school organisation and methods of instruction have been serviceable to us.

Whilst all information on educational subjects is valuable, I am disposed to think that in our efforts to construct an educational science we may gain more by inquiring what has been effected in some of the newer countries. Wherever educational problems have been carefully considered and schemes have been introduced with the express intention and design of training citizens for the service of the State and of increasing knowledge with a view to such service, those schemes may be studied with advantage. Thus we may learn much from what is now being done in our Colonies. Their efforts are more in the nature of experiments. Our Colonies have been wise enough not to imitate too closely our own or any foreign system. They have started afresh, free from prejudice and traditions, and it is for this reason that I look forward with interest to the closer connection in educational matters of the Colonies with the mother country, and I believe that we shall gain much knowledge and valuable experience from the discussions of the Federal Conference which has recently been held in London, and which, I understand, is to be repeated a few years hence.

But valuable as are the facts, properly collated and systematically arranged, which a knowledge of British and foreign methods may afford us in dealing scientifically with any educational problem, it is essential that we should be able to test and to supplement the conclusions based on such knowledge, whenever it is possible, by direct experiments, applicable to the matter under investigation. We have not yet recognised the extent to which experiments in education, as in other branches of know-

[1] Since this was written the President of the Board of Education has stated in the House of Commons that "it was the intention of the Board, if the Bill now before Parliament passed, to establish a medical bureau, which would guide and advise the local authorities as to the nature of the work they would have to do under the Act."

ledge, may help in enabling us to build up an educational science. Some years since there was established in Brussels an *École modèle* in which educational experiments were tried. I visited the school in the year 1880, and I could easily point to many improvements in primary education which found their way from that school through the schools of Belgium and France to our own country, and, indeed, to other parts of the world. From a special Report on Schools in the North of Europe, recently published by the Board of Education, we learn that in Sweden the value of such experiments is fully recognised. We are told that in that country "it was early felt that the uniformity in State Schools was of so strict a kind that some special provision should be made for carrying out educational experiments," and experiments in many directions have been made, mainly in private schools, which receive, however, special subventions from the State. We gather from the same Report that the State regards the money as well earned "if the school occasionally originates new methods from which the schools can derive profit." I venture to think that experimental schools might with advantage be organised under the direction of some of our larger local authorities. The children would certainly not suffer by being made the subjects of such experiments. The intelligent teaching which they would receive—for it is only the most capable teachers who should be trusted with such experiments—would more than compensate for any diminution in the amount of knowledge which the children might acquire, and indeed such experimental schools might be conducted under conditions which would ensure sound instruction. Many improved methods of teaching are constantly advocated, but fail to be adopted because there is no opportunity of giving them a fair trial. As a general rule it is only by the effort of private individuals or associations that changes in system are effected, and teachers are enabled to escape from the old grooves on to new lines of educational thought and practice. It is not difficult to refer to many successful experiments. The general introduction into our schools of manual training was the direct result of experiments carefully arranged and conducted by a Joint Committee of the City Guilds and the late London School Board. Experiments in the methods of teaching Physical Science, Chemistry, and Geometry have been tried, with results that have led to changes which have revolutionised the teaching of those subjects. The age at which the study of Latin should be commenced with a view to the general education of the scholar has been the subject of frequent trial. I would like to see such experiments more systematically organised, and I am quite certain that the curriculum of our rural and of our urban schools would soon undergo very considerable changes, if the suggestions of competent authorities could receive a fair trial under conditions that would leave no manner of doubt as to the character of the results.

It would seem, therefore, that if our knowledge of the facts and principles of education is not yet sufficiently organised to enable us to determine *a priori* the effect on individual or national character of any suggested changes, education is a subject that may be studied and improved by the application to it of scientific method, by accurate observation of what is going on around us, and by experiments thoughtfully conducted. This is the justification of the inclusion of the subject among those that occupy the attention of a separate section of this Association. Our aim here should be to apply to educational problems the well-known canons of scientific inquiry; and, seeing that the conditions under which alone any investigation can be conducted are in themselves both numerous and complicated, it is essential that we should endeavour to liberate, as far as possible, the discussion of the subject from all political considerations. Such investigations are necessarily difficult. We have to determine both statically and dynamically the physical, mental, and moral condition of the child in relation to his activities and surroundings, and we have further to discover how he is influenced by them, how he can affect them, and the character of the training which will best enable him to utilise his experiences, and to add something to the knowledge of to-day for future service.

Notwithstanding the undoubted progress which we have made, it cannot be denied that in this country there still exists a large amount of educational unrest, of dissatisfaction with the results of our efforts during the last thirty years. This is partly due to the fact that there is much loose thinking and uninformed expression of opinion on educational questions. No one knows so little as not to believe that his own opinion is worth as much as another's on matters relating to the education of the people. In this way statements, the value of which has not been tested, pass current as ascertained knowledge, and very often ill-considered legislation follows. In this country, too, the difficulty of breaking away from ancient modes of thought is a great drawback to educational progress. Suggestions for moderate changes, which have been most carefully considered, are deferred and decried if they depart, to any great extent, from established custom, and the objection to change very often rests on no historical foundation. Occasionally, too, the change proposed is itself only a reversion to a previous practice, which was rudely broken by thoughtless and unscientific reformers. The opposition which was so long raised to the establishment of local universities was largely due to want of knowledge on the subject; and certainly the creation, some seventy years ago, of a teaching University in London was actually hindered through a mere prejudice, which broader views as to the real purposes of University teaching and fuller information on the course of University development would have removed.

There never was a time perhaps when it was more necessary than now that education should be regarded dispassionately, apart from political bias, as a matter of vital interest to the people as a whole. Education nowadays is a question which affects not only the life of a few privileged, selected persons, but of the entire body of citizens. The progress that has been made during the last few years in nationalising our education has been very rapid. It may be that it has been too rapid, that sufficient thought has not been given to the altered social and industrial conditions which have to be considered. We have witnessed a strong desire and a successful effort to multiply Secondary and Technical Schools and to open more widely the portals of our Universities. The object of the desire is good in itself. As the people grow in knowledge the demand for higher education will increase, but the serious question to be considered is whether the kind of education which was supplied in schools, founded centuries ago to meet requirements very different from our own, is equally well adapted to the conditions which have arisen in a state of society having other needs and new ideals. Very rightly our students in training for the profession of teachers are expected to study the writings of Locke, Rousseau, Milton, Montaigne, and others; but many are apt to overlook the fact that these writers had in view a different kind of education from that in which modern teachers are engaged, and that their suggestions, excellent as many of them are, were mainly applicable to the instruction to be given by a tutor to his private pupil, and had little or no reference to the teaching of the children of the people in schools expressly organised for the education of the many. Only recently have we come to realise that a democratic system of education, a system intended to provide an intellectual and moral training for all citizens of the State, and so organised that, apart from any consideration of social position or pecuniary means, it affords facilities for the full development of capacity and skill wherever they may occur, must be essentially different in its aims and methods from that under which many of us now living have been trained. It has also been brought home to us that the marvellous changes in our environment, in the conditions under which we live and work, whether in the field, the factory, or the office, have necessitated corresponding changes in the education to be provided as a preparation for the several different pursuits in which the people generally are occupied. Yet, notwithstanding these great forces which have broken in upon and disturbed our former ideals, forces the strength and far-reaching effects of which we readily admit, we still hesitate to face the newly arisen circumstances and to adapt our educational work to its vastly extended area of operation and to the altered conditions and requirements of modern life.

When I say we hesitate to face the existing circumstances I do not wish to be misunderstood. As a fact, changes are continually being discussed, and are from time to time introduced into our schools. But such modifications of our existing methods are generally isolated and detached, and have little reference to the more comprehensive measures of reform which are now needed to bring our teaching into closer relation with the changed conditions of existence consequent on the alterations that have taken place in our social life and surroundings.

Four years ago, it will be remembered, a committee of this section was appointed to consider and to report upon the "Courses of Experimental, Observational, and Practical Studies most suitable for Elementary Schools." That committee, of which I had the honour to be chairman, presented a report to this section at the meeting of the Association held last year at York. The general conclusion at which they arrived was that "the intellectual and moral training, and indeed to some extent the physical training, of boys and girls between the ages of seven and fourteen would be greatly improved if active and constructive work on the part of the children were largely substituted for ordinary class teaching, and if much of the present instruction were made to arise incidentally out of, and to be centred around, such work." It is too early, perhaps, to expect that the suggestions made in that report should have borne fruit, but I refer to it because it illustrates the difference between the spasmodic reforms which from time to time are adopted, under pressure from bodies of well-meaning representatives of special interests, and the well-considered changes recommended by a committee of men and women of educational experience who have carefully tested the conclusions at which they have arrived.

There can be no doubt that, as regards our elementary education, there is very general dissatisfaction with its results, since it was first nationalised thirty-seven years ago. Our merchants and manufacturers and employers of labour, our teachers in secondary and technical schools all join in the chorus of complaint. They tell us that the children have gained very little useful knowledge and still less power of applying it. There is enough in this general expression of discontent to give us pause and to make us seek for a rational explanation of our comparative failure. The inadequacy of the results attained to the money and effort that have been expended is in no way due to any want of zeal or ability on the part of the teachers, or of energy on the part of school boards or local authorities. They have all discharged the duties which were imposed upon them. It is due rather to the fact that the problem has been imperfectly understood, that our controlling authorities have had only a vague and indistinct idea of the aim and end of the important work which they were charged to administer. If we look back upon the history of elementary education in this country since 1870, we cannot fail to realise how much its progress has been retarded by errors of administration due very largely to the want of scientific method in its direction. It is painful to reflect, for instance, on the waste of time and effort, and on the false impressions produced as to the real aim and end of education, owing to the system of payment on results, which dominated for so many years a large part of our educational system. We must remember that it is only within the last few decades that education has been brought within reach of all classes of the population. Previously it was for the few; for those who could pay high fees; for those who were training for professional life, whether for the Church, the Army, the Navy, Law, or Medicine, or for the higher duties of citizen life. This had been the case for centuries, not only in this country, but in nearly all parts of the civilised world. If we read the history of education in ancient Greece or Rome, or mediæval Europe, we shall see that popular education, as now understood, was unknown. All that was written about education applied to the few who got it, and not to the great mass of the people engaged in pursuits altogether apart from those in which the privileged classes were employed. Trade and manual work were despised, and were considered degrading and unworthy of the dignity of a gentleman. I need scarcely say that these social ideas are no longer held. The fabric of society is changed, and we have to ask ourselves whether the methods of education have been similarly changed, whether they have been wisely and carefully adapted to the new order of things. What is it that has really happened? Is it not true that we have annexed the methods and subjects of teaching which had been employed during many centuries in the training of the few and applied them to the education of the people as a whole—to those who are engaged in the very callings which were more or less contemned? Surely it is so, and the results are all too manifest. We have applied the principles and methods of the secondary education of the Middle Ages to our new wants, to the training of the people for other duties than those to which such education was considered applicable, and it is only within the last few years that we have begun to see the error of our ways. In the report of your committee, to which I have referred, it is pointed out that the problem of primary education has been complicated by the introduction of the methods which for many years prevailed in secondary schools, and at a meeting of the National Education Association, held only a few weeks since, it was truly said: "In this country secondary education preceded primary by several centuries, and so the nation now finds itself with the aristocratic cart attempting to draw the democratic horse."

Let it not be supposed that in the days not so far distant, yet stretching back into the remote past, the people as a whole were uneducated. This was not so. But we have to widen the meaning of education to include the special training which the people then received—an education that was acquired without even the use of books. It cannot for one moment be said that the artisans, the mechanics, the farm hands, male and female, were wholly uneducated in those far-off days. In one sense possibly they were. Very few of them could read or write. But from earliest childhood they had received a kind of training the want of which their descendants have sadly felt in the cloistered seclusion of the modern elementary school. They were brought face to face with Nature. They learned the practical lessons of experience; and as they grew up their trade apprenticeship was an education which we have been trying vainly to reproduce. They gained some knowledge of the arts and sciences, as then understood, underlying their work. Their contact with their surroundings made them thoughtful and resourceful, for Nature is the most exacting and merciless of teachers. The difficulties they had to overcome compelled them to think, and of all occupations none is more difficult. They were constantly putting forth energy, adapting means to ends, and engaging in practical research. In the field, in the workshop, and in their own homes boys and girls acquired knowledge by personal experience. Their outlook was broad. They learned by doing. It is true that nearly all their occupations were manual, but Emerson has told us, "Manual training is the study of the external world."

Compare for a moment this training with that provided in a public elementary school, and you cannot be surprised to find that our artificial teaching has failed in its results, that our young people have gained very little practical knowledge, and that what they have gained they are unable to apply; that they lack initiative and too often the ability to use books for their own guidance, or the desire to read for self-improvement. We seem to have erred in neglecting to utilise practical pursuits as the basis of education, and in failing to build upon them and to evolve from them the mental discipline and knowledge that would have proved valuable to the child in any subsequent occupation or as a basis for future attainments. We have made the mistake of arresting, by means of an artificial literary training, the spontaneous development of activity which begins in earliest infancy and continues to strengthen as the child is brought into ever closer contact with his natural surroundings. We have provided an education for our boys which might have been suitable for clerks; and, what is worse, we have gone some way, although we have happily cried a halt to make our girls into "ladies," and we have run some risk of failing to produce women.

If we are to correct the errors into which we have drifted, if we are to avert the consequences that must overtake us through having equipped our children for their life-struggle with implements unfitted for their use, we must consider afresh the fundamental ideas on which a system of elementary education should be based. Instead of excluding the child from contact with the outer world we must bring him into close relationship with his surroundings. It was given to man to have dominion over all other created things, but he must first know them. It is in early years that such knowledge is most rapidly acquired, and it is in gaining it that the child's intellectual activities are most surely quickened.

It is unfortunate that we failed to realise this great function of Elementary Education when we first essayed to construct for ourselves a national system. The three R's, and much more than that, are essential and incidental parts of Elementary Education. But what is needed is a *Leitmotif*—a fundamental idea underlying all our efforts and dominating all our practice, and I venture to think that that idea is found in basing our primary education on practical pursuits, on the knowledge gained from actual things, whether in the Field, the Workshop, or the Home.

Instead of fetching our ideas as to the training to be given in the people's schools from that provided in our old grammar schools, we should look to the occupations in which the great mass of the population of all countries are necessarily engaged, and endeavour to construct thereon a system with all such additions and improvements as may be needed to adapt it to the varied requirements of modern life. By this process—one of simple evolution adjusted to everyday needs—a national system of education might be built up fitted for the nation as a whole—a system founded on ideas very different from those which, through many centuries, have governed the teaching in our schools. In the practical pursuits connected with the Field, the Workshop, and the Home, and in the elementary teaching of science and letters incidental thereto, we might lay the foundation of a rational system of primary education.

These three objects—the Field, the Workshop, and the Home—should be the pivots on which the scheme of instruction should be fixed, the central thoughts determining the character of the teaching to be given in rural and urban schools for boys and girls. It was Herbart who insisted on the importance of creating a sort of centre around which school studies should be grouped with a view to giving unity and interest to the subjects of instruction. I have elsewhere shown how a complete system of primary education may be evolved from the practical lessons to be learned in connection with out-door pursuits, with workshop exercises and with the domestic arts, and how, by means of such lessons, the child's interest may be excited and maintained in the ordinary subjects of school instruction, in English, arithmetic, elementary science, and drawing. In the proposals I am now advocating I am not suggesting any narrow or restricted curriculum. On the contrary, I believe that, by widening the child's outlook, by closely associating school work with familiar objects, you will accelerate his mental development and quicken his power of acquiring knowledge. I would strongly urge, however, that the child should receive less formal teaching, that opportunities for self-instruction, through out-door pursuits, or manual exercises, or the free use of books, should be increased, so that as far as possible the teacher should keep in view the process by which in infancy and in early life the child's intelligence is so rapidly and marvellously stimulated. Already we have discovered that our unscientific attitude towards primary education has caused us to overlook the essential difference between the requirements of country and of town life, and the training proper to boys and girls. Our mechanical methods of instruction, as laid down in codes, make for uniformity rather than diversity, and we are only now endeavouring, by piecemeal changes, to bring our teaching somewhat more closely into relation with existing needs. But the inherent defect of our system is that we have started at the wrong end, and, instead of evolving our teaching from the things with which the child is already familiar, and in which he is likely to find his life's work, we have taken him away from those surroundings and placed him in strange and artificial conditions, in which his education seems to have no necessary connection with the realities of life.

The problem of primary education is to teach by practical methods the elements of letters and of science, the art of accurate expression, the ability to think and to control the will; and the ordinary school lessons should be such as lead to the clear apprehension of the processes that bring the child into intimate relation with the world in which he moves. During the last few years the importance of such teaching has dimly dawned upon our educational authorities, but, instead of being regarded as essential, it has been treated as a sort of *extra* to be added to a literary curriculum, already overcrowded. What is known as manual training is to some extent encouraged in our schools, but it forms no part of the child's continuous education. It is still hampered with conditions inconsistent with its proper place in the curriculum, and is uncoordinated with other subjects of instruction. Moreover, no connecting link has yet been forged between the teaching of the Kindergarten and workshop practice in the school. We speak of lessons in manual training as something apart from the school instruction, as something outside the school course, on the teaching of which special grants are paid. Twenty or thirty years ago people used to talk about "teaching technical education," and from this unscientific way of treating the close connection that should exist between hand-work and brain-work our authorities have not yet freed themselves.

It is true we have long since passed that stage when it was thought that the object of instruction in the use of tools was to make carpenters or joiners; but, judging from a report recently issued by the Board of Education, it would seem that it is still thought that the object of cookery lessons to children of twelve to fourteen years of age is the training of professional cooks. Until the Board's inspectors can be brought to realise that the aim and purpose of practical instruction in primary schools, whether in cookery or in other subjects, is to train the intelligence through familiar occupations, to show how scientific method may be usefully applied in ordinary pursuits, and how valuable manipulative skill may thus be incidentally acquired, it does not seem to me that they themselves have learned the most elementary principles of their own profession. An anonymous teacher, writing some weeks since in the *Morning Post*, said: "The cookery class can be made an invaluable mental and moral training ground for the pupils, the most stimulating part of primary education. It teaches unforgettable lessons of cleanliness and order, of quickness and deftness of movements. The use of the weights and scales demands accuracy and carefulness, and the raw materials punish slovenliness or want of attention with a thoroughness which the most severe of schoolmasters might hesitate to use. Practical lessons in chemistry should form an important feature of each class. . . . The action of heat and moisture on grains of rice provides an interesting lesson on the bursting of starch cells, and the children's imagination is awakened by watching the hard isolated atoms floating in milk change slowly to the creamy softness of a properly made rice pudding. The miraculous change in the oily white of egg when it is beaten into a mountain of snowy whiteness gives them interest in the action of air and its use in cookery."

Can the teaching of grammar or the analysis of sentences provide lessons of equal value in quickening the intelligence of young children?

I must add one word before passing from this suggestive illustration of the value of scientific method in the treatment of educational questions. We live in a democratic age, and any proposed reform in the teaching of our primary schools must be tested by the requirement that the revised curriculum shall be such as will provide not only the most suitable preparatory training for the occupations in which four-fifths of the children will be subsequently engaged, but will, at the same time, enable them or some of them to pass without any breach of continuity from the primary to the secondary school. There must be no class distinctions separating the public elementary from the State-aided secondary school. The reform I have suggested is unaffected by such criticism. The practical training I have advocated, whether founded on object-lessons furnished by the Field, the Workshop, or the Home, would prove the most suitable for developing the child's intelligence and aptitudes and for enabling him to derive the utmost advantage from attendance at any one of the different types of secondary schools best fitted for his ascertained abilities and knowledge. The bent of the child's intellect would be fully determined before the age when the earliest specialisation would be desirable. No scheme of instruction for primary schools can be regarded as satisfactory which is not so arranged that, whilst providing the most suitable teaching for children who perforce must enter some wage-earning pursuit at the age of fourteen, or at the close of their elementary school course, shall at the same time afford a sound and satisfactory basis on which secondary and higher education may be built. And I hold the opinion, in which I am sure all teachers will concur, that a scheme of primary education pervaded by the spirit of the Kindergarten which, by practical exercises, encourages observation and develops the reasoning faculties, and creates in the pupil an understanding of the use of books, would form a fitting foundation for either a literary or a scientific training in a secondary school.

I have purposely chosen to illustrate the main subject of this address by reference to defects in our primary instruction, because the success of our entire system of education will be found, year by year, to depend more and more upon the results of the training given in our public elementary schools. We have scarcely yet begun to realise the social and political effects of the momentous changes in our national life, consequent on the first steps which were taken less than forty years ago to provide full facilities under State control and local management for the education of the people.

At present all sorts of ideas are afloat which have to be carefully and scientifically considered. The working classes have to be further and somewhat differently educated, in order that they may better understand their own wants and how they are to be satisfied. We have placed vast powers in the hands of local bodies, popularly elected, powers not only of administration, for which they are well adapted, but powers of determining to a very great extent, by the free use of the rates, the kind of instruction to be given in our schools, and the qualifications of the teachers to impart it. Moreover, these local bodies have shown, in many instances, a distrust of expert advice and a desire to act independently as elected representatives of the people, which cannot fail for some time at least to lead to waste of effort and of means. It was said years ago, when the centre of our political forces received a marked displacement, that we must educate our masters. Our masters now, both in politics and education, are the people, and it is only, I believe, by improving their education that we can enable them to understand the essential difficulties of the problems which they are expected to solve, and can induce them to rely, to a greater extent than they do at present, on the results of the application to such problems of scientific method, founded on the fullest information obtainable from historical and contemporary sources.

I might have illustrated my subject by reference to the acknowledged chaotic condition of our secondary education. In the report of the Board of Education published in December last we read: "While the development of secondary education is the most important question of the present day, and is the pivot of the whole education as it affects the efficiency, intelligence, and well-being of the nation, yet its present position may be described as 'chaos.'" The "chaos" by which the present position of our secondary education is here described is intimately connected with the questions relating to primary education, which I have been engaged in considering. If we construct a system of primary education which serves equally for children of all classes, apart from social conditions—a system educationally sound, both as a preparation for immediate wage-earning pursuits and for more advanced and somewhat more specialised training in a secondary school—many of the difficulties which confront the Board of Education, and which are largely of an administrative order, would disappear. The difficulties are in part dependent on the question of curriculum, to the discussion of which a day will be devoted during the present meeting.

University education in this country, and indeed in other countries, has also suffered much from the hands of the unscientific reformer. In Germany, owing to many causes, the higher education has made considerable advances during the past century; but, even in that country, a more critical study of the development of University education and a truer recognition of the twofold function of a University might have prevented the early separation in distinct institutions and under separate regulations of the higher technical from University instruction. Only within recent years has France retraced her steps and returned to the University ideal of seven centuries ago. But perhaps the climax of unscientific thinking was reached in the scheme, happily abandoned, of founding a new University in Dublin on the lines suggested by Mr. Bryce in his now famous speech of January last.

Our conception of the functions of a University has undergone many violent changes. Between the ideal of the University of London prior to its reorganisation and that of a mediæval University, in which students were never plucked, obtaining their degrees whether they did their work well or badly, there have been many variations; but I think it may be said that, recently at any rate, we have come to realise the fact that our Universities, to fulfil their great purpose, must be schools for the preparation of students for the discharge of the higher duties of citizenship and professional life, and Institutions for the prosecution of research, with a view to the promotion of learning in all its branches, and that examinations for degrees, necessary, as they undoubtedly are, as tests of the extent of a student's acquired knowledge, must be regarded as subordinate to these two great functions.

I will not detain you longer. I have endeavoured to show under what limitations education may lay claim to be included among the sciences, and how a knowledge of the history of education and the application of the methods of scientific inquiry may help in enabling us to solve many of the intricate and complicated questions which are involved in the establishment on a firm foundation of a national system of education. I have taken my illustrations mainly from the reform of elementary, or, as I prefer to call it, primary education, and I have sought to indicate some of the errors into which we may fall when we fail to apply to the consideration of the problem the same principles of inductive inquiry as are employed in all investigations for the attainment of Truth.

I believe that this Section of the British Association has the opportunity of rendering a great service to the State. Numerous educational societies exist, in which questions of importance are discussed, and all, perhaps, do useful work. But none is so detached from separate and special interests; none stands so essentially apart from all political considerations; none is so competent to discuss educational problems from the purely scientific standpoint as are the members of this Association. If, in the remarks I have offered, somewhat hastily prepared under the pressure of many different kinds of work, I have contributed anything to the solution of a problem the difficulty and national importance of which all will admit, I shall feel that I have not been altogether unworthy of the honour of occupying this Chair.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Liverpool.—Mr. Percy E. Newbury has been appointed professor of Egyptology in the University.

London.—University College:—With the assistance of the Chadwick trustees, arrangements have been completed to hold a new course on school hygiene, including lectures, demonstrations, and practical work, beginning on October 16. The course will be given by Prof. Henry Kenwood and Dr. H. Meredith Richards. It is designed to meet the requirements of school teachers, school lecturers, and those qualifying to become school inspectors and school medical officers. A certificate of proficiency will be granted to those who qualify themselves.

A programme of the courses of study in the departments of pure and applied mathematics and astronomy of University College, London, has just been issued. In it are to be found full particulars as to the courses in the departments for students preparing for honours in the subjects above referred to, also of the facilities for research in the college. The programme may be obtained on application to the secretary of the college.

OXFORD.—Owing to the great increase in the number of students at Ruskin College, the staff is being increased. Prof. Lees Smith has retired from the position of vice-principal, and has been elected director of studies and chairman of the executive committee. He will for the present combine this with his duties in the newly created chair of economics and public administration at University College, Bristol, and with his work at the London School of Economics. Mr. Charles S. Buxton, of Balliol College, has been appointed vice-principal. Mr. H. S. Furniss, of Hertford College, has been appointed lecturer in economics. The plans for the new building are now under consideration. The building will be erected on the site of the temporary buildings adjoining Worcester College, and will accommodate 100 students. For this purpose the college will require about 20,000*l.*

A FURTHER 2000*l.* has been given by Sir Donald Currie towards the equipment fund of Queen's College, Belfast, bringing up his contributions to the sum of 22,000*l.*

THE calendar of the Merchant Venturers' Technical College, Bristol, has just been issued, and gives particulars of the courses of instruction at the institution and much other information. Although the main building of the college was partially destroyed by fire, the work of the institution has not been crippled, owing to the Bristol Education Committee having placed at the disposal of the governors large buildings planned to accommodate more than 1000 pupils. These buildings, temporarily known as the Castle Branch of the Merchant Venturers' Technical College, Castle Green, have been fitted with the necessary lecture theatres, laboratories, and workshops.

AN amendment to the Education Administrative Provisions Bill, recommending that power should be given to local authorities to make periodic anthropometric records of children which would afford definite information as to the physical condition and development of the children, was moved last week in the House of Commons by Sir Philip Magnus, who referred to the resolution upon the subject adopted at the joint meeting of the Anthropological and Educational Sections of the British Association, and the report upon such measurements conducted by the Glasgow School Board, which has just been issued by the Scotch Education Department; but upon the President of the Board of Education saying that clause 13 of the Bill as it stands gives the necessary powers the amendment was not carried. It is well, perhaps, to emphasise the fact that local authorities possess under the new Act the necessary powers to institute a system of scientific measurements.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 12.—M. Bouquet de la Grye in the chair.—Integral curves of differential equations: Georges **Rémoundos**.—The accidents arising during the manipulation of compressed oxygen, and on an arrangement permitting of their avoidance: Georges **Claude**. The ordinary forms of regulator for reducing the pressure contain a piece of ebonite, and this is liable to catch fire and even to inflame the steel cylinder. The author describes a simple modification of the regulator by which any local elevation of temperature in the neighbourhood of the ebonite is avoided.—A dynamo designed for wireless telegraphy: P. **Villard**. This dynamo has been designed so that the voltage curve is analogous to that of a Ruhmkorff coil, and, in addition, allows the time interval between the successive sparks to be regulated mechanically. The nature of the voltage curve produced has been studied by means of the oscillograph, curves from which are reproduced in the paper. Experiments have been made with this instrument both in the laboratory and in the field, and for equal motive power the results are much superior to those obtained with a coil. The dynamo is also useful for the production of X-rays.—The maximum of phosphorescence: J. **de Kowalski** and C. **Garnier**. A discussion of some recent results on the same subject by L. Bruninghaus.—The cause of the beating of the heart: H. **Kronecker**. Serum from the blood of a calf was subjected to diffusion in a current of flowing water so that the amount of sodium chloride was reduced to 0·6 per cent. This fluid was used to replace the blood in the cardiac cavities of the frog, toad, and tortoise, and it was found possible to suppress completely the beats of the heart for one hour. Any stimulus applied during this period of arrest caused either a strong pulsation or a group of pulsations. The effects of other solutions are also recorded. The conclusion is drawn from these experiments that the heart does not beat automatically, but requires stimulants of a chemical nature to act on the nervous plexus of the heart.—The reaction of tuberculin in leprosy (subcutaneous, dermic, and conjunctival inoculations): Charles **Nicolle**.—Observations on the Eocene and Oligocene in Hampshire: Jean **Boussac**.—The results of observations of the intensity of gravity at the island of Booth-Wandel, Grahamsland, by the Antarctic expedition of Dr. J. Charcot: M. **Matha**. An account is given of the experimental method used and the accuracy attained. The value of g found, 982·439, is higher than the value calculated from the formula of Defforges, $g = 978{\cdot}106(1 - 0{\cdot}005243 \sin^2 A)$, by 0·116 cm. This difference is in full accord with the results of Foster in the same regions.—The paroxysms of Stromboli: A. **Riccò**.

CONTENTS.

THURSDAY, AUGUST 29, 1907.

THE CONSTITUENTS OF THE EUROPEAN FAUNA.

European Animals: their Geological History and Geographical Distribution. By R. F. Scharff. Pp. 14+258; illustrated. (London: Archibald Constable and Co., Ltd., 1907.) Price 7s. 6d. net.

CHOOSING a suitable and expressive title is not unfrequently one of the most difficult tasks (next to writing a preface) in preparing a work relating to natural history, and in this particular instance we venture to think that the author has not done himself anything like justice in the one he has selected. "Animals" in popular estimation are still regarded (and to a certain extent we think justly so) as forming only one section of the animal kingdom; while, altogether apart from this, the title, "European Animals," which alone appears on the cover, suggests a work of a nature totally different from the one before us. At any rate, such was the impression in our own case, and we expected to find something in the shape of a text-book of at least the mammalian section of the European fauna. When the full title is read the situation is of course changed, although even then there seems something lacking. As a matter of fact, the volume, which is based on a course of (we believe much appreciated) lectures delivered at South Kensington, may be regarded as a sequel to and amplification of the author's previous work on the "History of the European Fauna."

After an introductory chapter, in which general matters affecting zoological distribution and the value of land mammals and molluscs as a basis for zoological geography are discussed, the author, as perhaps in duty bound, commences with Ireland, directing special attention to and attempting to account for the absence in that island of many types common in Great Britain. Scotland, England, and Wales form the subject of the next two chapters, after which the Spanish peninsula, the Alps, eastern Europe and the Caucasus, the western plain of Europe, and, finally, the east and west Mediterranean provinces are discussed in turn. Having expressed his belief in the supreme value of mammals and land-snails to the student of distribution, the author, as might be expected, takes these groups as his text, using other sections of the animal kingdom as collateral evidence whenever occasion may require. A special feature is formed by a series of maps of the geographical distribution of a number of mammals and land-molluscs, these being illustrated by insets displaying a portrait either of the animal itself or of its shell. Assuming these maps to be trustworthy (and such of them as we have examined appear to be so), they have a very considerable value, for few things are more difficult than to obtain accurate information in such matters.

The mention of the insets in these maps naturally leads to a few words with regard to the illustrations generally. Where photographs of shells, like the one of Clausilia on p. 95, have been reproduced, nothing can be better than the result. With regard to most of the other illustrations, we regret, however, that we are unable to congratulate the author. They start with the disadvantage that they are taken from stuffed specimens—a style of illustration which does not appeal to our taste. Added to this is the circumstance that they have been largely "faked" by the addition of false backgrounds. The least unsatisfactory is the frontispiece, representing a group of blue hares and grouse in the Dublin Museum, but even this is blurred and indistinct; while the group of badgers on p. 24, taken from a case in the British Museum, with an added background, is hopelessly bad. Worst of all is the portrait in the inset to the map on p. 78 of an apparently enraged hippopotamus careering on a mountain-top!

Lack of space prevents detailed reference to the views of the author as to the factors which have combined to form the modern fauna of Europe; but this is a matter of less moment since most of these are familiar through his previous work. An especially interesting chapter is the one dealing with the Caucasus and east Europe, in which the view of a former connection between the polar ocean and the Aralo-Caspian system is stoutly maintained; much importance in this respect being attached to the crustaceans of the genus Pontoporeia, which are common to the Caspian and the Arctic Ocean. The distinctness of the fauna of the Caucasus from that of south Russia generally (due, it is supposed, to a connection between the Caspian and Black seas) and its affinity to that of Asia Minor is another feature on which special stress is laid.

In conclusion, we may endorse the opinion of Sir E. Ray Lankester, that the lectures (whether or no we accept all the views therein expressed) on which this volume is founded contain so much valuable information that their publication was practically a duty owed by their author to the scientific world. The volume should be in the library of every naturalist. R. L.

THE GEOGRAPHY OF AUSTRALIA AND NEW ZEALAND.

Stanford's Compendium of Geography and Travel. (New issue.) Australia. Vol. i. Australia and New Zealand. Second edition, re-written. By Prof. J. W. Gregory, F.R.S. Pp. xxiv+657. (London: E. Stanford, 1907.) Price 15s.

ONE of the characteristics of the age of synthesis in which we live is a desire on the part of the people of Great Britain for a better knowledge of the Britains beyond the seas. Hence spring Imperial conferences and schemes for reciprocal education; hence, also, a crop of volumes dealing with the geography, history, and conditions of the colonies. Among these not one has been written with a deeper insight into the problems which confront a young nation than Prof. Gregory's work on Australia and New Zealand. It is too much the custom for writers to judge the measures of a new country by old-world standards, and to commend or condemn them according to the degree of their correspondence. But a moment's

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reflection will disclose the fallacy of such a criterion. If the problem of colonial administration could be satisfactorily solved by imitating ancestral patterns, what is the reason for the frequent failure of nations which systematically follow this course? why should it be thought necessary to utter warnings against the attempt to import Berlin into Uganda? and how is the success which attends the experimental and empirical methods of Great Britain to be explained?

Readers of NATURE are aware that evolution depends on the power of adaptation to environment, and will have no difficulty in recognising that the secret of the British Empire lies in the plasticity which permits the free play of variation, so as to fit novel functions to new requirements. A perusal of Prof. Gregory's book will disclose numerous experiments in social and industrial legislation which have been made to meet Australian conditions; and his appreciation of many of these departures presents an interesting contrast to the undiscriminating denunciations of most British observers. The volume is a compendium of geography; but the geography of to-day is a much wider subject than the dry-bone catalogues which formerly stood for that science, and which were so repulsive to students of the previous generation. Under the heading of Physical, Economic, and Political Geography, the author has succeeded in presenting a life-like picture of the countries he describes.

Isolation, according to Prof. Gregory, is the explanation of the physical, biological, and political features of Australasia. The strange forms of fauna in Australia are due to its long separation from other continents. The unique aspect of its vegetation is similarly due to development in what is happily called "a biological backwater"; but it is a mistake on that account to regard the flora as primitive in character; it is in reality highly specialised, and the author quotes with approval Spencer Moore's statement that in adaptation of plant life to a dry climate "the Australian flora is without a parallel the world over." It is also a common error to regard the Australian aborigines as archaic. They are closely allied to the hill tribes of Southern India; and here, again, the evidence of specialisation is abundant. The social system of the aborigines is elaborate, and on their own plane they have attained a fair degree of civilisation. Their mental capacity is considerable, and their disposition is described as "kindly, peaceful, and amiable." They are possessed of poetical imagination, and have an intense belief in the immanence of the spiritual world.

Prof. Gregory regards the prevailing aspect of Australian scenery as hopefulness, and this quality is reflected in the temperament of the inhabitants. Although Australians are happy in their dispositions, they are accustomed to make some present sacrifice of comfort for the sake of the future. This has been repeatedly shown by the labour party, to whose efforts advanced temperance legislation is largely due. Although, as a conservative in British politics, Prof. Gregory went to Australia with the "bogey" idea of the Australian Labour Party, he sees much to admire in their ideals. His observations on the White Australia policy show both sympathy and discernment. He remarks that "no nation has yet become great which left aliens to do its manual labour." Labour in Australia, though high-priced, is cheap because it is so efficient; dividends are paid out of deep quartz mines producing 2 dwts. of gold to the ton, and Australia holds the record of cheap and rapid deep-shaft sinking. The arguments for an Australian navy are fairly stated, as also are those for the Alien Immigration Acts. The chapters on the exploration and discovery of Australia are full of interest, and there is a concise description of Australian federation. Prof. Gregory's volume will well repay perusal, and is a welcome addition to descriptive works on Australasia.

JOHN A. COCKBURN.

AIR CURRENTS AND VENTILATION.

Air Currents and the Laws of Ventilation. By Dr. W. N. Shaw, F.R.S. Pp. xii+94. (Cambridge: University Press, 1907.) Price 3s. net.

THIS book contains the substance of a course of lectures delivered by Dr. Shaw at Cambridge in 1903. The author's reputation as a physicist will naturally lead those who open these pages to expect a scholarly treatment of the subject, and they will not be disappointed; and although we are told in the preface that "this volume is in a sense my last will and testament on the subject of ventilation," we venture, after a careful perusal of the book, to express a hope that Dr. Shaw may find time to extend so judicious and original a treatment of this difficult branch of applied science.

Writers on the subject of ventilation are apt either to deal with individual schemes which have come under their notice, leaving useful general inferences to be constructed by the reader, or, armed with mathematics, to plunge *in medias res* among all the factors of the problem in a manner which entirely obscures the main issue. It is the more satisfactory, therefore, to find a book free from such shortcomings.

While admitting the many and complex problems which deserve consideration, the author of this volume brings us, by a wise process of selection and rejection, to issues which, while admittedly approximate to truth, are at the same time most valuable generalisations, and this with a mathematical restraint which should considerably increase the field in which the utility of his work will be felt.

The leading feature of the book is the development of the subject by the utilisation of an analogy between pneumatic and electrical flow and resistance, originated by Dr. Shaw some years ago. We are shown, for example, the relation of air flow to "head," or "aëromotive force," and how to deal with pneumatic resistances in parallel and multiple arc, and the analogy is even taken so far as the use of null methods in such determinations. In this spirit we are conducted through a network of difficulties in a manner which anyone with the most elementary knowledge of the laws of electricity will much appreciate. This analogy is not confined to mere theorising. Actual apparatus consisting of thin plate orifices, large connecting boxes and delicately poised vanes, is figured and described by which the fundamental pneumatic laws may be demonstrated. For example, if H be the head or aëromotive force, R the resistance, or sum of resistances, and V the volume of air delivered, using comparable units, the relation $H=RV^2$, corresponding with Ohm's law $E=RC$, is shown to exist.

The book is divided into three chapters comprising respectively 26, 19, and 33 pages. The first deals with the laws of flow in air circuits and their verification, in the manner already referred to. The second with the physical principles applicable to the ventilated space, in which the important effects of changes of temperature and the convection currents resulting therefrom are discussed, and some sketches of delicate and simple apparatus used by the author in his investigations, together with some real and ideal thermal diagrams, are given. In the third chapter are discussed the essentials for practical ventilation, and, so far as the limits of the book permit, the various systems in general use. Here again the electrical analogy is given full play, and applied to the consideration of the open fire, the cowl, the vacuum and plenum systems, and to simple cross-ventilation.

The diction throughout the book is so clear and concise that we cannot even quarrel with Dr. Shaw when he refers to a draught along the floor as likely to set up "the reversed correlative of the therapeutic action" of putting one's feet in water, and we heartily endorse his suggestion that this important subject should receive more attention at the hands of those engaged in scientific research in our technical institutions.

OUR BOOK SHELF.

The Aim and Achievements of Scientific Method: an Epistemological Essay. By Dr. T. Percy Nunn. Pp. x+144. (London: Macmillan and Co., Ltd., 1907.) Price 3*s.* 6*d.* net.

This essay is an expansion of a paper read before the Aristotelian Society in February, 1906, and was in its present form printed in September, 1906, and presented to the University of London as a thesis for the degree of Doctor of Science. The results described were reached in the course of a study of the problems of science teaching in schools, but its pedagogical applications are not considered in the present volume.

The essence of the doctrine presented by the author is the view that a large part of the contents of our consciousness from moment to moment consists of elements which exhibit themselves as having a certain unique "priority" to our conscious processes. These elements constitute what he describes as the objective. The aim of the scientific process is to render objective facts intelligible to an individual consciousness by building up the primary facts into "secondary constructions" by means of ideas drawn from other contexts of experience. No hypothesis is considered essentially incapable of making primary facts intelligible on the ground of the context of experience from which it is drawn, while the hypothesis is in no case to replace (in the sense of accounting for the "reality" of) the objective facts which it has been employed to render intelligible. The extent to which unification of the various provinces of scientific inquiry can be brought about is identical with the range over which hypotheses drawn from a single context of experience can be applied to illustrate facts.

The author examines briefly the most systematic of the attempts that have been made to render the whole range of sensible facts intelligible by means of the concepts of "mass" and "motion," which are themselves drawn only from one province of primary facts. Huygens, in his discussion of the collision of elastic bodies, made use of what Mach calls an "instinctive perception," that the centre of gravity of a system left to itself cannot rise; this was by the Bernoullis developed into the principle of *vis viva*, upon which Helmholtz based his wider principle of the conservation of energy, which first brought the facts of heat into a line with those of mechanics. But though temperature changes are thus connected with mechanical facts, the doctrine does not effect a reduction of the former to the latter, nor is Lord Kelvin's absolute thermodynamic scale more successful, as it makes no attempt to deduce from dynamical data the experiences to which the notion of temperature refers. Even the theory of Helmholtz is only partially successful. The modern science of energetics expressly declines to attempt to explain one set of objective phenomena in terms of another, contenting itself with trying to bring physical facts into a form of unity without reducing them to one type. In doing so it exhibits a practice that accords with the philosophical tenets of Dr. Nunn's essay. The hypothesis has, as he shows, merely a transient function, to point the way to new facts, including relations between things, and should then efface itself.

The Principles and Practice of Brewing. By Dr. Walter J. Sykes. Third edition, revised by the author and Arthur R. Ling. Pp. xviii+588; illustrated. (London: C. Griffin and Co., Ltd., 1907.) Price 21*s.* net.

The publication of a new edition of this well-known book, which has been thoroughly revised by its author, the late Dr. Sykes, in conjunction with Mr. Ling, and brought well up to date, should be welcomed by all interested in the scientific aspect of the brewing industry. In one respect we think the late author and his colleague have lost an opportunity in not revising the original plan of the book, together with the matter it contains, for we have always considered that the book suffered to some extent in usefulness from the manner in which it was arranged; but, however this may be, the work in its present form stands easily first among books in our language devoted to a consideration of the complex scientific problems underlying the brewer's art.

The present edition, like the previous ones, is essentially a treatise on the scientific principles which underlie brewing technology, and although the word "practice" is included in its title, the space actually devoted to a description of the various processes of brewing and malting is comparatively small. In a book which deals in a somewhat encyclopædic manner with many different branches of science, naturally some unevenness is noticeable in the treatment of the various subjects included, but none of the more recent investigations of importance which bear on the subjects discussed appears to have been overlooked, and the references which are given add much to the value of the book. The strongest part of the book is undoubtedly the one which deals with the chemistry of the carbohydrates, more especially the chemistry of starch, and the author's *résumé* of the investigations which have been made in this country and abroad in connection with the transformation of starch by diastase is the most complete account of the subject we have yet seen. We recommend the book not only to those directly interested in the scientific aspect of brewing, but also to those chemists and biologists whose work in any way trends in the direction of brewing or malting problems.

Oberharzer Gangbilder. By Dr. Phil. B. Baumgärtel. Pp. 23+six plates. (Leipzig: Engelmann, 1907.) Price 7 marks.

THE text of this book describes the geological features of the Upper Harz, and the mineral veins that, according to von Koenen, were injected into the old rocks of the region as recently as Miocene times. It serves as an introduction to six very beautiful photographs of large rock-surfaces in the mines. The various minerals of the lodes have been coloured in effective but harmonious tints, so that the relations of each can be traced out precisely. This combination of photographic accuracy with diagrammatic clearness may serve as a model for reproductions in other branches of science. The old coloured geological landscapes of the days of Weaver and Delabeche occur to one's mind, and might thus with advantage be revived.

G. A. J. C.

LETTER 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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Atmospheric Absorption of Wireless Signals.

IN the *Electrical Review*, May 11 and 18, the writer has given curves which show that telegraph messages exchanged between Scotland and Massachusetts are received on some nights with practically no absorption, while on other nights and in daytime nine hundred and ninety-nine one-thousandths (0·999) of the energy is absorbed.

The fact that the daylight absorption was largely reduced between two stations 150 miles apart in Brazil by the use of a longer wave-length suggested that the masses of ionised air which are supposed to produce the absorption are broken up somewhat as clouds are. During the past six months experiments have been made between Massachusetts and stations at Porto Rico, Cuba, Washington (D.C.), and New York which seem to point to the same conclusion.

Two types of transmitting apparatus were used.

The first was an alternating-current dynamo giving 250 sparks per second and generating feebly damped waves. The energy used was between 10 and 12 kw., and the frequencies used were 200,000 per second and 81,700 per second.

Messages sent with the higher frequency from Massachusetts were received very strongly at night-time at Porto Rico and Cuba, and were officially reported on several occasions as having been received by naval vessels in the neighbourhood of Alexandria, Egypt (a distance of nearly 4000 miles), but no messages were received during daytime. The absorption comes on very suddenly, and in the West Indies increases sometimes nearly a thousand-fold in fifteen minutes as the sun rises.

With the longer frequency, however, though at night signals were considerably weaker, probably on account of the receiving stations not being adapted for such a long wave-length, the daylight signals were many times stronger, and it was found possible to work in daylight between Massachusetts and Cuba (a distance of nearly 1700 miles) when using the lower frequency without any increase in sending power. Tests between Boston and Washington now continuing for nearly six months show the same phenomena, *i.e.* that there is great daylight absorption at a frequency of 200,000, but almost no absorption at a frequency of 81,700.

The second type of apparatus used consisted of a high-frequency alternator capable of giving a frequency of 100,000, but for the purposes of this test run at a frequency of 81,700. The open-circuit voltage at this frequency is 150 volts, and its armature resistance six ohms. This apparatus is used for telephoning wirelessly between Brant Rock, Massachusetts, and the City of New York. A detailed description of a similar but less powerful apparatus used for telephoning between Brant Rock and Plymouth, Massachusetts, will be found in the *Electrical Review* of February 15, 22, and March 1, and in the *American Telephone Journal* of January 26 and February 2. The current used in the antennæ is from four to six amperes, and the speech received by the New York station is approximately five or six times louder than the limit of audibility. Tests have now been made with this apparatus over a period of nearly a month, wireless telephonic communication having been first established between these points about July 17. While this apparatus has not been tested for so long a period as the former type, the results obtained are in substantial agreement.

If the masses of ionised air were continuous there is no apparent reason why there should be less absorption with a long wave-length. The above experiments seem to point to the conclusion that the masses of ionised air which are supposed to produce the absorption are not continuous but are broken up in somewhat the same manner that water vapour is into clouds.

The fact that the wave-lengths must be increased as the transmission distance is increased in order to overcome the absorption does not necessarily indicate that the masses are of larger size as the distance above sea-level increases, though it is possible that this is the case.

The writer has found that the absorption at night-time varies with the direction from which the waves are received, and has obtained some results which seem to indicate that measurements of this phenomenon may have a meteorological value, and may assist in extending the range of weather forecasts.

REGINALD A. FESSENDEN.

Brant Rock, Mass., August 9.

PRACTICAL TELEPHOTOGRAPHY.

EARLY in 1881 I described in NATURE (vol. xxiii., p. 334) an experimental apparatus for the electrical transmission of pictures to a distance, in which use was made of one of the sensitive selenium cells devised a few months previously (*ibid.*, p. 58). Fig. 1 shows the arrangement diagrammatically. The transmitting cylinder T is mounted upon a screwed spindle, which moves it laterally through 1/64 inch at each revolution; a selenium cell S is fixed behind the pinhole H, 1/20 inch in diameter, and is electrically connected through the spindle with the line wires L, E; the picture to be transmitted—about two inches square—is projected upon the front surface of the cylinder by the lens *l*. The brass receiving cylinder R is of the same dimensions as T, and is similarly mounted; F is a platinum stylus, which is pressed vertically against the metal by the flat spring G; W is a variable resistance, and B_1, B_2 are batteries at the transmitting and receiving stations respectively. A piece of paper moistened with a solution of potassium iodide is wrapped round R, and, the pinhole H having first been brought to the brightest part of the focussed picture (thereby reducing the resistance of S to its minimum value), the resistance W is adjusted so that no current passes along the "bridge" C D, which, assuming the two batteries to be equal, will be the case when the resistance of W is the same as that of S. If now the Se cell is darkened, its resistance will be increased and a current will pass through the receiver in the direction C D, liberating iodine at the point of the stylus F.

To transmit a picture, the two cylinders are caused to rotate synchronously, at the same time moving from end to end of their traverses; in the course of its spiral path the pinhole H covers successively every point of the focussed image, the illumination of the Se cell being proportional at any moment to the brightness of the spot occupied by the pinhole; the consequent variation in the resistance of the cell causes the stylus F to trace upon the paper a brown line which is lighter or darker in correspondence with the illumination of the Se. The close spiral line with breaks in its uniformity constitutes a picture, which should be a counterpart of that projected upon T. The earliest achievement of the apparatus consisted in the reproduction of the image of a hole cut in a piece of black paper; after some improvements simple black and white pictures painted upon glass were very perfectly transmitted, as was demonstrated upon several occasions when the apparatus was exhibited in operation.[1] It was, however, unable to cope with half-tones, and owing to pressure of work the experiments were shortly afterwards discontinued.

The problem of telegraphic photography has recently been attacked with conspicuous success by Prof. A. Korn, of Munich, whose work is described in a little book entitled "Elektrische Fernphotographie und Ähnliches" (Leipzig, 1907). His latest

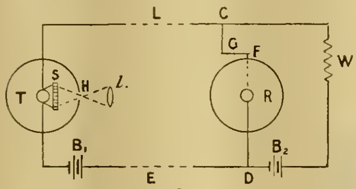


FIG. 1.

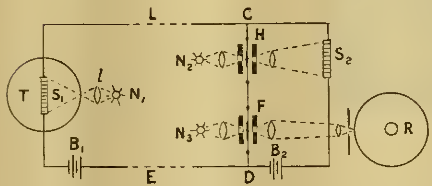


FIG. 2.

method is indicated in Fig. 2. The transmitting and receiving cylinders T, R turn synchronously on screwed axes, the regulating mechanism of the receiver is situated in the bridge C D, and a suitable resistance is placed at S_2. A celluloid film negative of the picture to be transmitted is wrapped round the cylinder T, which is made of glass. The light of a Nernst lamp N_1 is concentrated by a lens upon an element of the film, through which it passes more or less freely according to the translucency of the film at the spot, to the Se cell S_1, which is fixed in position, and does not, like mine, move with the cylinder; thus the resistance of the Se is varied in correspondence with the lights and shades of the picture. The receiving cylinder R is covered with a sensitised photographic film or paper, upon a point of which light from a lamp N_3 is concentrated. Before reaching the paper the light passes through perforations in two iron plates at F, which are, in fact, the pole-pieces of a strong electromagnet; between these is a shutter of aluminium leaf, which is attached to two parallel wires or thin strips forming the bridge C D. When there is no current through C D, the opening is covered by the shutter; when a current traverses the wires, they are depressed by electromagnetic action, carrying the shutter with them, and a quantity of light proportional to the strength of the current is admitted through the perforations. By means of this "light-relay," as it is termed, the intensity of the light acting at any moment upon the sensitised paper is made proportional to the illumination of the selenium in the transmitter.

It remains to mention a device of admirable ingenuity which has rendered it possible to transmit half-tones with fidelity. In its response to changes of illumination selenium exhibits a peculiar kind of sluggishness, to which reference was made in my old article: "Some alteration takes place almost instantaneously with a variation of the light, but for the greater part of the change an appreciable period of time is required." Prof. Korn has succeeded in eliminating the effects of the sluggish component by substituting for my box of resistance coils R a second

FIG. 3.

Se cell S_2, which is as nearly as possible similar to S_1, and which, by means of a second light-relay H, placed in series with the first, is subjected to similar changes of illumination. Thus any subpermanent fall in the resistance of S_1 due to the action of light is compensated by an equal fall in that of S_2, and only such changes as respond immediately to the varying illumination of S_1 are utilised for regulating the transmission current.

Such is in brief outline the nature of the new process. As regards the many carefully considered details which have made it a practical success, those interested will find ample information in the pamphlet mentioned above. The apparatus has been worked with excellent effect over long distances; a specimen of its performance, for which I am indebted to the kindness of Prof. Korn, is given in Fig. 3. The parallel lines traced by the point of concentrated light—in this case about 50 to the inch—are easily recognisable.

SHELFORD BIDWELL.

[1] Among others, at the Telegraph Engineers' *soirée* in 1881 (*see* NATURE, vol. xxiii., p. 563).

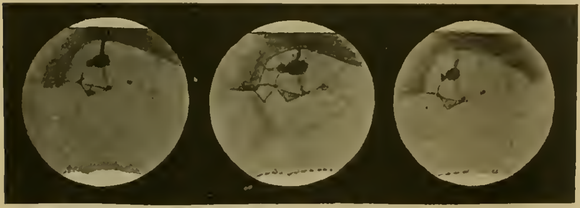
MARS IN 1907.

OBSERVATIONS AT THE LOWELL OBSERVATORY.

IN answer to the request of the editor of NATURE for an authoritative statement of the observations so far made here at this opposition, I have the honour to communicate two or three of the more important results obtained. They exceed what seemed likely, in view of the unfavourable declination of the planet, a position so southern as to render it practically unobservable in England, France, or the northern part of the United States.

The first of these relates to the polar caps. From the fact that the observations were begun in March, three months and a half before opposition, it was possible to catch both caps at an interesting phase of their careers—the southern one at its maximum, the northern at its minimum, extent. The moment was more propitious than has ever been the case before at the times at which the planet has been observed, because it was then upon an even keel as regards the earth, the equator lying nearly in the plane of sight. The southern cap at this epoch stretched across ninety-five degrees of latitude, counting from one side of it to the other; the northern only over eight.

From that date the dwindling of the southern cap and the making of the northern has been carefully watched to a complete confirmation of the curious manner in which the latter is formed, as witnessed here at the two previous oppositions.[1]



Photographs of Mars in 1907.

The next point has been the observed development of the canal system in the antarctic and south temperate zones. After the melting of the south polar cap had got well under way, canals began to make their appearance about it, running thence down the disc. These canals left its edge and joined the rest of the system in lower latitudes. Connected with such polar phenomena was the appearance of the most southern of the light regions of the planet, Thaumasia. This region, lying around the Solis Lacus, or Lake of the Sun, first showed symptoms of awaking activity. The Solis Lacus stood composed of two portions, a large oval patch on the east and a smaller round one to the west; from both of which canals ran into the dark areas. Now those on the south, such as the Ambrosia and the Bathys, were darker and more pronounced than those running north, the Tithonius, for example, which showed evidence of being in its dead or skeleton condition, while the former were in full tide of development. Meanwhile, the equatorial canals were steadily fading out. The process of evolution was in keeping with the method of development found here for the northern canals in 1903. The fact is of the nature of a prophecy fulfilled, and not only supports the previous observations, but proves the theory deduced from them to have been correct. It is a direct *sequitur* from this that the planet is at present the abode of intelligent, constructive life.

I may say in this connection that the theory of such life upon Mars was in no way an *a priori* hypothesis on my part, but the deduced outcome of observation, and that my observations since have fully confirmed it. No other supposition is consonant with all the facts observed here.

Another result of this opposition has been the success of the photographs taken of the planet. These have proved delineatory beyond expectation. The increased size of disc has enabled the method worked up by Mr. Lampland to be put into even more effective practice than at the last opposition. Plates have been taken by both Mr. Lampland and myself, and the amount of detail they show may be judged from the fact that I have already counted fifty-six canals on my plates, that the twin Gihon has been photographed double, and that such delicate markings as the Fons Juventae and the little canals leading to it appear unmistakably in the prints. Such grosser matters as the dwindling of the southern snow-cap show beautifully, and it looks as if a result in which Mr. Crommelin was much interested, the positioning of points of Martian topography by measures of the photographs, was in process of realisation.

Of the success of the expedition to the Andes to observe and photograph the planet sent out by this observatory under Prof. Todd, and with Mr. E. C. Slipher as the photographer, I prefer to speak later when fuller details come to hand. We already know by cable that their success has been beyond expectation.

PERCIVAL LOWELL.

[1] *See* Lowell Observatory Bulletin 30.

PROF. H. C. VOGEL.

ASTRONOMERS, and especially spectroscopists, will have received with profound regret the brief announcement from the Potsdam Observatory which conveyed the sad intelligence that Prof. H. C. Vogel, the director of that institution, had died on August 13. His scientific life extends over a period during which all the great triumphs of the spectroscope have been won, and he has been in the front rank of that energetic band of astronomers who have given new direction and increased interest to the science of astronomy. Hence to sketch his life would be to trace the history of spectroscopy from the time that Angstrom published the map of the normal spectrum, or from that of the epoch-marking Indian eclipse, when the riddle of the chromosphere was first read; when the application of the Doppler principle was first applied to star spectra; or when cometary spectra were first studied. Men's minds were still excited over these novel pursuits, and the possibilities they suggested, when Vogel took charge of the Bothkamp Observatory and began that career of continued and successful observation which only terminated with his death. How much has been accomplished since will be appreciated if we recall the fact, that Vogel's earliest work gave us accurate information of the peculiarities of the planetary spectra, and showed the effect of solar rotation in displacing the Fraünhofer lines.

In 1874 came the foundation of the Potsdam Observatory, and Prof. Vogel was seen in a new light as the director of the first purely astrophysical observatory. The staff was small, and the instruments were modest, but enthusiasm was great, and the outcome has been of the widest interest. One of the early fruits from this new observatory was the spectrum catalogue of 4051 stars, important, not only because it illustrated the manner in which large masses of work could be dealt with in the new institution, but for the extensive application of the method of classifying stellar spectra to which the name of Vogel is particularly attached. He early appreciated the probability that the phase of development of a particular star was in general mirrored in its spectrum, and that any rational classification of the stars could only be obtained by giving prominence to that central fact.

Another class of work which largely occupied Prof. Vogel's attention was his investigation by means of photography of the motions in the line of sight of all the brighter stars visible in Potsdam. If he was not the first to apply photography in this particular direction, he was certainly among the most successful. This success was due in a great measure to the fact that he recognised, more fully than was generally the case thirty years ago, the necessity of constructing an instrument to a definite end, of making it exclusively available for one particular object. The possession of the most suitable apparatus not only gave improved and consistent values for the motion of stars in the line of sight, but satisfactorily explained the cause of the variability of Algol and stars of that type. His determination of the elements of that spectroscopic binary is typical of an immense amount of work which Vogel effected in the case of many other binaries. In observing variable and temporary stars his energy found another large field for its display, but it is impossible to enter into details. His was a busy life with many interests, and he assisted science in various directions.

Although aided by able and zealous colleagues, he was responsible as director of the observatory for the conduct of several large pieces of work. It will be sufficient to refer here to his participation in the work of the International Chart of the Heavens, to which in its early days he devoted much attention. The rigorous determination of the magnitude of all the brighter stars in the *Bonn Durchmusterung* by means of the Zöllner photometer is another piece of heavy observation which he brought to a successful issue. Simultaneously with the steady progress of these and other inquiries has gone the remodelling of the observatory, and the substitution of larger and more powerful instruments for those which tended to grow obsolete. The mounting of the 80-centimetre refractor offers a proof of the care and foresight which he devoted to this part of his duties.

We believe that when the effect of Vogel's work is considered and judged, his capacity as a director must be fully and generously recognised. As guardian of a new institution for which there were no traditions to guide the future development, as a conductor of an untried experiment, uncertain in what direction progress might be anticipated, he has maintained the observatory at a uniformly high level, and produced a quantity of work of the most accurate character. This has been shown to some extent by his election into many learned societies, the members of which have appreciated his work and acknowledged his influence. He has left an example to be followed, and a reputation to be honoured. To his colleagues, some of whom have served with him many years, and who have suffered the loss of his experience and his kindly assistance, we offer our respectful sympathies.

W. E. P.

NOTES.

It is announced in the *Electrician* that the "John Scott Legacy Medal and Premium" of the Franklin Institute has been awarded to Prof. J. A. Ewing, F.R.S., and Mr. L. H. Walter for their method of detecting electrical oscillations.

The programme of proceedings of the forthcoming meeting (on September 23 and 24) of the Iron and Steel Institute in Vienna has now been issued; from it we learn that the following papers may be expected to be submitted:—on the development of the iron industry of Austria since 1882, by W. Kestranek; on the Styrian Erzberg iron-ore mines, by Prof. H. Bauerman; on steel and meteoric iron, by Prof. F. Berwerth; on the determination of the quantity of blast-furnace gas for a given make of pig iron, by Prof. Josef von Ehrenwerth; on the application of the laws of physical chemistry to the metallurgy of iron, by Baron H. von Jüptner; on case hardening of mild steel, by C. O. Bannister and J. W. Lambert; on a new blue-black paint as a protective covering for iron, by F. J. R. Carulla; on the hardening of steel, by L. Demozay; on the structure of hardened steel, by Percy Longmuir; on case hardening, by G. Shaw Scott; on the ageing of mild steel: further notes, by C. E. Stromeyer; and on the economical distribution of electric power from blast furnaces, by B. H. Thwaite.

Prince Henry zu Schönaich-Carolath has consented to act as president of the fourteenth International Congress for Hygiene and Demography, which is to take place in Berlin next month, and Dr. Rubner, Privy Councillor of Medicine and professor of hygiene at the Royal University of Berlin, and Prof. von Mayr, Under-Secretary of State, Munich, will be vice-presidents.

The eleventh congress of Flemish naturalists will be held from September 21 to 23 at Malines under the presidency of Prof. C. de Bruyn, professor of botany and zoology in the University of Ghent. The secretary of the congress is Dr. de Bruycker, place du Grand-Canon, Ghent.

An International Exhibition is to be held in Tokio from April 1 to October 15 of next year. The estimated cost is 2,000,000*l*., towards which the Japanese Government has set aside 1,000,000*l*.

According to a telegram in the *Times*, two sharp shocks of earthquake occurred at 4.32 of the afternoon of August 22 at Kingston, Jamaica.

Particulars of the preparations in progress for the Wellman Polar Expedition are given in a Reuter message dated from Spitsbergen, July 25, from which we learn it was expected that the expedition would be ready to start for the far north by the middle of August. One of the many difficult pieces of work which had to be accomplished was the packing and making ready for the *America* of the two "serpents" which form an important part of the project. One of the serpents—a pipe of strong, water-tight leather, 6 inches in diameter and 123 feet long, its outside surface covered with more than 29,000 steel scales, each about as big as a silver quarter, very thin, and riveted to the leather, overlapping like the scales of a fish—has been designed to have the smallest possible resistance in sliding over the ice or snow, or floating on the water, in which element it is buoyant. The retarder serpent, on the other hand, is designed to make the greatest possible resistance in proportion to its weight in dragging over the ice-floes, which are usually covered with a snow-crust and rarely present a smooth surface. The function of the retarder is to drag like a drag-anchor when the wind is adverse to the course and it is wished to drift gently with it, and without losing either too much headway or burning too much fuel in the motor. Hence this serpent is covered with 1875 steel scratchers, each with six sharp points about 1 inch in length, or a total of 11,250 points on the 75 feet of body. The equilibrer is intended always to have more or less of its length upon the surface of the earth; the retarder is to be let down to touch the earth only when necessary. Reserve supplies of food to the amount of 1438 lb. have been packed in the interior of the serpents.

THE Prince of Monaco has arrived at Tromsö on board the *Princess Alice*, having left the *Hjalmar*, the vessel conveying the Johansen expedition, at Kved Fjord about the middle of August. The *Hjalmar* left for Prince Charles Foreland, where it is the intention of Johansen to meet the Bruce expedition, and which will probably be the winter quarters of the explorers.

MR. W. F. DENNING writes to say that a rather fine meteor, presumably from the Draconid radiant, to which he referred in a letter in our last number, was seen at Bristol on August 26, 9h. 18m. The curious feature about the object was its fluctuation in brilliancy. At first nearly equal to Jupiter, it quickly dropped to about two magnitudes, and finally burst out with a lustre rivalling that of Sirius. Its path was from about $231°+57°$ to $213°+50°$. As viewed from Wales, the meteor must have been very conspicuous and striking, and Mr. Denning will be glad of any descriptions of it.

THE secretary of the Kite Committee of the Royal Meteorological Society has written to the Press to say that, of the twenty-four meteorographs sent up in July last in connection with the international investigations of the upper air, only a few have been returned. He thinks it possible that some may have fallen among the standing corn and other crops, and so have not yet been seen. The secretary requests that a sharp look-out may be kept for the cylinders containing the meteorographs, and that if any be found they may be carefully handled and returned to the address given on the label or to himself at the Royal Meteorological Society. The next special series of ascents will take place from September 4 to 6 next.

WITH a view to supplying Paris with electric energy for its railways and lighting, three Paris engineers have drawn up a project for establishing an immense power station by barring the Rhône Valley, at Gresin, near Bellegarde. The enterprise has, says the *Engineer*, received the support of the French authorities. The estimated cost is 2,400,000*l*.

WE are sorry to learn from the annual report on the British Museum that there has been a falling off in the number of persons visiting the institution during the year 1906. The total number of visits paid to the museum at Bloomsbury was 691,950, showing a decrease of nearly 122,000 from the number in 1905. The Sunday total of 55,738 was less by 4369 than that of the previous year. Not since the year 1900, with its 689,249 visits, has the total been so low as that of the past year. The report upon the Natural History Museum also shows a decline in the number of visitors. In 1905, 566,313 visits were paid, and in 1906 only 472,557. The attendance on Sundays was, in 1906, 61,151, and in 1905 70,084. The gifts to the Natural History Museum in 1906 numbered 2057, against 2092 in 1905; the principal donors were the Government of India (collections of Tibetan insects), the Duke of Bedford (zoological specimens from Japan and Korea), Mr. C. D. Rudd (specimens in continuation of his systematic survey of South African fauna), and Mr. W. E. Balston (natural history specimens from Western Australia).

PROF. F. A. FOREL has favoured us with a note of a very unusual shifting of the wind observed by him during a storm at Morges (north of Lake of Geneva) on August 15. At 6h. p.m. the wind, which was blowing strongly from S.W., veered during a succession of violent squalls to N.W., N.E., and S.E., back again to S.W. by 10h. p.m., making a complete gyration in four hours. The weather in north-west Europe was very unsettled; a cyclonic disturbance which had passed across England lay over the Skager Rack at 6h. p.m., and a heavy thunderstorm was in progress at Berlin. Prof. Forel thinks that the sudden changes of wind could only have been caused by thunderstorms which occurred in various quarters in the vicinity of Morges. The barometer, which previously had been slowly falling, rose 0·2 inch between 6h. and 10h. p.m.

IN an editorial article in *Symons's Meteorological Magazine* for August, objection is taken to the way in which meteorological papers are dealt with at the British Association meetings. Several papers this year were of special interest, *e.g.* examples of modern methods of treating observations, by W. P. Elderton, and recent developments of the methods of forecasting by means of synoptic charts, by Dr. W. N. Shaw, but they were sandwiched with papers on astronomy and other subjects with which meteorologists were not particularly concerned. The difficulties in the way of hearing and discussing the papers were aggravated this year owing to the bewildering acoustic properties of the hall, and Dr. Shaw's paper was cut cruelly short owing to want of compression in the case of a previous astronomical paper. The writer of the article considers that unless at least a subsection is devoted to the subject in future, it will not be worth while for meteorologists to contribute papers to the British Association.

IN the same magazine Colonel Bentley refers to a very severe thunderstorm which occurred in County Clare on July 22. On the east of the Kilbane Mountains, near Killaloe, gaps of 10 feet and one of 30 feet deep were made in the road, and five large stone bridges and one wooden bridge were carried away by the floods in a district three miles long and one mile wide. During the storm hail fell in large rugged lumps, and the damage to property is estimated at 6000*l*.

FROM the annual report of the principal chemist on the work of the Government Laboratory, we learn that during the past year there has been a notable increase in the number of samples analysed in the two branches of the laboratory (Customs and Inland Revenue). The total number of analyses and examinations made was 173,606, against 158,939 for the previous year, the increase being mainly in respect of tobacco examined under the various fiscal regulations. Among other points of interest, we note that manufacturers appear fully to appreciate the advantages of the new or "industrial" variety of methylated spirit, which, by reason of its lower price and greater purity compared with that formerly used, is expected to find increasing employment in manufacturing operations. The use of pure duty-free ethyl and methyl alcohols in the science laboratories of universities and colleges is also extending, 4017 proof gallons having been utilised last year against 2277 in 1905. In addition, 3783 bulk gallons of the denatured (industrial) alcohol were used for ordinary teaching purposes. For departments other than the revenue branches some 7000 samples were analysed. To check the importation of adulterated butter, legal proceedings were instituted in a number of cases, and it is satisfactory to learn that, as a result, there has been a great improvement in the character of the butter emanating from certain parts of the Continent. An interesting examination of dog-fish eggs was made for the Board of Agriculture and Fisheries in connection with the depredations committed by these fish along the coasts of Devonshire and Cornwall. With the view of ascertaining their economic possibilities, the eggs were analysed, and found to contain about one-fourth of their weight of protein and the same quantity of fat, or about twice as much of the two substances together as is found in an ordinary hen's egg. It is remarked that, apart from the question of using the eggs for food—as to which there is an obstacle in their fishy odour—the utilisation of the protein matter and oil would be quite feasible if some enterprise were shown in obtaining a regular and sufficient supply of the eggs.

REFERRING to a note published in NATURE (this vol., p. 280) on the recent series of determinations of fundamental atomic weights by Prof. Richards and his colleagues, Prof. Bohuslav Brauner, of Prague, writes to say that he considers that there can be no doubt as to the correctness of the recently advocated low value of the atomic weight of nitrogen (14·01); the physico-chemical researches of Leduc, D. Berthelot, Lord Rayleigh, Guye, and Gray, as well as those of Scott in 1901, all tend to show that the atomic weight of nitrogen does not exceed 14·009. Prof. Brauner refers to a paper which he read before the Bunsen Gesellschaft in May (reprinted in the *Chemiker Zeitung*, No. 38) for a full discussion of the question, and to his article on the atomic weight of nitrogen in Abegg's "Handbuch der anorganischen Chemie." The new value for the atomic weight of nitrogen has the advantage that it is directly related to the atomic weight standard O = 16, whereas that of silver is related very indirectly and only by imperfectly determined ratios to the oxygen standard. The recent work of Guye would indicate that potassium chlorate always contains potassium chloride, the quantity of the latter being sufficient to reduce the atomic weight of silver from 107·93, as found by Stas, to 107·89. Prof. Brauner considers that the results of Prof. T. W. Richards should be stated as follows:—"The atomic weight of nitrogen cannot be higher than 14·10 and lower than 14·08, and so the atomic weight of silver must lie between Ag = 107·880 and 107·883. The atomic weight of sulphur cannot be higher than S = 32·069, and therefore the atomic weight of silver cannot be higher than Ag = 107·88."

A REPORT by Dr. Leslie Mackenzie on the teaching of school and personal hygiene to students in training as teachers in Scotland has been issued by the Scotch Education Department. The object of the course of instruction which has been instituted is to assist the teacher in discovering such gross mental or physical defects as may unfit, or tend to unfit, the child for school work. The methods of instruction include lectures and demonstrations on elementary anatomy, physiology, and hygiene, and visitation of schools with inspection of classes and premises. Among other matters, the place of the subject in the curriculum, the relation of the course to medical inspection, and tests of proficiency are discussed, and selected illustrations of the work done in various training colleges are given. The Department has also issued a memorandum on systems of physical training, viz. military drill and physiological and hygienic exercises, and their relation to the personal hygiene of school life. The special education of the teacher for this is insisted upon, and it is recommended that a medical officer ought to be in charge of this branch at every training centre.

THE annual report of the British Consul at Dakar gives particulars of the steps which are being taken by the French Government in French West Africa to safeguard and develop the rubber resources of the country. A special survey is being made of the chief rubber-producing districts, and when the investigations have been completed the worst districts will be closed to rubber collection so that the plants may have time to recuperate. It is expected that a beginning in this direction will be made in 1908. For the purpose of stocking plantations with rubber-producing trees, a credit of 3200*l*. has been provided for the present year, with which sum it is expected that from 300,000 to 400,000 trees will be planted, in addition to nursery plantations for succeeding years. The intention is to set apart from 4800*l*. to 6000*l*. each year for this purpose, and to plant on an average 500,000 trees every year.

ACCORDING to the *Agricultural News* of Barbados, a plant has been discovered in Portuguese West Africa possessing a fleshy, tuberous, turnip-shaped root, the entire substance of which is permeated with laticiferous ducts, that yield a supply of rubber latex. The plant belongs to the natural order Asclepiadaceæ. Rubber has been obtained from the tubers by slicing them, applying pressure, and coagulating with alcohol. Tubers two years old weighed nearly 1½ lb., and yielded rubber of half of 1 per cent. of the total weight. It is estimated that more than 180 lb. of rubber per acre can be produced at the end of two years.

AMONG the various subjects dealt with in the Journal of the Royal Horticultural Society, vol. xxxii., an article by Mr. M. H. F. Sutton furnishes practical directions on the formation and care of lawns and golf greens. The author attributes great value to manuring the soil when laying out a lawn. In connection with the choice of seeds, a list of grass seeds is given, also the use of clover is discussed and its disadvantage for tennis lawns or putting greens is explained. Growers of campanulas will find a useful list of species and synonyms prepared by Colonel R. H. Beddome. A method of checking black-currant gall mites by the application of grease is described by Mr. Massee. The substance of a lecture by Sir George Watt on the cultivation and manufacture of tea is published, also an account of the West Indian lime by Mr. A. J. Brooks, and a description by Mr. J. C. Umney of the source and extraction of perfumes.

WITH regard to the flowering of bamboos, it has been noted that this takes place only after a period of years, that some species show sporadic or partial flowering, while the flowering of others is simultaneous or complete, and is always or nearly always followed by the death of the plant. Mr. W. J. Bean has collated in the *Kew Bulletin* (No. 6) some data regarding species that have flowered under cultivation within the last thirty years.

Arundinaria Falconeri flowered sporadically in localities in England and India in 1876, and partial flowering occurred in other localities in 1875 and 1877. Another partial flowering has been proceeding for the last three years; the author suggests that the present more protracted period may be due to cultivation. *Arundinaria Simoni*, after partial flowering for some years, flowered completely in 1904–5, and then the plants died off. Most of the varieties of *Phyllostachys nigra* have also succumbed to the efforts attending complete flowering.

To the popular series of garden pamphlets issued by the Agricultural and Horticultural Association has been added one by Mr. S. Arnott on hardy garden bulbs and how to grow them. The precise notes on planting details will be found useful, as also the selection of hardy and choice species. Another pamphlet, on the weather, by Hon. H. A. Stanhope, the president of the association, is not of such direct interest, but contains a number of facts that the weather-wise—and with good reason many gardeners have such a reputation—should know.

TEACHERS of geology and travellers in India will alike welcome Mr. Vredenburg's pamphlet of seventy pages, entitled "A Summary of the Geology of India" (Calcutta: Thacker, Spink and Co., 1907). It is a summary that is full of information, and yet it is both readable and attractive. The most recent work of the Geological Survey of India is included, as may be seen from the account of the Cretaceous Deccan Trap and the references to Burma and Baluchistan. The recession of the sea at the close of Cretaceous times is regarded as a "universal" phenomenon, while the "Glacial period" is spoken of lightly, as resulting in a "temporary glaciation of high latitudes." In both these statements we note a little more dogma than is prudent in an abstract, where discussion is impossible. Mr. Vredenburg is, however, no mere abstractor of the work of others, but an observer and a discoverer, whose personality adds weight to the present lucid summary.

A NEW gem is reported to have been discovered in San Benito County, California. It is described as a clear, transparent, blue stone with violet tints in the deeper-coloured portion, and to be about as hard as chrysolite and harder than moonstone or opal. Under heat it turns a bright red, but on cooling it resumes its normal colour. It has been given the name of Benito, from the county in which it was found.

A LARGE and remarkable cave was, according to the *Scientific American*, recently discovered in the Santa Susanna Mountains, some fifty miles from Los Angeles, California, U.S.A. The cave contains many halls, some of very large extent, and the walls of one are covered with rude drawings, some of which are almost obliterated, but others are quite clear. The drawings, says our contemporary, represent incidents of the chase, showing Indians on foot pursuing bear, deer, and other animals. One wall-drawing shows the bear pursuing the hunter. The work is executed by soft red stone.

THE connection between radium and the safe working of collieries does not at first sight appear to be a very intimate one, but the discovery announced by Profs. Elster and Geitel in *Die Welt der Technik*, that fire-damp contains six or seven times the amount of radium emanation that is generally found in the air of coal mines, brings the two into close relation with each other. Comparative tests of the electrical conductivity of the air due to the presence of the emanation can readily be made by means of a simple aluminium foil electroscope, and as only a comparatively small sample of the gas is necessary, the tests may be carried out outside the mine. It will be interesting to see the electroscope become part of the normal equipment of a colliery.

IN the July number of the *Bulletin de la Société d'Encouragement pour l'Industrie nationale*, M. O. de Faria gives a description and an account of the tests of his alternating electric current rectifier. The electrodes are of aluminium and an alloy of lead and antimony respectively, and the electrolyte a solution of phosphate of soda. The cell is so arranged that during working a rapid circulation of the electrolyte is maintained. In one of the tests of which details are given a rectifier intended for 10 amperes was run for five hours at 15 amperes on a 100-volt circuit, and showed an efficiency of 66 per cent. with a final temperature of 47° C. The efficiency appears to be independent of the temperature of the cell.

THE origin and relationships of the so-called Atlantic animals and plants of western Norway are discussed at considerable length by Dr. L. Stejneger in vol. xlviii., part iv., of Smithsonian Miscellaneous Collections. The mammals include the west Norwegian red deer (which the author regards as inseparable from the Scottish representative of the species, although markedly distinct from the Swedish race), the so-called Celtic horse or pony, the reindeer, lemming, and Arctic fox. It is concluded that if the more characteristic types of this "Atlantic biota" came from Scotland, they travelled by way of a land-bridge connecting that country with western Norway to the northward of lat. 59°. This bridge existed subsequent to the first great (Scandinavian) glaciation, and this portion of the "biota" certainly survived the second glaciation. The red deer and Arctic animals reached Scotland from Central Europe, whence they migrated first into Ireland and then into Scotland. Reindeer, on the other hand, appear to have reached Scandinavia by several routes, one stock having probably entered Sweden from the south and a second from the north-east *via* Finland and Russia, while the Norwegian stock arrived from the west. If well founded, these conclusions absolutely cut away the ground from Dr. Scharff's theory that reindeer reached Europe from Greenland, a theory controverted by several other considerations.

IN a paper on the birds of Labrador, forming No. 7 of vol. xxxiii. of the Proceedings of the Boston Society of Natural History, Messrs. C. W. Townsend and G. M. Allen take occasion to refer to the appalling destruction of birds and their eggs which is still allowed to go on in Newfoundland, Labrador. The fishermen, who use single-barrel, muzzle-loading guns, make no secret of the fact that they take every bird and egg upon which they can lay hands. If efficient means of protection are not promptly put in force, the authors are of opinion that the bird-nurseries of the district will become things of the past.

HAVING observed sand-martins in Hampshire during the winter—November to January—Mr. H. Beeston, in the July number of the *Zoologist*, confesses himself unable to explain where these birds passed the nights during the period in question. As there appear to be no sand-banks in the district where the observations were made, it seems impossible for the birds to follow their usual practice of sleeping in their nesting-burrows.

IN the *Entomologists' Monthly Magazine* for August, the attention of collectors is directed to the possibility that the south European wingless earwig (*Forficula decipiens*) may be indigenous to England, since two earwigs with aborted wings recently taken in the Isle of Wight appear indistinguishable from that species.

AN elaborate cloth-bound illustrated catalogue (in English) of the physical apparatus made by the firm of E. Leybold's Nachfolger, of Cologne, has been sent to us. It contains full descriptions of many pieces of apparatus, with instructions for use, and should be seen by all science teachers.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER :—

Sept. 3. 8h. Mercury and Venus in conjunction. Mercury 0° 26′ N.
4. Daniel's comet in perihelion.
12. 11h. 15m. Minimum of Algol (β Persei).
14. 13h. Venus in superior conjunction with Sun.
15. 8h. 4m. Minimum of Algol (β Persei).
,, 14h. 1m. Transit (egress) of Jupiter's Sat. III. (Ganymede).
16. 11h. 13m. Mars in conjunction with Moon. (Mars 4° 27′ S.).
17. 14h. Saturn in opposition to the Sun.
21. 7h. 10m. to 7h. 59m. Moon occults 30 Piscium (mag. 4·7).
,, 9h. 4m. to 9h. 37m. Moon occults 33 Piscium (mag. 4·6).
22. 14h. 42m. to 18h. 20m. Transit of Jupiter's Sat. III. (Ganymede).
23. 18h. Sun enters Libra. Autumn commences.
24. 12h. 51m. to 13h. 46m. Moon occults μ Ceti (mag. 4·4).
,, 18h. 1m. Transit (ingress) of Jupiter's Sat. IV. (Callisto).
26. 11h. 57m. to 12h. 59m. Moon occults δ^2 Tauri (mag. 4·7).
29. 18h. 58m. Transit (ingress) of Jupiter's Sat. III. (Ganymede).

DANIEL'S COMET (1907*d*).—The following is an extract from the continuation of Dr. Stromgren's ephemeris for comet 1907*d* as published in No. 4196 of the *Astronomische Nachrichten* (p. 337, August 23).—

Ephemeris 12h. (M.T. Berlin).

1907	α (true) h. m.	δ (true) ° ′	log r	log Δ	Brightness
Sept. 1	8 50·8	+13 34·6	9·7144	0·0534	19·1
,, 3	9 4·0	+12 59·3			
,, 5	9 16·8	+12 22·6	9·7123	0·0847	16·7
,, 7	9 29·4	+11 44·6			
,, 9	9 41·5	+11 5·7	9·7250	0·1139	13·7

An observation at Padua on August 18 gave corrections of +30s. and −0′·7 to this ephemeris.

On September 1 the comet will be 81′·5 N. of α Cancri, whilst on September 8 it will be 66′·4 N. of *o* Leonis.

The comet will rise about $2\frac{1}{4}$ hours before the sun on September 1, and about two hours before the sun on September 9.

FURTHER OBSERVATIONS OF MARS.—The August number of the *Bulletin de la Société astronomique de France* contains an interesting paper by M. Jarry-Desloges giving the results of observations of Mars made during July last at a temporary observatory erected on the summit of the Revard at an altitude of 1550 metres.

M. Jarry-Desloges and his collaborator, M. G. Fournier, confirmed the doubling of the Solis Lacus announced by Mr. Lowell. They also comment upon the cloudy appearance of the Martian landscape in the northern hemisphere as compared with the clear-cut features of the southern hemisphere of the planet.

The faint canals were difficult to observe, but the Ganges was seen to be very broad and appeared double, the two points where it emerges from the Auroræ Sinus being seen quite sharply; the observer states, however, that this observation needs confirming.

On July 19 the region north of Lacus Niliacus was clear, but twenty hours later, on July 20, details of white spots could be seen; thus it appears that in less than twenty hours the clouds or mists which covered this part of the planet vanished.

A SUSPECTED, LARGE PROPER MOTION.—Having occasion to measure the places of three B.D. stars (B.D. + 1°·2720, + 1°·2722, and + 0°·2957) on his star photographs, Prof. Barnard found that the positions determined by him for two of the stars differed considerably from the B.D. positions. That of 1°·2720 is unusually discordant with the B.D., though the difference may be due to an error in the latter; but in the case of 0°·2957 the difference between Prof. Barnard's position and that determined at Bonn amounts to nearly a second of time. Therefore, if the observations are correct, the star B.D. + 0°·2957 must have a considerable proper motion (*Astronomische Nachrichten*, No. 4195, p. 313, August 7).

THE ASTROGRAPHIC CHART.—From No. 386 of the *Observatory* (p. 329, August) we learn that the Potsdam Observatory does not intend to take and distribute the long-exposure photographs (chart plates) of the zone (+32° to +39°) allotted to it. The work will be done at the Royal Observatory of Belgium, which is being reorganised on a somewhat liberal scale.

THE SIMULTANEOUS INVISIBILITY OF JUPITER'S SATELLITES. —On March 7 we referred in these columns to the simultaneous invisibility of Jupiter's four major satellites on October 3 next. In the August number of the *Bulletin de la Société astronomique de France* (p. 356) M. Flammarion gives fuller details of the phenomenon, and shows, by means of a diagram, the disposition of the four satellites, in regard to Jupiter, between the hours of 19h. 56m. and 20h. 6m. on the date named. As Jupiter does not rise until after midnight, European observers will not be able to watch this unusual spectacle; it will, however, be visible in Asia and Oceania.

The first observation of this phenomenon was made by Galileo on March 15, 1611, and only on eight occasions since then has it been observed.

LATITUDE-VARIATION AND LONGITUDE DETERMINATIONS.— Part i., vol. ix., of the *Annalen der Sternwarte in Leiden* contains accounts of a series of latitude-variation observations made by Father J. W. J. A. Stein during the period June, 1899, to July, 1900, and of a determination of the difference of longitude between Leyden and Ubagsberg made by the director of Leyden Observatory, Dr. H. G. van de Sande Bakhuyzen, and M. J. H. Wilterdink.

Father Stein employed the Horrebow method, making 1590 observations on 117 nights. He discusses the observations, the instrument, and the reductions at some length.

Ubagsberg is a geodetic station situated in the province of Limbourg, between Maastricht and Aix-la-Chapelle, and is an important point from the fact of its having been made a station in three distinct triangulations. The difference of longitude between the geodetic pillar at Ubagsberg and the meridian circle at Leyden was found to be +5m. 52·314s. ± 0·015s.

THE COLOURS AND SPECTRA OF STARS.—A paper by Mr. W. S. Franks, appearing in No. 8, vol. lxvii., of the Monthly Notices (R.A.S.), discusses the relation between the colours and spectra of star classes.

He tabulates 1360 stars under colour, as observed by members of the B.A.A., and spectra as given in the Harvard publications, and finds, in general, a very close connection between the two features. Of 282 helium stars, 125 belong to the white or O colour class, whilst 168 of the 377 hydrogen stars come under the same heading. On the other hand, 210 of the 241 solar stars come under the colours between Y^2 and Y^3.

Whilst making the investigation Mr. Franks was impressed by the marked affinity of helium and bright-line stars (types B and O) with the galaxy. All the bright-line spectra met with were in or near the Milky Way, and when one remembers that the Wolf-Rayet stars, all the Novæ, and the majority of short-period variables are also galactical, it is obvious that the Milky Way is, in some way yet undetermined, probably the seat of cosmical actions of primary importance.

THE BRITISH ASSOCIATION.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY WILLIAM E. HOYLE, M.A., D.Sc., PRESIDENT OF THE SECTION.

(*Abridged.*)

THE impression left upon my mind by a score of Presidential Addresses to this Section, which it has been my privilege to hear, is that the speaker who treats of the subject matter of his own researches has the best prospect of making his remarks interesting and profitable to his audience. It is, therefore, in no spirit of egotism that I invite your attention this morning to the small and economically unimportant group of the Cephalopoda.

Some of my predecessors have been men who walked, so to speak, on the heights; who undertook the culture, or at all events the surveillance, of large domains. The extensive views and broad principles which they have thus been able to lay before the Section have been such as at once to compel the attention of all who are interested in any department of biology, or indeed of any branch of science at all. My own case has been far different; the plot I have tried to cultivate has been a very small one, and I have had but little leisure to peep over the fence and see what my neighbours were doing. I come before you, therefore, as a specialist, and not only so, but as that most humble kind of specialist—a systematist (a "mere systematist" is, I believe, the common phrase)—one whose main work has been the discrimination and definition of genera and species. I feel that some apology is necessary in asking zoologists of all departments to step for an hour into my particular allotment and see what has been going on there during the last few decades.

Before inviting you to enter, however, I should like to plead that even the systematist has his uses; for, properly considered, what is the systematic arrangement of any group of animals but the condensed formal expression of our present knowledge regarding its morphology, ontogeny, and phylogeny? Furthermore, how could the varied and complex problems of geographical distribution be attacked without the materials prepared by the systematist?

Having said this much by way of apology and defence, let me invite you without further prelude to consider two or three questions suggested by the study of the Cephalopoda.

Just half a century ago (August 1, 1857), there appeared in the *Annals and Magazine of Natural History* the translation of a paper by the late Prof. Steenstrup, of Copenhagen, which has ever since been regarded as marking an epoch in our knowledge of the Cephalopoda. The consideration of the scope and significance of this memoir may profitably engage our attention for a short time. In researches which were then comparatively recent, Vérany and Vogt and Heinrich Müller had shown that, in the genera *Tremoctopus* and *Argonauta*, the hectocotylus, a supposed parasitic worm which had been found in the mantle-cavity of the female, was in reality one of the arms of the male which had become detached and found its way thither, bearing with it the fertilising element—a procedure quite unique, not only among the Cephalopoda, but also among the Mollusca, if not in the whole animal kingdom. The gist of Steenstrup's discovery was that, although the separation of an arm was peculiar to very few forms, the modification of one or other of the arms for reproductive purposes was of common occurrence among the Cephalopoda; and, furthermore, that the situation of the particular arm, which was so modified, varied with the systematic position of the genus in question, and was constant through the main divisions of the class. To this less extensive modification of the arm he gave the name "hectocotylisation."

Stimulated by this discovery, other zoologists examined the Cephalopoda in their possession, and described the modifications in various genera, and now it is universally recognised that no definition of the Cephalopod is complete which does not include a description of the position and form of the hectocotylised arm. The descriptive anatomy of this organ is fairly well known. Out of twenty-two families, which may be regarded as well established, its structure is known in a number of genera in no fewer than twelve, whilst of the remaining ten it has been more or less conclusively shown that in seven no modification of the arm takes place, so that there are only three families in which we are still without any information regarding it.

Our knowledge of the physiology of the apparatus has not, however, advanced with anything like the same rapidity. Even in the case of those forms where a true hectocotylus is found (*Argonauta*, *Tremoctopus*, and *Ocythoë*) it is not known for certain whether the fertilising arm is deposited by the male in the mantle-cavity of the female (as I think is most probable), or whether (as is stated by some writers) the arm breaks off when mature and finds its own way to its destination. This much is certain, that for some time after its detachment it possesses the power of independent movement.

As regards the function of the modified but not detachable arm, we have the important and interesting observations of Racovitza made at Roscoff and Banyuls on the genera *Polypus* (*Octopus*) and *Sepiola*. It appears that in the first of these forms the extremity of the hectocotylised arm of the male is introduced into the mantle-cavity of the female, both individuals resting on the sea-bottom and at some distance from each other (about 25 cm. in the case of a male measuring 1·25 m. in total length). Although after an encounter the female appeared to flee the embraces of the male, and although the males, when two were placed in the same tank, fought with each other, there was no sign of any combat between the sexes as was described by Kollmann. In *Sepiola* the female is roughly seized by the male, and held with the ventral surface uppermost; the two dorsal arms are introduced into the mantle-cavity, whilst the other three pairs hold the female firmly. The efforts of the male are directed to keeping the female from attaching herself to any firm support. It would appear that the introduction of the arms of the male into the mantle-cavity interferes with the respiration of the female, and that she makes desperate efforts to escape as soon as she can attach herself to any neighbouring object. In this respect there is a marked contrast between the behaviour of these two genera, and it is greatly to be desired that observations should be made on other forms, but the difficulties in the way of this have hitherto proved insuperable.

Although, as we have seen, but little is known of the actual working of the hectocotylised arm, there are differences in the structures set apart in the female for the reception of the spermatophores, which correspond with the different arrangements of the hectocotylus in the male. For example, in *Polypus* (*Octopus*) the spermatophores are deposited in the termination of the oviduct; in *Rossia* there is a large plicated area surrounding the mouth of the oviduct for their reception; whilst in the nearly related *Sepiola* there is a pouch-like depression of the integument lying beside the mouth of the oviduct for the same purpose (von Maehrenthal). In *Sepia*, *Loligo*, and the other Myopsids in which the ventral arms are hectocotylised the spermatophores are received upon a specially modified area lying just to the ventral side of the mouth.

From this all too brief sketch of the function of these organs we may now return to the question of the systematic value of the modified arm of the male. Prof. Steenstrup was firmly convinced of the paramount importance of the hectocotylisation as a classificatory character, and he seemed to cling to this belief almost with the ardour of a devotee for a religious principle. In 1881 he published a memoir in which a new classification of the genera *Sepia*, *Loligo*, *Rossia*, and some other forms was propounded, based avowedly on the position of the hectocotylised arm; and when this scheme was attacked by the late Dr. Brock of Göttingen, he defended it vigorously in a further communication, placing at its head the following thesis much in the same spirit as Luther nailed his famous theses to the church door at Wittenberg: "Hectocotylatio bene observata et rite considerata divisionibus naturae semper congruit; incongrua divisionibus, eas arbitrarias et factitias esse indicat."

Steenstrup further explains that the point of most consequence is which pair of arms is affected by the hectocotylisation, whether the first, third, or fourth pair; next in importance comes the nature of the modification; while the question whether the right or left arm is affected is quite insignificant. It will be our business to consider how far the Danish naturalist's position is justified in the light of our present knowledge.

An inspection of the facts known up to the present time shows, first of all, that where hectocotylisation is known to take place it affects either the first, third, or fourth pair of arms; no instance is yet known where the second pair is modified, except in subsidiary relation to another pair, or in one or two rather doubtful cases in which all the arms are said to be modified. It appears, furthermore, that hectocotylisation of the third pair is confined to the Octopoda, while the first and fourth pairs are affected in the Decapoda, so that, as far as the main divisions of the Dibranchiata are concerned, the position of the hectocotylus is a correct index to them. We may, however, go a step further still, and point out that in every family, with one exception, the position of the hectocotylised arm is constant within the limits of the family, so that there is a very strong *prima facie* case for the truth of Professor Steenstrup's dictum. The difficulty arises when we come to consider the family Sepiolidæ and its allies, and endeavour to form an idea of their relationships to each other.

Steenstrup was so convinced of the truth of his thesis that he divided the Myopsida into two main divisions according to whether hectocotylisation affected the first or fourth pair of arms, and placed the four genera *Sepiadarium*, *Sepioloidea*, and *Idiosepius* (notwithstanding their *Sepiola*-like form) with *Spirula*, apart from *Sepiola* and *Rossia*, and along with *Sepia* and *Loligo*. It becomes necessary now to inquire how far this classification is justified by what we know of the morphology of the forms concerned.

It will be convenient to deal in the first place with *Spirula*, which has always been of great interest on account of the unique structure and position of its shell. It still belongs to the greatest of zoological varieties, only a dozen specimens with the soft parts having been obtained, of which one alone proved to be a male. This was examined by Sir Richard Owen, who described the hectocotylisation as affecting both the ventral arms, which are much enlarged, exceeding the others both in length and thickness: they are quadrangular in section, devoid of suckers, and the right is much larger than the left. The other arms appear to have a round truncated extremity which may be a secondary modification. The relationships of *Spirula* have recently been made the subject of inquiry by Prof. Paul Pelseneer, who completed the memoir in the *Challenger* reports begun by Prof. Huxley, and by Dr. Einar Lönnberg of Stockholm, who dissected a specimen obtained for him from Madeira by the late Captain Eckman. These two investigators arrived at different conclusions regarding its systematic position.

Pelseneer regards it as an Œgopsid, Lönnberg as a Myopsid, but the anatomical characters on which they are agreed are enough to show that, at any rate, these two forms cannot be so closely related to each other as to belong to the same sub-family, or even family.

With regard to the question at issue between them as to the Œgopsid or Myopsid nature of *Spirula*, I think, on the whole, that its resemblance is to the former rather than to the latter; but I believe that the branch of the ancestral tree which terminates in *Spirula* was given off from the main Cephalopod stem before the Œgopsida and Myopsida, as we now know them, had been separately evolved. Palæontology reveals a possible descent of *Spirula* from a Belemnitoid through such an intermediate form as *Spirulirostra*; and from this, on the other hand, it is easy to conceive of the descent of *Sepia* through a form resembling *Belosepia*. Such a relation could be expressed by the following diagram, which is, however, only a rough illustration of possibilities, for *Spirulirostra* is a Miocene form and *Belosepia* an Eocene, so that the former could hardly be the ancestor of the latter. It is only contended that these forms indicate a possible line of descent.

Unfortunately, in the present state of our knowledge, it is impossible to correlate the above diagram with one based upon the study of the soft parts of recent forms. It is sufficient if they do not contradict each other. We know nothing of the soft parts of the fossils, and there is no recent form, which exhibits shell characters, bridging over the gulf between *Sepia* and *Spirula*. To sum up, *Spirula* must be regarded as, at all events, the representative of a distinct family: it is not unlikely that it may one day become the type of a division coequal with Myopsida and Œgopsida, and it does not appear to me that the structure of its hectocotylised arms would be any argument against such a view.

We may now consider the genera *Idiosepius*, *Sepiadarium*, and *Sepioloidea*, regarding which there can be no doubt that on morphological grounds these three genera are more nearly allied to the Sepiolidæ than to the Sepiidæ or Loliginidæ; in fact, practically the only character of any importance which points in the opposite direction is the hectocotylisation. This portion of the subject has been very fully and clearly handled by Dr. Appellöf of Bergen, and to his memoir I refer those who desire more detailed information. We have here, then, a case in which forms the ventral arms of which are hectocotylised are more nearly related to forms with dorsal hectocotylisation than to others with ventral, and this shows that the position of the modified arm (or arms) is not by itself an infallible guide to systematic affinity. It is a striking instance of an aphorism of the late Prof. Rolleston, that "no single character can be regarded as a safe basis for a natural classification until it has been proved to be so."

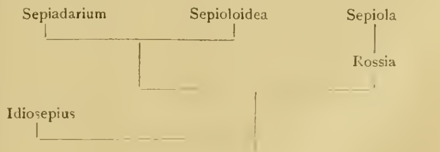
It may, however, be worth while to look a little further into the relationships of these forms, and to see whether the hectocotylisation of the dorsal arms is quite as sporadic and irregular as it at first appears.

After the separation of *Idiosepius* two possibilities present themselves as to the further evolution of this group.

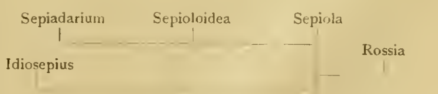
A. The main stem divided into two branches leading to *Rossia* and *Sepiola* on the one hand, and to *Sepiadarium* and *Sepioloidea* on the other.

B. The stem gave off first a branch leading to *Rossia*, and subsequently divided into two, one leading to *Sepiola* and the other to *Sepiadarium* and *Sepioloidea*.

These two alternatives may be expressed graphically thus:



(A)



(B)

These schemes are not entirely satisfactory. Certain difficulties are common to them both. The posterior salivary glands, which, it is assumed, were inherited in a fused condition from the primitive Œgopsid stem, and remain in that condition in *Rossia*, have been separated in *Idiosepius*, *Sepiadarium*, and *Sepiola*, as well as in *Sepia* and *Loligo*.

Furthermore, A presents the difficulty that the fusion of the mantle with the head in the nuchal region has been acquired independently by *Idiosepius*, *Sepiadarium* and *Sepioloidea*, and *Sepiola*.

On the other hand, B has the disadvantage of assuming that the hectocotylisation has been transferred from the fourth to the first pair of arms independently in *Rossia* and *Sepiola*.

If, as I believe to be the case, scheme A is admitted to offer the lesser of the two difficulties, it has the advantage of indicating that the hectocotylisation of the ventral arms has been directly inherited from the main stem common to Myopsids and Œgopsids, and has only been transferred to the dorsal arms in the branch common to *Rossia* and *Sepiola*.

Hence we reach the conclusion that, although the variations in the structure and position of the hectocotylus follow pretty closely the systematic divisions of the Dibranchiata, we are not justified in maintaining that the position of the hectocotylised arm is by itself a sufficient guide to the systematic position of a doubtful form; it is only one of many characters that must be taken into consideration.

The subject of fossil Cephalopoda has not formed any part of my own special researches, but a contribution has recently been made to our knowledge of these forms to which it seems desirable to allude, because it deals, not with systematic or stratigraphical facts, but with conclusions which may be drawn from shell structure as to the life-history and habits of certain important and interesting forms. Prof. Jaekel, formerly of Berlin, now of Greifswald, the author of the memoir referred to, lays down a number of theses regarding the organisation and mode of life of these extinct species, and I venture to give an abstract of his views, premising that my acquaintance with palæontology does not justify me in expressing a definite opinion as to the validity of his conclusions, though they seem extremely reasonable.

His opening statement is that *Orthoceras* and its allies were not free-swimming but sessile organisms, and this is based on the following arguments amongst others. The shells were thicker and heavier than any that are found in pelagic organisms; the external sculpture shows that the shell was not embedded in the soft parts, and if it were exposed the annulate arrangement of many forms is inconsistent with their easy passage through the water; the "lines" (in the naval architect's sense of the word) of an organism intended for navigation are always smooth and not wavy; otherwise undue friction against the water would be created; whilst the straight transverse margin of the aperture of the shell shows that it was not carried by a creeping body like that of a snail. Their sessile nature is further shown in the first place by the radial symmetry, which is rare in free-swimming forms, and almost unknown in those the axis of which is long in proportion to their diameter. Further, the termination of the shell is generally broken off: of all the thousands of specimens which have been examined, but very few show the initial chamber; in those cases in which the apex is preserved it shows a scar, where the siphuncle entered the protoconch. The separation of the shell into chambers by transverse septa occurs only in sessile forms, but in such it is found in many divisions of the animal kingdom. The reason of this cameration is to be found in a constant effort to keep the body of the animal above the surface of the mud in which it is rooted. On this view the siphuncle admits of a simple explanation; it is the vestigial part of the body which has been contracted and partially cut off as the body has moved successively forward to the enlarged superior portion of the shell.

It may be added that J. M. Clarke has recorded a case in the American Upper Devonian rocks in which the majority of the large Orthoceratidæ were fossilised in a vertical or but slightly sloping position.

The forms such as *Phragmoceras*, &c., in which the aperture of the shell is contracted, and often shows bilaterally symmetrical notches, are interpreted as having lived buried in the mud. The notches served for the protrusion of the arms, vent, and siphon, which latter were probably elongated tubes stretching up through apertures excavated in the mud, much in the same way as the heart-urchin (*Echinocardium*) among the sea-urchins lives buried in the mud, and obtains nourishment by stretching its tube feet up to its surface. The arrangement of the arms was probably like that seen in the embryos of Dibranchiata, or of the circumoral appendages of *Nautilus*.

Turning to the extensive and interesting group of Belemnites, Prof. Jaekel enunciates the view that these were not, as has been commonly believed, active free-swimming forms, the rostrum (guard) serving as the pointed ram of a battleship, but stationary, the rostrum playing the part of a pile by which they were rooted in the mud at the sea-bottom, like the pointed base of a *Flabellum* or other deep-sea coral, or the anchor-spicules of a glass-rope sponge. In favour of this view may be adduced the size, weight, and solidity of the rostrum, which, if the animal moved about in a horizontal attitude, would have thrown its centre of gravity too far towards that end of the body: its circular section, which points to a radial, not a bilateral, symmetry, and hence, as above mentioned, to a sessile rather than a free-swimming habit. The pointed form of the rostrum would be admirably adapted to fixation in a muddy bottom, whilst its weight would render it a very effective anchor. Further, it is to be noted that Belemnites are found abundantly in strata of argillaceous origin.

This view has a strong recommendation in the fact that it presupposes gradual progress in the Cephalopoda in the direction of greater mobility as evolution advanced, thus:

A. Orthoceras—firmly attached.
B. Belemnites—anchored in the mud.
C. Recent Dibranchiata—free-swimming.

Another interesting discovery of Prof. Jaekel is that of a slab of Solenhofen stone, upon which are certain specially arranged impressions, apparently made by the hooks on the arms of a Cephalopod. If this determination is correct, the fact is of the greatest interest, for it would show that these animals walked upon the ground with the head downwards and the distal extremity of the body elevated; that in them the arms were not merely morphologically, but also functionally, the equivalent of a foot.

In conclusion let me direct your attention to a subject which is almost entirely the growth of the last fifteen years. I mean the discovery and investigation of luminous organs in the Cephalopoda. These have now been observed in no fewer than twenty-nine out of about seventy well-characterised genera of Decapoda, and have been found to present a most interesting variety in position and in structure.

Before passing on, however, to consider the structure of these organs, it may be well to lay before you the evidence on the strength of which a photogenic function has been ascribed to them. The actual observations are remarkable chiefly for their paucity; indeed, it may seem to some that the foundation of solid fact is too slender for the superstructure raised upon it, but still due consideration will show that this is not the case. The first recorded occurrence of phosphorescence in the Cephalopoda is due to Vérany, and dates back rather more than seventy years, though it was not published till 1851. The description is so definite and concise as to be well worth quoting:

"As often as other engagements permitted, I watched the fishing carried on by the dredge on the shingly beaches which extend from the town of Nice to the mouth of the Var. On the afternoon of September 7, 1834, I arrived at the beach when the dredge had just been drawn in, and saw in the hands of a child a cuttle-fish, unfortunately greatly damaged. I was so struck by the singularity of its form and the brilliance of its colour that I at once secured it, and, showing it to the fishermen, asked whether they were acquainted with it. Upon their replying in the negative I called their special attention to it, and offered a handsome reward for the next specimen secured, either alive or in good condition, and then passed on to other fishermen and repeated my promise. Shortly afterwards I was summoned and shown a specimen clinging to the net, which I seized and placed in a vessel of water. At that moment I enjoyed the astonishing spectacle of the brilliant spots, which appeared upon the skin of this animal, whose remarkable form had already impressed me: sometimes it was a ray of sapphire blue which blinded me; sometimes of opalescent topaz yellow, which rendered it still more striking; at other times these two rich colours mingled their magnificent rays. During the night these opalescent spots emitted a phosphorescent brilliance which rendered this mollusc one of the most splendid of Nature's products. Its existence was, however, of short duration, though I had placed it in a large vessel of water. Probably it lives at great depths."

The species thus referred to was *Histioteuthis bonelliana*, which we shall have occasion to refer to in the sequel.

The next observation, so far as I am aware, was made by Prof. Chun, on board the *Valdivia* during the German deep-sea expedition, on a form which he has called *Thaumatolampas diadema*. The specimen captured lived long enough to allow of a photograph being made of it whilst in a state of functional activity, and the appearance it presented is thus described by the observer:

"Among all the marvels of coloration which the animals of the deep sea exhibited to us nothing can be even distantly compared with the hues of these organs. One would think that the body was adorned with a diadem of brilliant gems. The middle organs of the eyes shone with ultramarine-blue, the lateral ones with a pearly sheen. Those towards the front of the lower surface of the body gave out a ruby-red light, while those behind were snow-white or pearly, except the median one, which was sky-blue. It was indeed a glorious spectacle."

Finally we have the genera *Heteroteuthis* and *Sepiola*, the phosphorescent properties of which were seen last year by Dr. W. T. Meyer and Dr. W. Marchand in the Zoological Station at Naples.

This short list comprises all the actual observations on the luminosity of these animals; in these, however, the photogenic function has been definitely associated with special organs, and it is by comparison with these that other organs in other species have been regarded as having the same significance.

The history of the anatomical examination of these organs dates back only to the early 'nineties, and, so far as I can ascertain, the right of priority of the discovery rests with Prof. Joubin, who made a communication to the Société scientifique et médicale de l'Ouest at Rennes on February 3, 1893, a brief account of which was published by the Société de Biologie of Paris on the 10th of the same month: this communication related to *Histioteuthis rüppelli*, and in it attention was called to Vérany's observation quoted above. Sections of the organs of *Abraliopsis* were exhibited at the Göttingen meeting of the German Zoological Society and at the Nottingham meeting of this Association in the same year. Successive memoirs by Joubin and others followed, and in 1903 Prof. Chun delivered an address to the German Zoological Society at Würzburg, in which he gave a masterly survey of the whole subject, brought forward instances of similar organs previously overlooked, and showed the great variety in structure, not only in the organs of different species, but even in organs of one and the same individual.

More or less adequately authenticated luminous organs have now been recorded in no fewer than thirty-three species of Cephalopoda, and they have been found to occur in the following situations:

(1) Ventral surface of mantle.
(2) Ventral surface of body-wall within the mantle-cavity.
(3) Ventral surface of siphon.
(4) Ventral surface of head.
(5) Ventral surface of arms (usually confined to the ventral and ventro-lateral, rarely found on the dorso-lateral, and very rarely on the dorsal).
(6) Ventral surface of eyeball.
(7) Ventral surface of tentacles.
(8) Dorsal aspect of the dorsal arms.
(9) Dorsal surface of fin.

The most striking fact apparent from this summary is that luminous organs are practically confined to the ventral aspect of the animal. Another remarkable fact is the existence of organs concealed beneath the mantle and beneath the integument covering the eyeball, which can only be effective by reason of the transparence of the tissues in the living creature.

To give a detailed description of the structure of these many and varied organs would be out of place on the present occasion; it must suffice to group them into more or less well-defined classes and take an example from each.

The luminous organs of Cephalopoda may be divided in the first instance into

A. Glandular.
B. Non-glandular.

A. *Glandular Organs.*—In this class we have to deal only with the type of structure found in *Heteroteuthis, Sepiola,* and *Rossia,* which has been investigated by Dr. W. T. Meyer, of Hamburg, a pupil of Prof. Chun. When working at the Naples Zoological Station he was fortunate enough to obtain a specimen of *Heteroteuthis dispar*, and Dr. Lo Bianco called his attention to its luminous properties. On examination in a dark room it was easy to see the organ lying on the ventral surface of the body, just behind the funnel, showing through the transparent mantle with a pale greenish light like that of the glowworm. It appeared, further, that when the animal was irritated it shot rapidly through the water, leaving behind it a trail of luminous secretion which floated in the form of separate globules, and were afterwards drawn out by the currents into long threads. Dr. Meyer was able to repeat this exhibition of fireworks several times.

In *Sepiola* the luminous secretion is not ejected, but remains attached to the surface of the gland; and, furthermore, the light is only given off on powerful stimulation, as, for example, when the mantle is cut open. The structure of these organs has as yet been only very briefly described by their discoverer: they consist of paired glands, situated as above described one on either side of the anus, and partially concealed by the lateral margin of the ink-sac, which forms a recess for their reception. Beneath and to the inner side of the gland there is a reflector, and above it is a rounded gelatinous mass, fibrous in structure, transparent during life, covered with a delicate muscular layer. Dr. Meyer hesitates as to the function of this mass; but I think, in view of the structure of the luminous organs in other species, we may hazard the suggestion that it is some kind of lens. This organ is of particular interest, because it is the only instance yet recorded of a luminous organ among the Myopsida and the only glandular luminous organ in the Cephalopoda. Glandular luminous organs are, however, known in many species of fish, and in *Pholas* among the Mollusca.

B. *Non-glandular Organs.*—These may perhaps be divided into

(i.) Simple, without special optical apparatus.
(ii.) Complex, with more or fewer of the following structures: pigment layer, reflector, lens, diaphragm.

(i.) As a type of the simpler kind we may take the branchial organ of *Pterygioteuthis giardi*, in which we have a central mass of parenchymatous tissue, with a delicate superficial membrane (consisting of two thin layers), and resting upon a rather thick layer of close, compact tissue, which stains very deeply; beneath this organ is a single layer of cells containing a reddish-brown pigment. The corresponding organ in the nearly allied *Pyroteuthis* (or *Pterygioteuthis*) *margaritifera* is a degree more complex, for underneath the central cell mass is a thick layer of scale-like bodies, similar in structure to that regarded in other cases as a reflector ("tapetum" of Chun). In both these cases it seems necessary to regard the central cells as the source of light (see Fig. A).

Another organ, almost equally simple, is that found in the tentacles of *Thaumatolampas*, where the central portion of the stem of the tentacle for about 2 mm. of its length is occupied by a large rounded cell-mass whose diameter is more than half that of the tentacle. The nerve which usually occupies this position is pushed to one side and flattened out like a ribband. Most curious is the fact that on the side opposite to the nerve a second organ is superposed on the first, which is of more complex structure, inasmuch as it has in its centre a mass of photogenic cells surrounded by a system of radiating fibrils with a pigment layer and tapetum at one side (see Fig. 1

(ii.) As an example of the complex organs we may conveniently take those of *Histioteuthis rüppelli*, where they are scattered over the ventral surface of the mantle, siphon, head, and arms, forming in particular a definite ring round the ventral half of the margin of the ocular aperture. The organ itself is an ovoid body, about 1 mm. in length and somewhat less in diameter. The deeper three-fourths of this cup are covered with a thin layer of pigment, which is lined with a thick coating made up of small lenticular bodies packed closely together and forming a kind of mirror. The space within this, equal in diameter

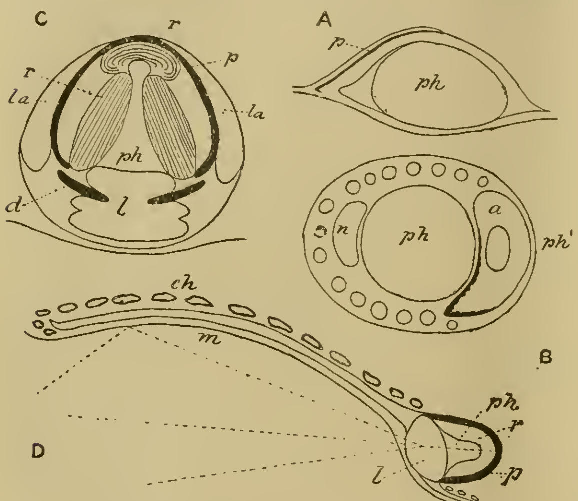


FIG. 1.—Semi-diagrammatic sections of typical luminous organs:—A, Branchial organs of *Pterygioteuthis giardi* B, Tentacular organs of *Thaumatolampas*, C, Pallial organ of *Abraliopsis*. D, Pallial organ of *Histioteuthis rüppelli*. *a*, Accessory tentacular organ. *ch*, Chromatophores. *d*, Diaphragm. *l*, Lens. *la*, Lacuna. *m*, Mirror (external). *n*, Nerve. *p*, Pigment. *ph*, Photogenic cells. *ph'*, Photogenic cells of accessory organ. *r*, Reflector (internal).

to about half the diameter of the organ, is filled with a mass of large deeply staining cells with large distinct nuclei. The more superficial portion of the organ is made up of what seem to be refractive structures. The deeper portion is conical, fitting into a hollow in the photogenic mass, whilst the upper part is bounded by a definite convex surface, the function of which is obviously lenticular. Nerves have been traced passing through the mirror to the light-producing cells in the centre. This ovoid body is situated at the posterior end of a somewhat hollowed patch of an elongated oval shape, which may measure as much as 10–12 mm. in its antero-posterior diameter. A consideration of the form and position of this hollowed patch and of its relation to the axis of the organ shows pretty clearly that it is an external mirror, destined to throw the rays of light downwards and forwards (see Fig. D).

One of the most complicated organs known is that found in the mantle of *Abraliopsis*. Here the whole apparatus is spheroidal in form and surrounded by a black coating, derived apparently from a number of confluent chromatophores. The photogenic cells lie rather in front of the centre, and before them again a ring of black cells seems to discharge the functions of an iris diaphragm. Behind the source of light is a reflector consisting of two parts: the deeper is concave, spheroidal, and made up of numerous concentric layers; the more superficial portion is conical, and also composed of concentric lamellæ. Partly in front of and partly behind the diaphragm is a lenticular mass of tissue. These little lanterns are scattered in considerable numbers over the ventral surface of the mantle, funnel, head, and arms, and the appearance of the animal when they are functionally active must be brilliant in the extreme (see Fig. C).

If we examine the organs just described and the others above enumerated, we see that certain conditions are fulfilled in all cases—namely, the presence of a mass of deeply staining, active cells with distinct nuclei, supplied with blood-vessels and nerves. These, then, are the essential parts of the apparatus, though even here differences obtain: for example, in *Thaumatolampas* the cells are polyhedral, highly refractile, and clearly defined, with spherical nuclei and distinct nucleoli. In *Chiroteuthopsis* the cells are few and large, and partially fuse one with another. In *Pterygioteuthis* the fusion has proceeded so far that the cell-boundaries are no longer recognisable, and there is present a finely granular mass in which numerous nuclei of varying size may be distinguished. In other cases the cells branch out into fibres and form a reticulate structure (*Calliteuthis*). In rare cases, as, for instance, the tentacular organ of *Thaumatolampas*, above described, this essential part constitutes the whole organ; but generally other structures are superadded, such as a pigment coat, reflector ("tapetum" of Chun), lens, and diaphragm, as has been mentioned in the complex organs just described.

Numerous interesting questions at once suggest themselves in regard to these structures, and it is very disappointing to admit that in regard to almost every one the answer is a confession of ignorance.

The first inquiry is: What is the origin of these organs, and from what primitive structures are they evolved? Here it is possible to say but little; there is no instance in which the development of these organs in the embryo has as yet been studied. A larva, believed to be that of *Histioteuthis*, came into my hands a short time ago, and full of hope I had a portion of the mantle cut into sections, but with no result whatever; there was nothing which I could interpret as the rudiment of such an organ.

Those organs occur in so many and such scattered families that it seems clear they must be polyphyletic. Furthermore, even in one and the same species the different organs are not all constructed on the same plan. In *Abraliopsis*, for example, the pallial organs are quite different from the ocular; but the most striking example of this sort of complexity is found in the remarkable *Thaumatolampas*, which has altogether twenty-two organs constructed on no fewer than ten different principles. It seems difficult in such a case to resist the conclusion that these organs have been separately evolved at different times, and perhaps from different origins, during the phylogenetic history of the species.

This variety in the structure of these organs naturally suggests the query: Do these differently designed lamps give out different kinds of lights? Here we have the observation of Prof. Chun on board the *Valdivia* to guide us, according to which in the living animal the middle ocular organ shines with an ultramarine light, whilst the middle of the five ventral organs is sky-blue and the anal organs are ruby-red. It may also be observed that even in preserved specimens, when examined in a strong light, the different organs seem to shine with different colours, although there is under such conditions no actual emission of light. Furthermore, in some forms (*e.g.*, *Calliteuthis*) there are chromatophores in the superficial layers of the integument over the luminous organs, through which the light admitted must pass. A somewhat similar arrangement obtains in the curious structures in *Chiroteuthis*, which were regarded by Joubin at the time of their discovery as "thermoscopic eyes," but which are, I think rightly, in the present state of our knowledge, considered to be a special kind of luminous organ. In these instances the function of the superficial chromatophores may be to colour the light which passes through them.

The question of the utility of these variously coloured lights to the creature possessing them admits of an answer which is, at all events, extremely plausible. It was suggested in the case of deep-sea fishes by Brauer, and has been adopted by Chun in reference to the Cephalopoda. They serve as recognition marks by which the various species can identify their fellows; just as certain colour patches in the plumage of birds enable them to find their mates, so in the darkness of the ocean abysses do these fairy lamps serve their possessors. Another and perhaps even more obvious utility is suggested by the general distribution of these organs. It has above been pointed out that they are, almost without exception, on the ventral aspect of the body, that is, the inferior surface in the position in which the animal habitually swims. It must happen, therefore, that when the creature is moving over the floor of the ocean in the quest for food, this must be illuminated by its lamps, and the advantage of a series of searchlights playing over the ground will be at once apparent.

Finally we have the question: How is the light produced? To this we can only say that this is an instance of the transformation of one kind of energy into another. We are quite familiar with the production of heat in the animal body by the processes of oxidation which go on in it; we are also familiar with the production of kinetic energy when a muscle contracts under a nervous stimulus; and we are also aware that electric discharges are produced under similar conditions in certain organs of the Torpedo and other fish. The production of light is a phenomenon of the same kind. When we can explain how stimulation applied to a nerve causes contraction in a muscle, then, and not till then (so far as I can see), shall we be within reasonable distance of explaining the action of these living lamps.

One point is worthy of notice which has been ascertained, not by experiments on the Cephalopoda, but on other animals, namely, the remarkable economy of this illuminant. A perfectly infinitesimal proportion of the energy expended is wasted on the production of heat. From this point of view animal phosphorescence puts to shame our most modern devices. Whether we shall ever be able to rival Nature in this respect remains to be seen.

We have thus shown how rapid has been the growth of our knowledge regarding the distribution and structure of these fascinating organs, and yet how little we have learned of the mode of their operation, and we end, as all scientific inquiries end when pursued far enough, with a confession of ignorance.

What I have ventured to lay before you are a few of the fruits of the little garden plot in whose culture I have been privileged to take a humble share. If it has appeared to you that the labour spent upon their production by a few enthusiastic workers has been well expended; if they show that in this, as in any other group of animals, the study of small details conscientiously carried out leads to problems of the deepest interest, my object in the preparation of this Address will have been fully achieved.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

ON Thursday, August 1, at 10 a.m., Prof. A. E. H. Love, F.R.S., read his presidential address, which has already appeared in full in these columns (see NATURE, August 1). A vote of thanks, moved by Sir D. Gill and seconded by Sir G. Darwin, was carried with acclamation.

The Hon. R. J. Strutt commenced the ordinary proceedings with a paper on helium and radio-activity in common ores and minerals. He was inclined to attribute the helium which can be obtained from minerals, not to a radio-activity of the rocks themselves, but to the radium which they contain. The evidence on which this conclusion was based is that the ratio of radium to helium present is nearly constant. A great exception occurs in the case of beryl, which shows no radio-activity, but contains a large quantity of helium. Prof. Rutherford suggested that thorium should be looked for in beryl as a source of the discrepancy. In his reply, Mr. Strutt stated that he had found thorium in granite but not in beryl in sufficient quantities to afford an explanation of its peculiar behaviour.

Lord Kelvin followed with a paper on the motions of ether produced by collisions of atoms or molecules containing or not containing electrions. To him it seems extremely improbable that differences of grouping atoms all equal and similar should suffice to explain all the different chemical and other properties of the great number of substances now commonly called chemical elements. The impossibility of the transmutation of one element into any other he declared to be almost absolutely certain. The ether he takes as an elastic, compressible, non-gravitational solid. It is, however, only under the *enormous* forces of attraction or repulsion exerted by atoms on ether that augmentation or diminution of its density is practically influential. Purely dynamical reasoning leads him to infer generally similar theorems for an atom to those worked out by Heaviside for an electron. The association of atoms with electrions (or atoms of resinous electricity), and the interaction of both with the ether, form the basis of a general explanation of physical phenomena.

In a paper on secular stability, Prof. Lamb explained the difference between ordinary or temporary stability, *i.e.* stability as asserted by the method of small oscillations, and secular stability, *i.e.* stability when account is held of possible frictional forces; and he gave an experimental illustration of the latter kind. A pendulum hangs by a Hooke's joint from the lower end of a vertical shaft which can be made to rotate by a pulley with constant angular velocity ω. The effect of the rotation is that its two circular component vibrations have different periods, that one being the faster the direction of revolution of which agrees with that of the shaft. The criterion of secular stability imposes a limit to the speed for which the vertical position of the shaft is stable; for speeds higher than the limiting one a new position of equilibrium is possible in which the pendulum rotates at a constant inclination θ given by $\cos\theta = Mgh/(A-C)\omega^2$, where A and C are the two principal moments of inertia of the pendulum at the joint.

The beginning of the session on Friday had been allotted to a discussion on the constitution of the atom, and the committee of the section had not been in error in expecting that this would be of intense interest. Prof. Rutherford, whom we now have permanently in this country, opened it with a speech which was specially intended to suggest lines for discussion rather than to be a dogmatic statement of his own views. It was perfectly clear, however, that he regarded the electron as having come to stay, although at present it is impossible to decide whether the electrons which are set free in radio-activity or are revealed by the optical properties of an atom are merely an outer circle or are a revelation of the internal constitution of the inner core of the atom. He declared in favour of a kinetic view of the atom in opposition to statical views such as that developed by Lord Kelvin. Only on a kinetic theory could the great velocity of the β particles be explained. Sir O. Lodge in his contribution to the discussion took up a very definite line: "The electrical theory explains both inertia and radiation; and when a satisfactory explanation is given it ought to be supposed to be the right explanation, inasmuch as it is unlikely that two different systems will both fit the facts." One difficulty that has to be faced is that dispersion, absorption, and radiation (which are all connected) appear to indicate that the electronic constituents of an atom are few, but the electrons so tested may be only those which are comparatively free, and are not completely encased or submerged in an opposite charge. Such deep-seated or constitutional electrons would be inaccessible to light vibrations, and would take no part in dispersion unless violently shaken by chemical clash. The real difficulty is our present ignorance of the nature of positive electricity. Sir Wm. Ramsay urged that the chemist is at present more interested in the detachable electrons, and leaves the nature of the constitution of the atom as non-essential from the point of view of chemistry. These detachable electrons are the cause of valency, and chemical elements of the metallic class must be regarded as compounds; for example, HE may represent an atom of hydrogen the E of which is an electron; for hydrogen chloride, dissolved in water, gives as one of its products H, while the E is transferred to the chlorine atom. He referred to Prof. Rutherford's statement that no profound change had been discovered to take place in matter by the *loss* of electrons, and he pointed out that nickel under combined bombardment by electrons is partially transformed into a radio-active body belonging to that series of metals which yield insoluble sulphates. A *gain* of electrons, therefore, produces a permanent change in matter.

To Mr. F. Soddy, the philosophic unification for which Sir O. Lodge had pleaded seemed "unphilosophic and strained." It was possible to retain the idea of the inertia of electricity as being due to the magnetic field around the moving charge without taking the further step of supposing that matter was ultimately electrical in character. The subject is being approached from both the speculative and experimental sides, and the hypotheses of the former side often failed when subjected to the supreme test of prediction, and were sometimes little more than an ingenious mimicry of known facts. Mr. G. A. Schott considered that it was too soon to expect the mathematical physicist to predict new phenomena, since it is only within the last few years that he has been supplied with the materials necessary for his method, *e.g.* the electron. He adduced one positive result which may help to decide between the static and the kinetic view of the atom. A uniform magnetic force acting on a *rotating* ring gives a periodic mechanical force capable of producing resonance. In consequence, a rotating ring is capable of yielding a magnetic moment very much larger than it would do if at rest relatively in the field. Prof. Larmor claimed the right of physicists to make hypotheses even with regard to the atom. He considered that our views about the electron would have been just the same as they now are if radio-activity had not been discovered, and he gave a short historical account of the development of electronic theory from Faraday through Maxwell to modern times. Lord Kelvin preferred to regard the atom as a big gun loaded with an explosive shell. The firing of a shell does not cause the destruction of the gun; the electron, however, changes its nature in a way analogous to the bursting of the shell after explosion.

The discussion throughout was very stimulating, even if few decisive statements could be made. It was noteworthy that no allusion was made to the latest optical papers of Drude, in which he allocated the parts played by bodies the mass of which is that of an electron, and bodies the mass of which is comparable with the mass of an atom, in determining the optical dispersion of solids, *e.g.* fluorspar.

A paper was next read by Sir Wm. Ramsay detailing the remarkable discoveries announced in a letter to NATURE, July 18. Briefly stated, it appears that helium, neon, or argon is formed from radium emanation according as it is dry, dissolved in water, or dissolved in a strong solution of a copper salt. Simultaneously, lithium and perhaps sodium are formed, the presumption being that they are formed at the expense of the copper. The importance of the former discovery is that this is the first time the nature of the products of radio-active disintegration has been found to be controllable.

In a paper by Mr. F. Soddy and T. D. Mackenzie (Carnegie research scholar) on pseudo-high vacua, it was shown that the electrical characteristics of a high vacuum occur in helium (purified by calcium and subjected to further purification by the passage of the discharge) at pressures between $\frac{1}{4}$ mm. and $\frac{1}{3}$ mm. of mercury, whereas in hydrogen the same holds at 1.25 mm. These pressures are far higher than is commonly supposed. The absorption of helium, argon, and neon in spectrum tubes after continuous running occurs mainly in the volatilised film of aluminium deposited from the electrodes. The gas can be mainly recovered by dissolving the film in mercury or heating the tube.

Prof. Larmor gave a very brief summary of a paper on the range of freedom of electrons in metals. It was remarked that a hopeful plan for elucidating the mechanism of the transfer of electricity (electrons) from molecule to molecule is to study the time relations. The optical phenomena of metals introduce times, viz. the periodic times of the vibrations which are small enough for this purpose. Hagen and Rubens's experiments on the connection between infra-red radiation and electric conductivity show that the time required to establish conduction completely is a small fraction of the period of such waves. If the semi-free electrons to which conduction is due have a velocity of mean square determined by the gas laws, this restricts their range of freedom almost to the interspaces between the molecules. On the other hand, the fact that the square of the quasi-index of refraction of light for the nobler metals is not far removed from being a real negative quantity, indicates that the number of such free electrons is of about the same order of magnitude as the number of molecules.

The proceedings on Monday, August 5, opened with a paper by Dr. L. Holborn on optical pyrometry, in which he outlined the various radiation methods of measuring temperature. The most recent optical experiments give for the melting point of platinum the value 1790° C. if the melting point of gold (1064° C.) is taken as the fundamental point. Prof. C. Féry followed with a discussion of the various difficulties which are met with in connection with the subject. He mentioned that an apparatus had recently been devised in which there is nothing electrical. In this the thermometric receiver, instead of being a thermo-element, is a bimetallic spiral which deflects a pointer over a scale attached to the instrument.

Dr. Harker, who had in recent years obtained a considerably lower value for the melting point of platinum, pointed out some of the defects to which the optical method was liable. In particular, there is an uncertainty arising from the absorption of the light by the vapour given off the walls of the furnace.

After the end of this discussion the section divided into two departments. In the department of mathematics Prof. Forsyth led the way with a brief review of the progress of the calculus of variations during the last century, and in particular of the work of Weierstrass. After referring to later developments of the subject, he gave an outline of the set of four conditions to be satisfied by an integral involving a derivative of the first order of a single dependent variable, and discussed the necessity and sufficiency of these conditions.

Dr. W. H. Young gave an outline of some new results reached by himself in the theory of functions of a real variable. He proved that there could be no difference between the right- and left-hand discontinuities of a function except at a countable number of points, and that a similar result held good for non-uniform convergence. Dr. W. de Sitter, in a paper on a remarkable periodic solution of the restricted problem of three bodies, showed that one of the orbits worked out by Sir G. Darwin is very nearly of the type called by Poincaré a periodic solution *de seconde espèce*.

Mr. H. Bateman followed with a paper on essentially double integrals, and the part which they play in the theory of integral equations. Starting with the integral equation of the first kind, $f(s)=\int_a^b \kappa(s,t)\ \phi(t)dt$, in which the forms of κ and f are known and ϕ is to be determined, he showed that the solution of this equation was unique if no solution could be found of the so-called "homogeneous" allied equation

$$0=\int_a^b \kappa(s,t)\ \phi(t)dt$$

if

$$\int_a^b\int_a^b \kappa(s,t)\ \omega(s)\ \omega(t)dsdt$$

is essentially positive whatever the form of the (continuous) function $\omega(t)$. Types of such functions $\kappa(s,t)$ are given in the paper, and also a simple proof of a theorem of Hilbert.

Major MacMahon read a paper on operational invariants, in which he obtained several interesting and elegant results in this abstruse department of analysis.

Prof. Love read the first of a group of papers on the best methods of introducing certain fundamental results in analysis. In this he detailed a method of proving the fundamental properties of the exponential function. Starting from the attempt to differentiate a^x, he introduced the number e as the limit of $(1+1/n)^n$ when n is infinite, and by applying the theorem of the mean value to the expression

$$\phi(x)=e^b-e^x-(b-x)e^x-\frac{(b-x)^2e^x}{\lfloor 2}-\frac{(b-x)^{n-1}e^x}{\lfloor(n-1)}-\frac{(b-x)^n}{b^n}\mathrm{R}$$

where R is the difference between e^b and the first n terms of the series for e^b, he obtained readily the exponential theorem. In the interesting discussion which followed this paper Dr. Young suggested that the concept of an infinite series was really simpler than that of a limit, since the former involved only a countably infinite number of steps, which was not necessarily true of the second. Dr. Hobson emphasised the value of Prof. Love's method as making the student familiar with a type of proof of great generality and power, but Mr. C. S. Jackson deprecated the too early introduction to beginners of difficult mathematical concepts.

In the department of general physics, which proceeded simultaneously with the above, Mr. Sidney Russ read a paper on the transmission of the active deposit from radium emanation to the anode. He showed that, whereas the amount of active deposit obtained on the negative electrode diminishes as the pressure of the air is diminished, as has already been found by Makower, it is found that the amount obtained on a positive electrode simultaneously increases. Experiments have also been made in various gases on the amount of active deposit on the two electrodes, and it is shown that between the pressures of 0·1 mm. and 1 mm. hydrogen behaves differently from air.

Miss I. Homfray detailed a series of experiments on the absorption of argon by charcoal. Miss Homfray finds that a formula of the same type as Bertrand employed for vapour pressures holds for the equilibrium pressures of the absorbed gas at various temperatures and constant concentration. The constants in the equation change with the concentration, and moderately simple equations are obtained expressing the mode of dependence. The resulting equation is much more satisfactory than the experimental formula usually taken.

Sir Oliver Lodge then read a paper on the density of the ether, in which he summarised the arguments for a very high density of the ether which had been given by him in NATURE, March 28, p. 519. His conclusion is that every cubic millimetre of the universal ether of space must possess the equivalent of a thousand tons, and every part of it must be squirming internally with the velocity of light. The latter part of this statement is based on the fact that the existence of transverse waves in the interior of a fluid can be explained only on gyrostatic principles, and the internal circulatory speed of the intrinsic motion of such a fluid must be comparable with the velocity with which such waves are transmitted.

Prof. Trouton showed an electrical experiment illustrating the two modes of condensation of water vapour upon surfaces. If a bell jar be placed over a Bunsen and then placed over a charged gold-leaf electroscope, this often leaks as though the air were ionised. The action is, however, somewhat uncertain. If the insulating shellac of the electroscope is gently dried with a flame, the experiment if made fails, but if the shellac be now moistened and wiped so dry with a cloth as not to conduct, the experiment if made will be successful. The action is therefore due to the moisture, but in the former case it is deposited with difficulty for the same reason that well-dried phosphorus pentoxide absorbs moisture with difficulty.

An important paper was read by Mr. A. O. Rankine on a theoretical method of attempting to detect relative motion between the ether and the earth. If a dumb-bell shaped body shortens in accordance with the Lorentz hypothesis in the direction of the ether drift, its moment of inertia will depend upon its azimuth unless its effective mass changes in a compensating manner. The change in its mass necessary for compensation turns out to be of opposite sign to that which would be indicated by the ratio between longitudinal and transverse mass, as given by any of the current theories. Thus there is either something very wrong in these theories or a real effect arising from motion relative to the ether is theoretically detectable in opposition to the view held by Larmor, Einstein, and others. Unfortunately, it has to be recognised that the effect is too small to be actually detected by experiment. In the discussion Sir Oliver Lodge advised caution amongst the many pitfalls in this difficult subject, and appeared to be in favour of the view that when allowance is made in accordance with a complete theory which holds good for large as well as small velocities, the supposed effect will be found to vanish. Prof. Trouton mentioned another experiment which he was making in collaboration with Mr. Rankine. If a wire changes in dimension with its azimuth, it might be expected that its electrical resistance will simultaneously change. Four coils are connected to form the arms of a Wheatstone's bridge, adjacent arms having their axes at right angles to one another. Balance is obtained, and then the framework on which the coils are mounted is rotated through a right angle. When the temporary disturbance has subsided, the arrangement is again tested for balance. The experiments are in progress, and so far a small positive effect has been obtained, but it requires confirmation before so minute though important an effect can be considered certain.

The afternoon meeting began with a challenging paper by Prof. H. E. Armstrong on the nature of ionisation. This attracted the physical chemists in particular, who appeared with the object of combating Prof. Armstrong's views. These may be summarised as follows:—

We do not "need to imply more by the term *ionisation* than that the medium is in a state in which it will conduct electricity." "The doctrine of electrolytic dissociation is destitute of common sense." Ohm's law is consistent with a modified Grotthus hypothesis. "The assumption that any electromotive force, however small, will condition sensible electrolysis" is a fact which cannot be regarded as established, as it is impossible to avoid some polarisation. Electrolytic conductivity and chemical activity *se confonde* (Arrhenius). Chemical interactions are dependent on "mutual attractive relations of the particles." In effecting hydrolysis in the case of sugars, "enzymes act selectively; therefore their action cannot be attributed to dissociated hydrogen ions." "The mistake has been made that liquids are comparable with gases—a preposterous contention." "'Ionised' molecules are complex, reversible systems formed of solvent and solute under the influence of the force of residual affinity." "As such systems break down under the influence of the current new ones to take their place must arise spontaneously in the solution: the molecules, therefore, would draw one another apart at a rate proportional to the polarisation," and hence Ohm's law would be satisfied. In the discussion Sir O. Lodge emphasised the distinction between the terms "electrolyse" and "ionise." Electrolyse signifies decomposition, ionise means making ready for decomposition, or, if we like, to decompose and to leave the products of decomposition in the fluid instead of getting rid of them at the electrodes. It really means converting a substance into an electrolytic conductor, and for that process the term is wanted. As to the nature of ionisation, the facts to be expressed are that the atoms are perfectly free to travel, that an extremely minute force will set them in motion. They are either free, therefore, or else potentially free. The merest trace of E.M.F. suffices to practically transfer them in one direction. To account for this, we may suppose a certain proportion of the atoms are either continually or persistently free, which is improbable; or that they are constantly interchanging with others, in such a way that they are free between their combinations; or else that they are combined into such a loose and large aggregate that the attraction in all directions is equal—which is really a case of potential freedom barely distinguishable from actual freedom. If the instinct of chemists really prefers this view to the idea of actual dissociation, then great weight should be attached to that instinct, and the aggregation mode of specification should be preferred; but for practical purposes it makes very little difference, and in treating the matter mathematically, actual dissociation is the idea most easily expressible.

He was not surprised that Prof. Armstrong prefers this hypothesis of aggregation, inasmuch as he has for twenty years preached the doctrine of residual affinity as explanatory of solution, of molecular combination, and of many other such things, as distinct from simple and undivided units of valency. Now this doctrine is entirely consistent with the electrical theory of chemical attraction. For the single bond with which, say, sodium is attached to chlorine is, on the electrical view, not a unit of which no fractions are possible, as perhaps it used to be regarded, but a group or bundle of lines of force which can be split up into any number of fractions, a few lines being easily diverted. Thus a few are thrown off to encounter any water molecules which may come into the molecular neighbourhood; and although the attraction of each water molecule for the sodium or the chlorine must be much less than the attraction of sodium and chlorine for each other, yet in a dilute solution, when the water molecules are numerous, the cooperation of a lot of them may exert a pull sufficient to balance the attraction of the atoms of the salt itself, and either actually or potentially to tear the salt molecule asunder. But whether it is really torn asunder or not, or whether it goes about with an aggregate of water molecules hanging on to it, ready to be torn asunder by the slightest addition of applied electric force, is a matter on which as a physicist, at least from the electrolytic point of view, he would express no opinion. It is possible that some of the phenomena now known to physical chemists may afford a criterion for distinguishing between these two extremely adjacent hypotheses. But he wished to testify to the fact that the residual affinity doctrine, when developed in accordance with the electrical theory of chemical action, is a luminous one, and explains, not only the influence of a solvent, but mass action generally; and that we owe a debt to Prof. Armstrong for keeping the chemical reality of the facts thus able to be explained always before us.

As to the objection to thermodynamical reasoning; he should allow that thermodynamics is a method of arriving at results, but it is not ultimately to be regarded as the most satisfactory method. For it does not pay attention to the process by which the results are obtained: it is rather a method of proceeding blindfold, or in blinkers, and reaching the result by an ingenious scheme of argument without attention to the process involved. It is remarkable that reasoning can be carried on in this way, but it is undeniable that so it is.

So far from chemistry being cold-shouldered by physics, it would appear rather to be the other way; and the great interest of the present state of things is that the facts of chemistry, or at any rate the most fundamental of them, seem now able to be tackled by mathematical methods, and to show signs of being more completely understood than ever before.

This is a process which, however puzzling it may be in its early stages, will surely be welcomed by chemists in the long run; and it will be a great day when such an empirical generalisation as the periodic law really yields up its secret to mathematical analysis—based, as that probably will be, on the hypothesis of the electric constitution of the atom.

With all that had been said about Prof. G. F. FitzGerald he heartily concurred, but he seldom or never found himself in disagreement with that great man; and inasmuch as Prof. Armstrong seems to agree with him too, at any rate to a great extent, there appears to be less difference between the physicist and the chemist than might superficially appear.

Meanwhile, we should not avoid the use of the word "ionisation," but should use it carefully, and should determine the nature of the process which it represents.

Prof. Abegg reminded Prof. Armstrong that combination between solute and solvent is admitted by everyone. But this alone does not explain the duplication of the number of molecules which is indicated by any method of counting, such as lowering of freezing point, osmotic pressure, &c. The difficulty felt by some chemists in realising how simple solution should effect such a thorough change of molecular state is lessened if it is recognised that even in the solid state the molecules are often dissociated. Internal friction is the cause of the small conductivity of solids, not want of dissociation. No theory explains the same number of facts as the dissociation theory. Prof. Werner emphasised the necessity for postulating association as well as dissociation, bringing forward his own work on complex inorganic combinations. Without association there is no ionisation. Dr. T. M. Lowry said he had been led to advocate a hydrate theory of ionisation. The molecule does not fall to pieces, but is torn apart by the affinity of the solvent for the ionic nuclei of which the salt is composed (Trans. Faraday Society, July, 1905). Dr. Burch said chemists and physicists had attacked the subject from opposite ends, like engineers driving a tunnel, and the question was whether they would meet in the middle, and he thought they would.

Dr. Senter directed attention to Werner's demonstration that in such compounds as $Co(H_2O)_6Cl_3$ the water was associated with the positive ion, and that it had also been shown that the positive ions of the alkali and alkaline earth salts were also hydrated to a considerable extent in solution (*cf.* Senter, *Science Progress*, January, 1907). He considered that Armstrong's theory that the variation of electrical conductivity with dilution could be accounted for by hydration alone was opposed to the law of mass action; the requirements of this law will be satisfied only if the molecule splits up into two parts which convey the current.

Dr. N. T. M. Wilsmore claimed that the ionisation theory was a growing one, as was indicated by the recognition to-day of the influence of the solvent. Against a Grotthus theory he urged that, since two molecules are involved, the conductivity would vary as the square of the concentration. Dr. Haber inquired how the theory of a concentration cell could be worked out if no dissociation occurs. He also discussed the bearing of solubility, *e.g.* with regard to the decrement of solubility of AgCl by addition of sodium the quantitative relations are the same as we deduce from conduction experiments. He would express the solution of a salt such as sodium chloride by the equation

$$\mathrm{ClNa} + (+)(-) \rightleftharpoons \mathrm{Cl}(-) + \mathrm{Na}(+)$$

where $(+)$ stands for a unit positive and $(-)$ a unit negative charge.

Throughout the discussion the term hydration was employed. We may point out that we believe Prof. Armstrong would not take this term as adequately connoting the formation of the complexes that he postulates.

Two papers were read by Prof. Rutherford, the first on the production and origin of radium, in which he gave evidence that there must be an intermediate substance formed in the derivation of radium from uranium. Sir O. Lodge drew from Prof. Rutherford the statement that he did not know whether or not this substance was radioactive. The second paper, in collaboration with J. E. Petavel, was on the effect of high temperatures on the activity of the products of radium, in which they detailed experiments made with radium inside an explosion chamber, proving that a *sudden* rise of temperature does not affect the rate of disintegration, but that subsequent effects are due to a change as if of B and C together.

In the discussion on the latter Mr. Makower stated that the experiments afforded a confirmation of his own experiments and those made by him in conjunction with Mr. Russ. The only point in which the experiments do not agree with the view that it is radium C which is affected by temperature is that after the diminution of activity succeeding the explosion the rate of recovery is too slow. This might be accounted for by assuming a sudden change in the activity of radium C accompanied by a change in its period instead of assuming a change of activity in both B and C.

Mr. H. Stansfield read a note on the echelon spectroscope and the resolution of the green mercury line, in which the detection of several faint new components is described; and a paper by Mr. L. F. Richardson, on a freehand potential method, had to be taken as read owing to lack of time.

The proceedings on Tuesday, August 6, opened with a discussion on modern methods of treating observations. This was initiated by a paper by Mr. W. Palin Elderton expository of the methods developed by Prof. Karl Pearson. After defining the principal quantities involved in the new methods, the paper dealt with correlation and its calculation. Examples were given examining possible correlation between rainfall in different districts, rainfall and typhoid in Surrey districts, and other meteorological questions. In the case of rainfall and typhoid, the statistics made use of indicated so little correlation that "it is impossible to assert definitely that there is any relation" between them. In the discussion Dr. W. N. Shaw emphasised the present need of a consideration of "departures from the mean." He directed attention to other methods of treating observations besides that of Prof. Pearson; for example, Prof. Schuster's periodogram method and the "method of residuation" adopted by Prof. Chrystal in discussing the component periods of oscillation of the seiches of Scottish lochs. He showed diagrams, prepared in the Meteorological Office, which illustrated the relation of the mean to the frequency of occurrence of the various values. Mr. G. Udny Yule explained that to be content with the arithmetic mean was to neglect all the other characters in which two frequency distributions might differ. The standard deviation was the most convenient measure of "scatter," but the difference between the two values, which were just exceeded by one-quarter and three-quarters of all the observations respectively, was the most readily calculated. The correlation coefficient was a measure of the approach towards a simple linear relation between two variables, and could be extended to cover more complex cases.

Mr. A. R. Hinks, who was somewhat sceptical as to the general applicability of the new methods, inquired what meaning could be attached to the value 0·3 of the correlation coefficient in such cases as $y = \log x$. He also gave an example in which questionable conclusions had been arrived at by the method, the reason being that certain groups of stars had been studied for special purposes, while others had been neglected. The choice of observations introduced a fictitious law of distribution. The discussion was continued by Mr. Hooker, Prof. Turner, and Prof. Edgeworth.

Prof. Hicks then read a paper on the use of calcite in spectroscopy. In order to be able to make use in spectroscopy of the large dispersion in the ultra-violet produced by calcite, Prof. Hicks first polarises the light in order to do away with the duplication of the spectral lines. When a quartz lens is employed in the collimator it is made a compound lens of right- and left-hand quartz; the polariser for very short wave-lengths (down to λ 2300) was a small Foucault fixed like a comparison prism. The Hon. R. J. Strutt pointed out the great advantages that fused quartz would have.

A series of papers on astronomy and cosmical physics were now taken. Dr. O. Backlund detailed the work done in determining the variation of latitude. Dr. W. N. Shaw read a paper on some recent developments of the method of forecasting by means of synoptic charts. These are the methods of M. D. Gréville, of Paris, and M. Guilbert, of the Meteorological Society of Calvados, for obtaining an approach to a second approximation in forecasting weather. Mr. C. Michie Smith gave an account of the Kodaikanal Observatory in South India. The Rev. A. L. Cortie, S.J., read a paper entitled "The Variability in Light of Mira Ceti and the Temperature of Sun-spots," the purport of which was to indicate the relatively low temperature of sun-spots from the behaviour of the bands of titanium oxide in *o* Ceti, when the star is at two different temperature levels represented by a whole magnitude in luminous power. Concomitant evidence of the variation of temperature of the star was furnished by the character of the hydrogen lines.

Prof. H. H. Turner read a paper descriptive of a method which is being tried at Oxford for improving the constants of the plates for the Astrographic Catalogue. He also read one on the determination of periodicity from a broken series of maxima. For example, observations of the light curve of a variable such as U Geminorum are generally absent altogether near a minimum, and cannot be supplied; moreover, the maxima are often lost from cloudy weather, &c. The paper suggests a method of examining these for the detection of periodicity. Let E_1, E_2, E_3 be the epochs of maxima. Find the differences between these and the *nearest* theoretical maxima E_0, $E_0 + 2n$, $E_0 + 4n$, &c., where $2n$ is a period to be tried. Find (*a*) the algebraic mean of these differences, (*b*) the sum of their squares. In certain circumstances (*b*) should be a minimum when we have hit on a real periodicity. If (*a*) comes out sensibly different from zero, we must alter E_0 until (*a*) is small enough. When there is no periodicity near $2n$, (*b*) will approximate to $mn^2/3$, m being the number of maxima treated. Miss M. White, T. V. Pring, and J. E. Petavel communicated a note on an analytical study of the meteorological observations made at the Glossop Moor kite station during the session 1906–7, and a preliminary note by W. A. Harwood and J. E. Petavel was read on the recent international balloon ascents (Manchester station). A paper by T. J. J. See, on results of recent researches on the physics of the earth, was taken as read.

Meanwhile, the mathematical department had been meeting separately, continuing the group of papers on the elements of analysis with one by Dr. W. H. Young on the introduction of the mathematical idea of infinity. Dr. Young stated that, of the three types of mathematics, viz. the logical, formal, and practical, his sympathies were with the first and third rather than with the second. He pointed out a number of instances in which learners were brought into contact with the notion of infinity, and advocated the policy of boldly facing the difficulty instead of trying to avoid it. A paper by Mr. C. O. Tuckey on the teaching of the elements of analysis unfortunately had to be cut short owing to lack of time.

Mrs. Boole-Stott exhibited a series of beautifully constructed models of three-dimensional sections of regular hyper-solids in four dimensions, and models illustrating the rotation of a four-dimensional body about a plane. Prof. Schoute showed some lantern slides in connection with this subject. He also exhibited three models of developable surfaces the tangent planes of which are given by the equations

$$u^3 + 3u^2x + 3uy + z = 0$$
$$u^4 + 6u^2x + 4uy + z = 0$$
$$u^6 - 15u^4 + 15u^2x + 6uy + z = 0$$

and indicated certain results when the parameter u in the equation of the plane occurs to a higher degree. Prof. A. M. Worthington showed a series of slides, directing attention to the fact that the impact of a drop excavates a perfectly spherical hollow which reaches its greatest depth at apparently the same time that the water thrown up attains its maximum height. The volume of this pit is enormously greater than that of the drop. The object of the paper was to obtain suggestions from mathematicians explanatory of this phenomenon, but none were forthcoming. Prof. Hilton gave an account of a new property of Abelian groups, and Lieut.-Colonel A. Cunningham read a paper on the factorisation of the terms τ_n, v_n, of the Pellian equation $\tau_n^2 - Dv_n^2 = 1$.

Besides these papers, reports were presented by various committees nominated by the section. Owing to the plethora of papers, these, as a rule, were taken as read, printed copies being distributed to members present.

The committees presenting reports were those denoted by their well-known abbreviated names of "electrical standards," "kites," "Ben Nevis," "Bessel functions," "teaching of elementary mechanics," "Falmouth," and "seismology." An account was given of the last by Prof. Milne.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE most noticeable feature about the proceedings of the Anthropological Section was the great predominance of papers of an archæological character, those on physical anthropology and general ethnography being far fewer in number than usual. The general level of the papers was, however, quite up to the usual standard, and several of the communications were of the first importance.

As the archæological papers were so much the more numerous, it may be advisable to deal with them first. On the Monday morning an important discussion on the Iron age was initiated by Prof. Ridgeway in a paper on the beginnings of iron. He argued that Central Europe was the true centre of the use of iron as a metal, and that it was first diffused from Noricum. He considered that the general opinion as to the early knowledge and use of iron in Egypt is explained by the fact that hæmatite was known and used, but that it was not treated as a metal, but as a stone. That iron was worked from a remote period in Central Africa he considered unlikely, as it only became known for the first time in Uganda some five hundred years ago, and there was no reason to suppose that it was worked much earlier in the more central part of the continent. As it was also certain that the peoples beyond the Caspian and along the shores of the Indian Ocean did not use iron until a late date, it seemed clear that its use as a metal was due to Central Europe.

In the discussion which followed Prof. Edouard Naville drew a distinction between the knowledge of iron and its general use. Referring to the two or three cases of iron being found of the time of the Old Empire, he pointed out that, in spite of this, it did not seem to be in common use under the New Empire, and that no iron tools were discovered in the Deir el-Behari excavations. His own feeling was that the general use of iron in Egypt was not anterior to Greek times.

Prof. Petrie emphasised the necessity of keeping clearly in view the distinction between the general and sporadic use ot iron. Iron was known for 4000 years before its use became general, and this sporadic use strongly supported Prof. Ridgeway's views of the use of iron in its native state, as, had processes of reduction been known, it was unlikely that it would have taken 4000 years for its adoption to have become general.

Prof. J. L. Myres argued that there was no logical connection between Prof. Ridgeway's view that the knowledge of iron, as a useful metal, spread from a centre in Noricum and his assumption that the question of the early Iron age in Europe was that of the first use of iron at all. He pointed out that materials, for example tobacco and gunpowder, were not infrequently looked upon as mere curiosities in one area, and that their real utility was not discovered until they were transferred to another district. He also dwelt on the effect which the introduction of the blast furnace from the north must have had upon the output.

Mr. Arthur Evans considered that the great objection to Prof. Ridgeway's theory was the comparatively late date of the Iron-age civilisation of Hallstatt. Earlier phases are seen in southern Bosnia, and still earlier in the geometrical and sub-Minoan tombs of Greece and Crete. He considered that the general adoption of iron in the countries of the Ægean corresponded with the break-up of the earlier Minoan and Mycenæan type of culture.

Prof. Bosanquet felt that a great difficulty in the way of accepting the views of Prof. Ridgeway was the impossibility of testing the theory that the general use of iron had made its way into Greece from the north, owing to the very little available evidence as to Bronze-age culture in Macedonia and Epirus.

Mr. Crooke considered that India may have been the seat of an independent discovery of the metal.

As usual, Egypt took a prominent place in the proceedings, and the section had the advantage of numbering Prof. Naville among those who read papers. Besides giving a descriptive account of the excavations at Deir el-Bahari, which have now been brought to a satisfactory conclusion, Dr. Naville read an important paper on the beginnings of Egyptian civilisation. The conclusion at which he arrived was that the Egyptians were a nation formed of a mixture of Hamitic conquerors from Arabia settling among an indigenous stock of Hamitic-African origin, an amalgamation made the easier as both races were of the same stock and had no religious differences. Prof. Petrie also gave a paper to the section describing the excavations carried out by the British School of Archæology, under his direction, at Gizeh and Rifeh. In this communication he described the interesting series of pottery soul-houses, found on the latter site, which are of great importance apart from their religious significance as showing the design and evolution of the ordinary Egyptian house, about which little had previously been known.

Greek archæology was dealt with in papers by Prof. Bosanquet and Mr. R. M. Dawkins. Both of these papers dealt with the work now in progress at Sparta, but while Mr. Dawkins gave a general description of the excavations, Mr. Bosanquet dealt especially with the scourging of the Spartan boys before the altar of Artemis Orthia, which was shown by the excavations to have occupied the same position for more than a thousand years. Prof. Bosanquet traced the history of the scourging festival, and showed that the cruel whippings described by Roman writers are an artificial revival of an old discipline which apparently originated in a rough game played by the Spartan youths, in which at first there was no element of passive endurance so characteristic of the later ordeal. This game itself seems possibly to have originated in a still earlier custom, in which the lads hit each other, for luck, with boughs cut from the sacred tree, the *Agnus castus*.

The recent expedition undertaken by the University of Liverpool to northern Syria and Asia Minor was described by Prof. Garstang. The work done was of very great interest, the most important find being what is apparently an altar of dedication, similar to those discovered in Crete. Many inscriptions were also found, as well as a large sculpture of an eagle standing on three lions.

In English archæology Dr. Auden described a series of objects, referable to the Viking age, recently discovered at York. Several of the objects have not previously been reported as occurring in England, and amongst these the brass chape of a sword scabbard, with an interlacing zoomorphic design, is of peculiar interest. The general consensus of opinion is that the finds may be referred to the first half of the tenth century, at which time Scandinavian influence in York was at its height.

The progress of the excavations at Caerwent, including the discovery of the Forum and Basilica, was described by Dr. Ashby, who also, in a paper on Sardinia, directed attention to the *nurhagi* or stone towers and their resemblance to the brochs of Caithness.

Another important archæological paper, dealing, however, with a very different area, was one in which Dr. Seligmann and Mr. Joyce described a series of prehistoric objects from New Guinea. The objects described consisted of stone weapons, engraved shells, and pottery, and are truly prehistoric, inasmuch as the present natives do not know who made them, and in some cases cannot even say for what purpose they were made. It is interesting to note that some of this prehistoric pottery is superior both in make and ornament to that now in use among the natives.

The most important papers on physical anthropology were those by Mr. Gray and Dr. Shrubsall, which opened the discussion on anthropometrics in schools. This discussion was held conjointly with Section L (Educational

Science), and will be found fully reported in the account of the proceedings of that section. Apart from these two papers, the most noteworthy contribution was one by Messrs. James and Fleure, giving an account of the progress of the University of Wales Ethnographical Survey. It is hoped to extend the survey to all the purely Welsh people, but at present only a limited area has been examined. Still, the results, although purely tentative, are very striking, and the population of the district examined may be said to fall into four distinct groups, of which two may be provisionally identified with *Homo mediterraneus* and the "Northern Race." The survey which has been so auspiciously started is one from which most important and valuable results may be expected, and it is to be hoped that the work will be energetically pushed forward, as the population is rapidly changing, and in a comparatively few years it may be too late.

In papers dealing more or less with ethnography, Mr. J. W. Crowfoot directed attention to the importance of the Anglo-Egyptian Sudan as a field for anthropological research. A great part of the district is virgin soil, and only waits the advent of the anthropologist to produce most important results, while in the northern Sudan the dervish rule has completely changed the conditions, whole tribes having been devastated, transplanted, or mixed with foreign blood. Still, the three main language groups remain, but the problem of the origin of the people using them still awaits solution. It is a matter for regret that Dr. Pirrie was unavoidably prevented from giving his promised account of the Buruns, as his observations would have had an important bearing on Mr. Crowfoot's paper.

Apart from the president's address, on "Religious Survivals," which has been reported in NATURE, the only paper dealing purely with religions was Dr. Farnell's criticisms of Dr. Usener's theories concerning Sonder-Götter and Augenblick-Götter. The divinities of which Dr. Usener treats are those which have no proper personal names, but mere appellatives, to express their functions. Such divinities are found in the Roman and Greek cults, and a few examples have been noted among savage peoples. The system may be regarded as a peculiar form of animism. Dr. Usener's theory assumes that these divinities are relics of a very primitive period, when imagination had not created concrete personal divinities, and that the Greek Pantheon was deeply indebted to this system. Dr. Farnell argued that the Greek evidence did not support these assumptions, and that many of these Greek appellative *numina* may be creations of personal polytheism, mere emanations of concrete divinities.

The subject of totemism was dealt with by Mr. G. L. Gomme in a paper on its origin. Mr. Gomme was of opinion that totemism must have arisen from conditions of human life which are universal, and which are probably supplied by migration. Sex cleavage was produced by the fact that woman was the stationary animal, and in this way became more closely associated with friendly animals, plants, &c., to which she looked for protection and food rather than to the male, who constituted a migratory element; women thus influenced the totem names. Mr. Gomme's conclusion was that totemism began as an artificial association of groups of people, and was not based on a kinship society.

Sociology was also dealt with in two papers by Dr. Rivers, one criticising Morgan's Malayan system of relationship, and the other offering some most valuable suggestions for the definition of the technical terms used by anthropologists, especially with regard to the divisions of society and marriage and descent. He urged the importance of the terms used being strictly defined, and also the necessity of some general agreement in their use being obtained.

A most suggestive technological paper was one by Prof. J. L. Myres on a terminology of decorative art. The necessity of arriving at a terminology was strongly emphasised, as persons would thus be enabled to describe by some recognised terms the arrangement and *motif* of any pattern in the same way as the herald is able to describe, without graphic illustration, the colours and component parts of any coat of arms, however complicated. The basis of any such system must be strictly technological; it must be a description of what the artist did, of the order in which he did it, and of the effect produced, and all minor elements in the design must be located by reference to the major element on which they are based. Such a terminology must, of course, be elaborated gradually, but Prof. Myres's valuable suggestions should serve as an admirable basis on which the work may be built up, and it is to be hoped that all persons interested in decorative art will assist him in his efforts to arrive at a sound scientific terminology, the practical value of which cannot be overestimated.

Attention was directed by Mr. Newbery and Dr. Bryce to what is practically an unworked field, namely, the so-called "door-step" art of the west of Scotland. The patterns, which are drawn solely by women, are of great variety, are purely geometrical and conventional, and are used to decorate doorsteps, hearths, &c. The drawings are very primitive, and represent an early stage of artistic evolution. Mr. Newbery was of the opinion that the designs were the expression of a primitive art instinct, but since they are traditional in character, being handed down from generation to generation, it seems more likely that they are a survival. However this may be, there can be no question as to their interest, both in themselves and as a field for research. Another paper of interest to which passing reference may be made was one in which Prof. Ridgeway sought to identify the origin of the crescent as a Mohammedan badge, not with the young moon, but with the well-known amulet of two boar's or other animal's claws or tusks set base to base in crescent form.

Amongst the reports of committees, reference should be made to that appointed to excavate the Lake Village at Glastonbury, which hopes to be able to complete its long work this month (August), and to the Stone Circles Committee. This committee was able to make the announcement that it had received permission to conduct excavations in the Avebury Stone Circle, from which important results cannot fail to be obtained, results which should go far towards accomplishing the object of the committee, namely, to ascertain the age of these structures.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—University College: In consequence of the removal of University College School to Hampstead, the south wing of the college buildings has been set free for university purposes, enabling the following developments to take place, beginning with the new session:—In the mechanical engineering department a new hydraulic laboratory will be provided in the basement, and also additional space for experimental work in mechanical engineering during the second and third years. A separate laboratory will be set aside for research work, thereby leaving the main laboratory entirely free for undergraduate work. In the department of electrical engineering, the present lecture-room will be replaced by a large new lecture-room with a small demonstration class-room adjoining it. The old lecture-room will be fitted up as an experimental room for advanced students. The electrical engineering department will also contain a research laboratory with apparatus and preparation rooms adjoining. The department of applied mathematics will also receive considerable extensions, providing two special research laboratories and ample accommodation for the work being carried on in the Galton Eugenics Laboratory. New accommodation will be provided for the department of geology, and include a museum, with a research room, and a lecture-room suitably equipped with lantern apparatus. Applications for the prospectus should be made to the secretary of the institution.

LORD KELVIN will open the new science buildings of Queen's College, Belfast, on September 20.

A COMMITTEE has been formed to promote the raising of a memorial to the late Major D. M. Moir, I.M.S., professor of anatomy at the Medical College, Calcutta, who died of septicæmia contracted in the execution of his public duties. It is hoped that sufficient money will be obtained to found a prize or to endow a bed, after providing for a tablet and portrait in the college hospital. The treasurer of the fund is Dr. Suresh P. Sarbadhicary, 79, 1 Amherst Street, Calcutta.

The Paris correspondent of the *Lancet* states that the Governor-General of Algeria has brought a proposal for the founding of an Algerian university before the financial delegates, who have adopted it. It will be remembered that the late M. Moissan and Prof. Bouchard, having inspected the secondary schools in Algiers, reported favourably on the founding of a university. They proposed the establishment of an institute of natural science, experimental botany, zoology, and hygiene, and pointed out the political and social effects of the foundation of a university which would form a powerful link between the various races which form the population of Algeria.

The secondary and agricultural school at Bigods Hall, Dunmow, which was established by Lady Warwick ten years ago to provide a scientific education in agricultural affairs for the boys and girls of the district, is to be closed. The Earl of Warwick, in a letter to the chairman of the Essex Education Committee, explains the reasons for the taking of this step. He states that, although the county committee has given the school a grant, it has intimated the possibility of a re-consideration of the educational necessities of the locality, and the headmaster has received the offer of another appointment; complaint is also made that the school has suffered from a lack of cordial support from the committee.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, August 19.—M. A. Chauveau in the chair.—Presentation of vol. xiii. of the *Annales de l'Observatoire de Bordeaux*: M. **Lœwy.** This volume contains an account of the work done at Burgos on the total eclipse of the sun of August 30, 1905, by MM. Rayet and Courty, also actinometric observations made by M. Esclangon at Bordeaux, from a balloon, on the same occasion. The observations made during 1899 and 1900, forming the contribution of the Bordeaux Observatory to the photographic catalogue of the sky, are also given.—Symmetrical dimethylethylene oxide, $CH_2—CH—CH—CH_3$:

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Louis **Henry.** A study of the reaction between this oxide and methyl-magnesium bromide. The tertiary alcohol, $(CH_3)_2.C(OH).C_2H_5$, is formed exclusively, from which it follows that this substituted ethylene oxide behaves towards the magnesium compound as though it were first converted into the isomer $CH_3.CO.CH_2.CH_3$.—The comet 1907*d*: Ernest **Esclangon.** Observations with the large equatorial of the Observatory of Bordeaux on August 1, a specially clear night, brought out many details of the comet's structure. The nucleus was brilliant, sensibly circular, and appeared like a star of 5·5 magnitude. No scintillation was noticed, from which it may be concluded that the nucleus has a real sensible diameter, corresponding to the apparent diameter of the image of about 8″. Combining this with the known distance from the earth, the nebulosity forming the head would have a diameter about thirteen times that of the earth. The structure of the tail of the comet is shown in a figure.—The results of observations made at Cistierna, Spain, during the total eclipse of the sun on August 30, 1905: A. **Lebeuf** and P. **Chofardet.** Clouds interfered with observations during totality, but measurements were made of the first and fourth contacts, a reduction of these measurements being given.—The variations of the absorption bands of crystals of parisite and tysonite in a magnetic field at the temperature of liquid air: Jean **Becquerel.** The magneto-optical properties of two crystals of the same family present close resemblances, but with marked difference in details. From the behaviour of the bonds in parisite it is concluded that either there must be an inversion of the magnetic field in certain parts of the interior of the crystal, or positive and negative electrons must exist simultaneously.—The motion of electricity without action between the electric charges and without external forces: T. **Levi-Civita.**—Some modifications which produce the splitting up of the curve of rate of decay of induced radio-activity: Ed. **Sarasin** and Th. **Tommasina.**—The atomic weight of radium: Mme. **Curie.**—The disengagement of the emanation by radium salts at various temperatures: L. **Kolowrat.** It is known that the quantity of emanation produced in unit time is constant. When the salt is in solution, the whole of the emanation is evolved, but in the solid state a part remains in the salt. The author confirms the observation of J. Curie and J. Danysz, that when the radium salt is fused the whole of the emanation is given off. At a fixed temperature the quantity of emanation obtainable from a salt previously deprived of its emanation in a given time is a function of the temperature. It results from this work that, in the application of the method of heating to the estimation of radium in minerals or other solid substances by the disengagement of the emanation, it is absolutely necessary to fuse the material.—The dissociation of calcium carbonate: D. **Zavrieff.** A repetition of the work of H. Le Chatelier, especial care being taken to secure uniformity of temperature. The dissociation pressures are given for six temperatures ranging between 815° C. and 926° C.—The alloys of nickel and tin: Em. **Vigouroux.** Alloys containing between 57·65 per cent. and 66·76 per cent. of tin treated with hydrochloric acid leave residues richer in nickel, approximating to Ni_3Sn_2; treatment with nitric acid, on the contrary, gives alloys richer in tin, tending towards NiSn. All these alloys are brittle, brilliant, and non-magnetic.—Study of the alloys of cobalt and tin: F. **Ducelliez.** Alloys containing less than 50 per cent. of tin behave as mixtures of cobalt and Co_3Sn_2, the latter remaining when the alloys are subjected to the action of dilute nitric acid.—The action of some substances upon potassium iodide: B. **Szilard.**—A new and very sensitive method for the qualitative detection of nickel: Emm. **Pozzi-Escot.** The method is based on the fact that molybdate of nickel is insoluble in presence of an excess of alkaline molybdate, whilst cobalt molybdate is very soluble under the same conditions.—The preparation of unsymmetrical halohydrins and the properties of the corresponding ethylene oxides: MM. **Fourneau** and **Tiffeneau.**—Rhinanthin: Marcel **Mirande.**—The ichthyological fauna and the age of the shell marls of Pourcy (Marne): Maurice **Leriche.**

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THURSDAY, SEPTEMBER 5, 1907.

MARIGNAC'S COLLECTED PAPERS.

Œuvres complètes de Jean-Charles Galissard de Marignac. Edited by E. Ador. In two vols. Vol. i. (1840–1860), pp. lv+701, with a portrait; vol. ii. (1860–1887), pp. 839. (Geneva: Ch. Eggimann et Cie.; Paris: Masson et Cie.; Berlin: Friedländer und Sohn.)

AMONG the great chemists of the nineteenth century, and especially those engaged with inorganic chemistry, Jean-Charles Galissard de Marignac takes high rank, and in the notable advances which were made in chemical science during his lifetime he played a conspicuous part. The pride which his native city felt in his long and fruitful career has found expression in this sumptuous edition of his published papers, a worthy monument to the untiring energy that characterised him all his life so long as strength remained. It has been issued under the auspices of the Société de Physique et d'Histoire naturelle. The editing has been entrusted to the capable hands of his son-in-law and, for a time, colleague, Prof. E. Ador, who has executed what was evidently a labour of love with reverent care, and has contributed the interesting sketch of the life and works of Marignac which prefaces the first volume.

Marignac's personal life seems to have been singularly uneventful. Sprung from a French family which had settled in Geneva early in the eighteenth century, he was born in that city in 1817. With the view of entering the French service as a mining engineer, he underwent the course at the École polytechnique at Paris, and in accordance with the enlightened custom that prevailed in that country was dispatched at the end of his training on a scientific mission to foreign countries in order to study their methods. While at Stockholm he made the acquaintance of Berzelius, and there can be little doubt this meeting had a profound influence on the course of his life and turned his bent more definitely towards chemistry. At any rate, when, soon after his return to France, he was offered the chair of chemistry at the Academy of Geneva, he, despite the, from a worldly point of view, far better prospects that awaited him in France, accepted the offer without hesitation; and, as it turned out, he filled the post for thirty-eight years, until in 1878 failing health compelled him to tender his resignation.

It is pleasant to note the sympathetic consideration which Marignac experienced from the French Government. He was permitted to vacate his post and yet to retain the title of Ingénieur des Mines, and in the course of his letter the Minister of Public Works remarked:—

"Le gouvernement français ne peut voir qu'avec faveur que le gouvernement de Genève vienne chercher en France les hommes auxquels il confie le soin de répandre les lumières de la science, et, en remplissant avec distinction le poste qui vous est confié, ce sera encore un service indirect que vous rendrez à la France."

Shy and retiring by nature, he seemed to find happiness only in his laboratory; indeed, it was with considerable reluctance that he tore himself away for a few days at the time of his marriage. To quote Prof. Ador:—

"Marié en 1845, c'est à peine s'il consent à s'éloigner pendant quelques jours de son laboratoire; il emporte chaque matin un petit pain qu'il dévore à la hâte, ne pouvant se décider à interrompre ses travaux au milieu du jour";

a picture of a thinker, absorbed in his work and almost oblivious of every-day life. He shunned any position which brought him before the public gaze, and to the end found it irksome to lecture before a fresh generation of students.

The conditions under which most of Marignac's work was performed would be rather a shock to those accustomed to the greater luxury of these latter days. His laboratory is described by Prof. Ador thus:—

"Cette méchante cuisine enfouie dans le sous-sol, sombre en plein midi, avec ses cornues de grès ou de verre qui lui donnaient l'air d'une officine d'alchemiste."

Yet amid such forbidding surroundings were carried out elaborate researches with a care and completeness such as would be with difficulty surpassed at the present day even with the advantage of the improved apparatus now available. More commodious premises were eventually provided in 1873 when the academy was transformed into the university; but not long afterwards he was compelled to retire, and, although for a few years he continued work in his private laboratory, his strength at length failed so completely that he was practically confined to his couch. He died in 1894. The excellence of his work was recognised by the numerous honours conferred upon him; among them we may note that he was elected in 1881 a corresponding member of the Royal Society, and received in 1886 the Davy medal.

At the time when Marignac went to Geneva, the atomic weight of few of the elements had been at all accurately determined, and although some confidence might be felt in the numbers obtained by such a master as Berzelius, it was imperative that they should be confirmed by independent investigators and by other methods. There was at the time considerable speculation as to the question of the rigid application of Prout's law. Perceiving the pressing need for further trustworthy determinations of these fundamental data, on which the whole fabric of chemical science is based, Marignac resolved to devote his scientific energy to this important investigation. As was pointed out by Stokes, the president of the Royal Society, when bestowing on him the Davy medal, his work was the more important since he gave so much of his attention to the atomic weights of the more common elements on which the determination of new atomic weights is generally made to depend. In the whole of his researches he exercised the greatest care in considering the possibilities of error which might have occurred in the operations of previous workers, and displayed more than ordinary ingenuity in devising new methods to avoid such errors, and at the same time he paid particular attention to the necessity of employing the purest material in such work. He was never satisfied with even repeated experiments on different amounts by the same method, and always, whenever practicable, adopted two or more independent methods. If we include those elements which he did not completely study, he determined the atomic weights of no fewer than twenty-nine of the elements, and in nearly every case his numbers differ little from those now adopted —a remarkable feat for one man working without any assistance. In the course of his investigations he analysed certain of the minerals containing the rare earths, and succeeded in separating two new elements, ytterbium from gadolinite and gadolinium from samarskite.

The process of time has brought it about that much of his work begins to have mainly historical interest, and probably at the present day most chemists will feel more vivid interest in researches which were to some extent incidental to the principal investigation. Prominent among these is his elaborate work relating to the intricate and puzzling problem in analysis presented by titanium, niobium, and tantalum. So difficult is the separation of these three elements, when occurring together in the same substance, that many eminent chemists have imagined the existence of other elements; for instance, Hermann strongly insisted on the presence of ilmenium in samarskite, but Marignac showed it to be really a mixture of niobium and tantalum. Although it cannot be said that he solved the problem with complete success, yet Marignac was the first to devise a method—the differing solubilities in hydrofluoric acid of the double fluorides of the three elements with potassium—which effected any real separation, and which to this day has not been superseded by any more satisfactory. The problem is one that still awaits solution, and is occupying the attention of many chemists. It is of interest to note that, in recognition of the method devised by him, the name marignacite was recently assigned by Mr. Weidman and Mr. Lenher to a variety of pyrochlore from Wausau, Wisconsin. Of little less vivid interest is his comprehensive investigation relating to the formula of zirconia and the atomic weight of the element. He made use of the law of isomorphism propounded by Mitscherlich, of which he was early a keen advocate, and undertook a complete chemical and crystallographical examination of a large number of fluozirconates. None of his experiments lent any confirmation to the idea put forward by Svanberg that zirconia contains three distinct metallic oxides. Nevertheless, the question is one deserving of further consideration. Prof. Church and other observers have noted a remarkable range in the density of zircons, 4·0 to 4·7, and an even more remarkable alteration in the density effected in certain stones of low density by the application of heat, and the conclusion has been drawn that there are three varieties of zircon. Further, the crystallised native zirconia, baddeleyite, presents almost as wide a range of density, which is even more difficult to understand in the case of an apparently simple oxide. It is possible that zirconium has never been completely isolated; it is well known that a satisfactory method for separating it from titanium has yet to be found.

Marignac found time to examine the chemical and crystallographical characters of a large number of minerals, and also of artificial salts prepared by him in the laboratory. The sentence with which he opens one of his elaborate papers is indicative of the thoroughness characterising his work, and embodies a maxim which even now is by no means universally appreciated by chemists:—

"L'intérêt que présente l'étude des formes cristallines des divers composés chimiques, m'a engagé à ne jamais négliger de déterminer exactement les formes de ceux qui s'offraient à moi, en cristaux déterminables, dans le cours de mes travaux de laboratoire."

Towards the end of his career his attention was attracted to the physical side of chemistry, and he carried out with his customary skill and care a lengthy series of thermochemical determinations; unfortunately, the complete collapse of his physical vigour brought his work to a premature close. To his other investigations—for instance, on ozone—space will not permit us to allude.

As regards the appearance of the volumes, the quality of the paper and the style of the printing are beyond criticism, and care has been taken to indicate the original pagination. Most of the papers were published in the *Bibliothèque Universelle de Genève* or the *Annales de Chimie et de Physique*; those dealing with mineralogical subjects appeared in the *Annales des Mines*.

THE BLOOD-SUCKING GNATS.

A Monograph of the Culicidae or Mosquitoes. Mainly Compiled from Collections received at the British Museum. Vol. iv. By F. V. Theobald. Pp. xix+639; 16 plates. (London: Printed by order of the Trustees, 1907. Sold by Longmans and Co., B. Quaritch, Dulau and Co., and at the British Museum [Natural History].) Price 1*l*. 12*s*. 6*d*.

THIS work forms the second supplementary volume to Mr. Theobald's original monograph of the Culicidæ of the world, in two volumes, published by the trustees of the British Museum in 1901. The present volume deals very largely with the new species which have been added to the national collections, and besides these it also embodies the descriptions of one hundred and sixty species which have been described by various authors since the issue of the first supplementary volume in 1903.

It would be difficult to overestimate the great scientific value of Mr. Theobald's most exhaustive faunistic work on these insects. It is a model of painstaking scientific accuracy, and we congratulate him on its issue.

With the exception of the adoption of a few characters in an admirable scheme of general classification drawn up by Dr. Lutz, no changes have been made in this volume. The Corethrinæ have, however, been excluded from the Culicidæ and raised to family rank, partly on account of the asiphonate character of the larvæ, but mainly by the absence of piercing mouth-parts and of scales in the adults.

Felt's[1] new method of classification, based upon the genital armature of the males and the wing venation, is discussed at some length, but abandoned as unpractical on the grounds (1) that the majority of known mosquitoes are females only, and thus we should not be able to place many of our well-known species in any genus; and (2) that the cross-veins in the venation of the wings are subject to so great a variation that generic characters cannot be fixed by them. The author also points out that Messrs. Dyar and Knab's[2] unusual classification of the Culicidæ by larval characters only cannot be admitted. We need scarcely point out that any radical changes in the classification of these insects will result in endless confusion, especially so if based mainly upon local knowledge; and as practically all British, French and South American doctors and entomologists have adopted the Theobaldian classification, anything more than a modification of this system would be followed by somewhat disastrous results, especially among the students of the medical profession who are engaged in the study of the Culicidæ in connection with tropical diseases.

In the general notes we find a reference to Major Adie's evidence as to the benefit of *Lemma minor*, L., as a means of preventing mosquitoes from laying their eggs on water. He states that "tanks covered with this flat weed never contain larvæ of Culicidæ, whilst others at the same time of year are full of them." This genus of plants has apparently the same marked effect upon the frequency of both Anopheles and Culex in this country.

The natural reservoirs formed by the flowers of *Heliconia brasiliensis*, Hook., in Ceylon, the leaves of Nepenthes and various Bromeliaceous plants and the cut ends of bamboo in South America, are given as the breeding places of both Anophelines and Culicines. Mr. E. E. Green, of Ceylon, has contributed some notes on *Myzomyia rossii*, Giles, which he found breeding in the brackish lake at Batticaloa. There are also some interesting notes on the bionomics of *Nyssorhynchus fuliginosus*; but apart from these and a few other references to the habits of mosquitoes, very little is known of the earlier stages of a large proportion of the Culicidæ, so that those who have the opportunity of observing these insects have the pleasure of discovery before them.

In a work which has been so admirably performed, it is invidious, perhaps, to direct attention to any errors either of omission or commission, but we note that Patton's[3] important ~~~er in which he describes five new species of Anophelinæ has been quite overlooked, nor do we find any reference to Grünberg's[4] new Anophelines described in 1905.

[1] Bull. 79, Ent. 22. New York State Museum. (1904.)
[2] "The Larvæ of Culicidæ classified as Independent Organisms." Journ. New York Ent. Soc., vol. xiv., pp. 169–230. (1906.)
[3] Journ. Bombay Nat. Hist. Soc., 1905.
[4] Zool. Anzeiger, Bd. xxix., No. 12, September, 1905.

Myzomyia hebes, Dönitz (p. 42); *Cellia punctulata*, Dönitz (p. 109); and *Howardina chrysolineata*, Theob. (p. 218), are all omitted from the synoptical tables; while *Pyretophorus pitchfordi*, Power (p. 72), and *Nyssorhynchus indiensis*, Theob. (p. 98), are omitted both from the synoptical tables and the lists of species given under the respective genera.

Myzomyia listoni, Liston, is given priority on pp. 41, 43, but is sunk to the position of a synonym of *M. christophersi*, Theob., on p. 51. Under *Culicada fitchii*, Felt and Young (p. 321), Fig. 112 is described as *Grabhamia fitchii*; there are also some minor errors in the text, evidently printer's. R. N.

COMMERCIAL ORGANIC ANALYSIS.

Commercial Organic Analysis. By A. H. Allen. Vol. ii., part iii. Pp. xii + 547. Third edition, re-written and revised by the Author and A. R. Tankard. (London: J. and A. Churchill, 1907.) Price 20s.

WITH the publication of this volume, the whole of this standard work on the analysis of organic materials occurring in commerce is again available in a revised form. The preparation of this portion was undertaken by Mr. Allen so long ago as 1898, but, owing to his ill-health, little progress was made, and after his untimely death in 1904 the completion of the book was undertaken by Mr. Tankard.

The recent considerable additions to our knowledge of volatile oils, rubbers, gutta-perchas, and resins, the four principal groups of products now dealt with, have necessitated extension of the space devoted to these subjects in previous editions. As regards resins and volatile oils the author was assisted by Mr. E. J. Parry, and in the preparation of the article on oil of turpentine Mr. Archbutt was consulted, whilst Dr. Leffmann, of Philadelphia, contributed a portion of the section on aromatic acids and their hydroxy-derivatives.

The method of treatment adopted is to give a short critical *résumé* of the present position of the chemistry of each product, followed by a summary of the analytical methods available for its examination, one or more of these being finally recommended as giving trustworthy results in the author's own experience.

In spite of the care which has evidently been taken to secure accuracy in the information given, the specialist will be able to find here and there in the sections in which he is particularly interested statements requiring emendation or amplification. Thus the important matter of the botanical sources of rubber should not have been dismissed in the statement that it is "obtained from the latex of trees growing in S. America, Africa, India, &c.," supplemented by the inaccurate footnote, "A *new* source of caoutchouc has been recently discovered in the root-bark of *Landolphia thrallonii*, a plant growing in Lower Guinea and the French Congo." The statement that gutta-percha occurs in the latex of various trees belonging to the Sapotaceæ (*e.g. Palaquium pustulata* and other species) is all the information vouchsafed regarding the source of this important product, and is misleading since the best gutta is obtained from *Palaquium gutta*, *P. pustulata* yielding an inferior product of little commercial value. There is a reference on p. 384 to "Spanish oil of hops" or "Cretan oil of marjoram," described as obtained from *Origanum hirsutum* and *O. creticum*. This appears to refer to the material better known in this country as "Cretan origanum" or "red thyme" oil, which is generally believed to be obtained from *Origanum hirtum*. The tabular statement of the constituents of volatile oils is incomplete in some respects; thus, under "basil oil," there is no reference to the terpene ocimene isolated by van Romburgh from this source in 1901; and the information given under the head of "applications" in these tables is in some cases rather inadequate.

There is a reference in the list of "errata and addenda" to the recent confirmation by the Philippine Bureau of Science of Trimen and Bentley's statement that "elemi" is obtained from *Canarium luzonicum*, but, curiously enough, the generic name is wrongly given as Conarium.

The arrangement of the subject-matter adopted facilitates reference to the information given regarding most of the products described, but it would have been an advantage if a fuller index had been provided.

As a guide to the analysis of commercial vegetable products this book fully maintains the high standard set in previous editions, and those concerned in its revision are to be congratulated on the satisfactory way in which they have accomplished their work.

T. A. H.

SCIENTIFIC ASPECTS OF PHOTOGRAPHY.

Investigations on the Theory of the Photographic Process. By Dr. S. E. Sheppard and Dr. C. E. Kenneth Mees. Pp. x+342. (London: Longmans, Green and Co., 1907.) Price 6*s*. 6*d*. net.

DURING the last four years the authors have been working with the object of preparing theses for their degrees according to the regulations of the University of London, and in this volume they present in order the records of their work by republishing together their communications to several scientific societies. That particular branch of photography that the authors refer to as *the* photographic process is the exposure, development, fixation, and sensitometry of gelatino-bromide plates—in short, negative making as now understood, but without reference to the after-treatment of the fixed plate by such processes as intensification, or to such collateral matters as the production of developer stains.

As indicated by the title, the volume is theoretical rather than practical, though the results often have an important practical significance. The subjects are dealt with from the point of view of what is now understood as physical chemistry, and the work is described in the language of that branch of science. This will make the volume probably more acceptable to students interested in photography who have devoted themselves specifically to physical chemistry, but it imposes a serious difficulty in the way of those who have not. This difficulty is increased by the constant use of symbols instead of words in the text. We would suggest the addition of a glossary giving the exact meaning of each of the symbols used.

Some of the apparatus used appears to be disadvantageously complex. For measuring opacities a spectrophotometer is employed, though dispersion of the light is unnecessary, and appears to be undesirable, for it must add sources of error. The authors use the bright green part of the spectrum, but do not say why they throw away the rest. They recognise the fact that the light transmitted by the silver deposits in films is largely scattered, and that their instrument takes very little cognisance of scattered light. They apparently assume that the scattered light generally bears a constant proportion to the whole, but it is very doubtful whether such an assumption is well founded. On certain occasions the authors endeavour to obviate the error due to scattering by making the film itself the practical light-source by means of a diffusing medium, placed in contact with it. Opal glass, which they use, is probably the best diffusing medium available, but the present writer does not call to mind any proof that it is thoroughly effective for such a purpose. Other methods of measurement are well known that do not suffer from these drawbacks.

The authors deal with many questions that are of a very debatable character, and it in no sense belittles their work to say that they remain debatable. They adopt the "germ" theory of the developable image, but limit the effect of each germ to the grain or nodule of which it forms a part. The "suspicion of a vicious circle in the argument" that the authors refer to in connection with the "molecular strain" theory is, we fear, much more widely applicable than they appear to realise. The authors remark that "it may be said of the physical theories that they shirk a real explanation by treating the phenomena to be explained as a quality of the physical modification of the halide"; to which one might reply that those who advocate the chemical theories assume a decomposition of which there is no evidence. And so it remains a matter of opinion as to which is the safer and more useful hypothesis. We make only one other observation, namely, that it seems undesirable to speak of the *law* of constant density ratios, when, as the authors themselves admit, it is "frequently not followed." When this "law" was first propounded by Messrs. Hurter and Driffield they maintained that it was really a *law*, which it was very difficult, if possible, to get away from.

This volume will find a place, which it will worthily fill, in the libraries of all who are interested in the scientific aspects of photography, because it contains the record of a series of carefully conducted experiments under stated conditions, and gives copious references to the literature of the subject.

C. J.

OUR BOOK SHELF.

Surgical Instruments in Greek and Roman Times. By Dr. John Stewart Milne. Pp. xii+187; illustrated. (Oxford: The Clarendon Press, 1907.) Price 14*s*. net.

BOTH the author and the Clarendon Press are to be congratulated on the issue of this very valuable work—Dr. Milne because it represents work well done, and the Press on account of the successful manner in which the fifty-four plates of surgical instruments have been reproduced.

The book has grown out of a thesis written by Dr. Milne for the degree of doctor of medicine at the University of Aberdeen. It shows him to be a scholar of no mean capacity, and a fit member of a profession which used to be a great deal more learned and much less practical than it is at the present time. Knowledge about ancient surgical instruments is singularly scattered. There are descriptions of them in the medical and surgical writers of classical times, and there are remains of the instruments themselves in most of the national museums of Europe and America. But in modern times very little attention has been devoted either to the instruments or to their descriptions, and those who still read descriptions of the operations in the classical authors have either been contented to imagine the instruments with which they were performed or have had to draw upon their recollection of what they saw at Naples. Dr. Milne has now removed this reproach, and any intelligent surgeon, even though he be ignorant of Greek and should know but little Latin, can follow easily the manipulations of the older surgeons. Some day, perhaps, a surgeon with an archæological bias will do for Egyptian surgery what Dr. Milne has accomplished for Greece and Rome. Dr. Milne describes the instruments under the general headings of knives, probes, forceps, bleeding cups and clysters, cauteries, bone and tooth instruments, bladder and gynæcological instruments, sutures, and the portable outfit which was necessary for the surgery of so migratory a race as the Romans. In an appendix is an inventory of the chief instruments which Dr. Milne has seen in the various European museums, and a bibliography of the subject, short but apparently complete. There are no less than three indices, the first an index of subjects, the second a Latin index, and the third in Greek. Dr. Milne has done his work so well and so accurately that as this monograph is the first dealing with the subject it must remain for a long time the standard authority until further finds prove or disprove some of the disputable conclusions drawn by the author. The monograph presupposes a considerable amount of knowledge on the part of the reader. He must in the first place be skilled in the practice of his profession, he must be interested in its antiquities, and he must be a fair classic. These qualifications being granted, the book is most excellent reading, and throws abundant light, not only on the subject of which it treats, but also on many collateral points.

Diptera Danica. Genera and Species of Flies hitherto found in Denmark. Part I. By William Lundbeck. (Copenhagen: G. E. C. Gad; London: William Wesley and Son, 1907.) Price 4*s.* 6*d.* net.

This work is expected to be completed in about ten parts; and the first part is accompanied by a portrait of R. C. Stæger, an eminent Danish dipterist. The book is written in English, and as it appears to be very carefully done will prove very useful to English entomologists who take up the study of Diptera, which has been more neglected in England than any other order of insects, and respecting which we possess no complete work at present; though most European countries possess good monographs of Diptera in their own languages. The introduction relates chiefly to structure, illustrated by figures of structure and neuration. The other text-illustrations represent details of structure, such as heads, wings, palpi, &c. One term is new to us—the "yowls," which from the context seems to apply to the lower part of the face. The English is very good, but somewhat stilted, and occasionally rather unfamiliar words are used, such as "kinks" and "kneeformed."

There is no general table of families, which we regret; but detailed tables are given of subfamilies, genera and species. The descriptive part of the book appears to be very good, as well as the accounts of habits, transformations, and localities. There is even a table of the larvæ of the genera of Stratyomiidæ, the first family included in part i., the others being Xylophazidæ, Cœnomyiidæ, Tabanidæ, Leptididæ, and Acroceridæ.

It appears that the last estimate of the number of Danish Diptera was given by Zetterstedt in 1855 as 1439, to which Prof. Lundbeck will doubtless be able to add considerably by the time that his work is completed. The number of British species is probably somewhere between 2500 and 3000; and a considerable proportion of the Danish species probably also occur in the British islands, though the latter may be expected, when the Diptera of both countries are fully known, to possess a richer fauna than Denmark, owing to the greater extent and more varied character of the country.

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 intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Radiation of Meteors.

The shower of November Andromedids which occurred in 1885 exhibited a very large area of radiation, the flights being directed from a region variously estimated from 7° to 15° diameter. The Draconids of August, with a radiant near *o* Draconis and centre at about $290° + 60°$, appears to exhibit a similar feature, for the rich shower this system presented in 1879 had a very ill-defined radiant. An active shower of Taurids seen on November 2, 1886, also formed a very dispersed or scattered radiant.

The Draconids alluded to above returned rather plentifully this year between August 15 and 28, and they exhibited the same indefiniteness of radiation as in 1879. The feature is an interesting one, but it is very difficult to investigate it properly because of the errors of observation and mistakes in attributing meteors to their correct systems.

As a rule, it may be accepted as a general fact that showers of slow meteors have more diffused radiants than the swift meteors. I have often found the radiant points of the Perseids, Orionids, and Leonids very contracted and exact centres, while certain displays of slow meteors have proved rather puzzling to me in fixing their correct positions owing to the evident diffuseness in the intersections of the paths. W. F. Denning.

Bishopston, Bristol, August 30.

Experiment on the Rusting of Iron.

In view of recent work on the rusting of iron, the following simple experiment will be of interest. It is the result of a number of attempts to devise a simple method —for class-demonstration purposes—of showing that carbon dioxide is necessary for the rusting of iron.

A 500 c.c. flask was taken, and into it were put about 100 c.c. of 15 per cent. caustic potash solution. A partially bored sound cork was inserted in the neck, and the flask shaken occasionally for two days. Then a piece of bright iron wire (a long nail is suitable) was, after boiling in distilled water, pushed through the unbored portion of cork, leaving about an inch outside. After four months the iron inside shows no sign of rust, whilst that outside was rusted in as many days. Geo. A. Watson.

Grammar School, Cork.

THE EXPLOSION OF GASES.

THE earliest work on the explosion of gases was that of Humphry Davy, who in 1817 published those celebrated experiments on "the propagation of flame through small tubes and orifices" which led him to the construction of the miner's safety-lamp.

More than half a century later Bunsen devised the non-luminous gas burner, observing that unless the flow of the mixture of coal-gas and air exceeded a certain rate the flame became unsteady and passed down the tube. Bunsen believed that this rate represented the velocity with which an explosion would travel in the combustible gases in a closed tube, and he obtained definite values for a number of mixtures by leading the gases through an orifice at the end of a tube, igniting the jet, and determining the minimum speed at which the gases must be forced through the tube to prevent the flame passing back through the opening. The rates of explosion measured in this way were comparatively slow, the fastest observed being about thirty-seven yards a second.

FIG. 1.

But in 1881 Berthelot and Vieille discovered that when an explosive mixture is ignited at the end of a long pipe, the velocity of the explosion rapidly increases from its point of origin until it reaches a maximum velocity, which remains constant however long the column of gas may be, and which greatly exceeds the speeds of combustion measured by Bunsen; this discovery was confirmed by the independent investigations of Mallard and Le Chatelier, published at the same time. Berthelot gave the name "l'onde explosive" (detonation-wave) to the flame travelling with its maximum velocity, thus distinguishing it from the variable progressive combustion which precedes its development. The velocity of the explosion-wave constitutes a physical constant which has a specific value for each inflammable mixture; measurements by Berthelot and H. B. Dixon have shown that it is approximately equal to the velocity of sound in the burning gases at the temperature of the explosion. For a mixture of hydrogen and oxygen in equivalent proportions the velocity is about 3000 yards a second.

Mallard and Le Chatelier succeeded in recording the slow movements of the flame of progressive combustion by photographing the flash on a piece of sensitised paper fixed on a revolving cylinder. They found that when the gases are ignited at the open end of a long tube, the flame travels for some distance with a uniform slow velocity of the order measured by Bunsen; the flame next begins to vibrate, swinging backwards and forwards with oscillations of increasing amplitude; then it either dies down or sometimes the gas detonates. If the gas is fired near the closed end of the tube, the movement of the flame is uniformly accelerated until the detonation is set up. Le Chatelier's apparatus was not fast enough to analyse the wave of detonation itself.

The apparatus used by Prof. H. B. Dixon consists of a drum carrying a narrow strip of Eastman film, which can be rotated at the rate of 100 metres a second. The explosion tube is fixed horizontally, and the image of the flame is focussed on to the vertically moving film. The photographs show an inclined line of light compounded of the two motions. Fig. 1 is a photograph of the explosion of cyanogen with oxygen. The mixture was fired near the middle of a tube by an electric spark s. The flame moves slowly in both directions; to the left it passes out of the field of view, to the right its speed increases until at x the detonation-wave is set up. The detonation-wave, moving with constant velocity, is represented by a straight line (x, d), while the slower movement of the progressive combustion preceding it is shown as a curve (s, x), the steepness of which diminishes as the motion of the flame accelerates—the speed of the drum being uniform. The duration of the flash was less than 1/100 second. The period before the detonation is distinguished not only by the slow movement of the flame, but also by slow and incomplete combustion and feeble luminosity.

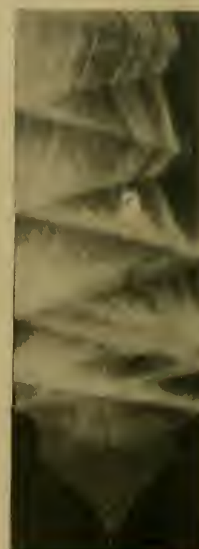

FIG. 2

The initiation of the detonation-wave is marked by certain characteristics—(1) a sudden increase in intensity of the flame, accompanied by an instantaneous rise in pressure; it is found that glass tubes are most often fractured at the point where the detonation originates; (2) rapid and complete combustion; (3) the setting up of a strongly luminous backward wave (x, r)—the so-called "retonation-wave"—which under certain conditions travels as rapidly as the detonation-wave itself. The sudden rise in pressure is due to the increase of chemical action, and this pressure not only produces the forward detonation, but also sends a backward wave of compression into the slowly-burning gases behind it; this compression-wave raises the temperature of the combining gases and increases the luminosity. It should be observed that the light produced by the explosion is chiefly due to particles knocked from the glass and raised to incandescence; the small particles suspended in the burning gases glow by the heat imparted to them by the hotter but invisible gaseous products of combustion.

The detonation-wave is set up only after the flame has run some distance, which depends on the nature of the mixture and on the size of the spark.

Fig. 2 shows the explosion of hydrogen and oxygen in a closed glass tube too short to allow of the detonation being set up. The gas is fired in the middle of the tube, and the flame spreads right and left with faint luminosity. The flame is preceded by an invisible compression-wave which travels with the velocity of sound through the unignited gas, and is reflected from the ends of the tube. The flame is checked while these two compression-waves pass through the burning gases, and is then helped forward by the waves moving in the same direction. The movement then becomes unsymmetrical; the flame to the left is checked a second time before it reaches its end of the tube, that to the right reaches the end of the tube and sends back a strong retonation-wave. The wave from the right is of greater intensity and moves more rapidly than that started a little later from the left, and, although the reflections of these waves at first run nearly parallel, the stronger gradually overtakes the weaker and coalesces with it, and the single wave continues to traverse the tube from end to end. As many as one hundred reflections have been counted in an explosion of this kind. Fig. 3 shows in outline the movements of the flame and compression-waves.

The flame in its initial stage is only very feebly luminous, a fact which has led to erroneous beliefs in regard to the mechanism of explosion. Von Oettingen and von Gernet, failing to photograph the flame itself, introduced finely-divided salts into the tube, and obtained brilliant pictures of the explosion showing a series of parallel waves. They believed that the explosion itself was *quite invisible*, the movements shown in the pictures being compression-waves rushing through the burning gases after the explosion was completed. These parallel waves, following each other in close succession, were supposed to be due to "successive partial explosions" proceeding from the spark, in accordance with Bunsen's theory of discontinuous step-like combustion.

Fig. 3.

The influence of water vapour on the combustion of hydrogen with oxygen has formed the subject of much recent research. Some years ago Dixon showed that an electric spark would fire ordinary electrolytic gas whether in the dried or moist condition, and that the velocity of detonation was practically unaffected by the presence of aqueous vapour. The experiments of Baker with very pure hydrogen and oxygen have, however, shown that the initiation of the flame is largely influenced by the purity of the mixture. It might be expected that the initial phase of the explosion (before detonation is set up) would be modified if the interaction of the gases depends on the presence of previously formed water molecules. Dixon and Bradshaw have shown by photographs that this is not the case; the flame, once it has been started by a spark, spreads with the same velocity in the dry as in the moist gases, and undergoes the same changes in intensity. So far as the development and movements of the flame are concerned, the presence of water-vapour appears to make no difference in the union of hydrogen and oxygen.

In a recent paper Dixon and Bradshaw have shown that the compression-wave which travels in front of the flame in the initial stage of the explosion may, under certain conditions, bring about the spontaneous inflammation of the gases in a region of the tube some distance from the spark. Fig. 4 shows the explosion of hydrogen and oxygen in a tube one end of which has been drawn off in the blowpipe flame in the manner of a Carius bomb-tube, so that the end has the form of a funnel followed by a short capillary. The explosion is started in the middle of the tube (*s*); almost simultaneously the gas inflames in the capillary (*c*). The flames meet midway between the fine dark vertical lines, which are reference marks produced by fastening narrow strips of black paper outside the explosion tube to eclipse the flame as it passes. The broad band is due to the clamp which held the tube in position. The firing of the gas in the capillary is caused by the sudden increase of pressure in the funnel, the heat of compression raising the gases to the temperature of ignition. The wave produced is analogous to the tidal "bore" in a funnel-shaped estuary. L. B.

c

s

Fig. 4.

THE SEVENTH INTERNATIONAL ZOOLOGICAL CONGRESS.

The meeting of zoologists at Boston was formally convened on Monday, August 19, in the Jordan Hall. Prof. Alexander Agassiz, as president, welcomed the members and delegates, and gave a short but vivid address on the recent progress of oceanographical research, especially in its zoological aspects. He directed attention, for instance, to the extremely interesting facts which he has discovered in regard to the relations of the deep-sea faunas on the two sides of the Isthmus of Panama. In a country where the stranger cannot but be impressed with the amount of public and private money which seems to be placed at the disposal of scientific institutions, it was interesting to hear Prof. Agassiz's complaint that the Government had not taken any steps to publish an account of the treasures of the *Albatross* expedition. It was one of those touches of nature which make the whole world kin.

Vice-presidents were appointed, such as Mr. Bateson (England), Prof. Hubrecht (Holland), Prof. H. F. Osborn (United States), Dr. Watase (Japan); and, on the report of Prof. Blanchard, the Czar Nicolas prize was awarded to Prof. Cuénot, of Paris, for his research on hybrids. Special mention was also made of theses by M. Loisel, of Paris, and M. Standfuss, of Zürich, which did not arrive in time to be considered in making the award. Prof. R. Hertwig, of Munich, gave a long address on the most recent researches on cytology. He spoke in German, and it was not always easy, in spite of his lucidity and illustrative charts, to follow his discussion of the intricate relations between the nucleoplasm and the cytoplasm. Of particular interest was the account of his observations on the influence of temperature on the size and rate of division of the chromosomes.

The meetings of the sections were held in the truly magnificent buildings of the Harvard Medical School, which stand like five marble temples on the three sides of a quadrangle, and are admirably designed for internal re-adjustment or for external extension outwards as future circumstances may demand. The internal equipment of the various departments, *e.g.* Prof. C. S. Minot's embryological laboratories, called forth universal admiration. Great praise is due to the organisers of the congress for the way in which they secured the orderly accomplishment of the scientific business and for the embarrassingly tempting arrangements for excursions. For creature comforts most thoughtful care was taken, from the providing of *al fresco* luncheons to the presence of a nurse!

The intellectual bill of fare—a metaphor which cannot be avoided amid so much hospitality—was all too full. Never can the zoologist of good appetite and digestion have wished more ardently that he could be, as Sir Boyle Roche's bird, "in two places at once." For in spite of clever arrangements, there was no avoiding the simultaneous occurrence of interesting events. This holds especially true in regard to the sectional addresses, which included the following:—The problem of the vertebrate head, by Prof. J. P. McMurrich; the chemical aspect of fertilisation, by Prof. Jacques Loeb; cytology and taxonomy, by Prof. C. E. McClung; facts limiting the theory of heredity, by Mr. William Bateson; fœtal membranes, by Prof. A. A. W. Hubrecht; operative factors in development, by Prof. W. Roux; economic entomology, by Dr. L. O. Howard; the relations between North American and European Hemiptera, by Dr. Geza Horvath; the problem of organic development, by Prof. C. O. Whitman; migrations of Tertiary faunas, by Prof. C. Depéret; the scope and promise of systematic zoology, by Dr. T. Gill; the evolution of continents as illustrated by the geographical distribution of animals, by Dr. R. F. Scharff.

One of the most striking of the sectional addresses delivered at the congress was that on the chemical character of fertilisation, by Prof. Jacques Loeb, of Chicago, delivered before an audience of about three hundred. He began by distinguishing between the function of the spermatozoon as a bearer of hereditary qualities and its function as an instigator of development. In connection with the latter the foremost effect is the enormous synthesis of nuclear matter. To attain to some understanding of the hydrolytic and other processes which the spermatozoon sets up in the egg, the most promising path at present is to study the phenomena of artificial parthenogenesis. By adding to "hypertonic" sea-water a small quantity of a monobasic fatty acid, Prof. Loeb has been able to induce in sea-urchin ova the formation of an egg membrane and perfectly normal development in the great majority of the eggs of a given female. The effects of the spermatozoon were thus more perfectly imitated than by the previous purely osmotic methods. Prof. Loeb's results lead him to the general conclusion that the membrane-formation is connected with the solution of a layer of fatty material underneath the surface-film of the egg. It seems that the essential feature of the process of fertilisation consists first in a liquefaction or hydrolysis, or both, of fatty compounds in the egg, and second, in starting the processes of oxidation in the right direction. The lecturer ended his discussion by making a very suggestive comparison between the chemical processes in the germination of oily seeds and those in the early development of the animal ovum. The general idea to which the experiments on the artificial parthenogenesis (of sea-urchins, Lottia, Polynöe, and Sipunculus) point is that the spermatozoon acts as a catalyser.

Sir John Murray gave a general afternoon address on the progress of oceanography, and another was given by that genial iconoclast, Prof. W. K. Brooks, who calmly asked, "Are Heredity and Variation facts?" If philosophy is a criticism of categories, the latter address was certainly philosophical, for its aim was to show that specialisation—none the less dangerous because often unconscious—necessarily leads to partial abstractions. Such, according to Prof. Brooks, are heredity and variation. The former means likeness between offspring and their parents; the latter means divergence of the offspring from the likeness of their parents. But these two aspects in isolation are not facts; they express our artificially abstracted realisation of *one* fact—kinship and individuality are inseparable. It might be suggested that heredity is more correctly definable as the relation of genetic continuity between successive generations—a relation which presents, on the one hand, the aspect of continuity, persistence, or hereditary resemblance, and, on the other, the aspect of divergence, novelty, or variation; but the lecturer would not accept this suggestion.

Much of the lecture, which was enlivened by a fine humour and by epigrams condensing much reflection, was in great part an apologia for the individuality of the living creature. "Like never does produce like, but only something like." "The sheep which the morphologist finds to be all alike, are all unlike, as the shepherd's dog knows. Each ewe knows its own lamb." (Is even this a fact?) "One never meets the average man, the normal man of the statistician." "Statistics of mortality are very useful, but they have no bearing on your death or mine." "We speak of *the* struggle for existence, but every struggle is private and particular in every respect."

If we follow Prof. Brooks's line of argument, we are led to the conclusion that since we cannot think of a living organism without an environment in which it lives, then the living organism is not a fact—it is only a scientific abstraction of one side of a fact; and so far as we understand, the Berkeleyan biologist did not hesitate to take this step. "The being is not in itself, but in its reciprocal relations." It is therefore illusory to speak of a material substratum of inheritance; the real creature is not in the idioplasm, or the chromosomes, or the determinants, or the vital units; it is to be sought and found in the reciprocal interaction between the organism and its environment. A luminous section of the lecture was devoted to showing that supposing one knew the pre-Cambrian Rhizopod from which all animals are descended, and knew it thoroughly, yet one would not be able to foresee from such knowledge all that was to follow. The history was not really in the pre-Cambrian ancestor, for living creatures, as they have evolved, have, so to speak, worked time into their being, and evolution is continual creation.

The last days of the formal meetings of the congress were overcrowded with remarkable communications, too numerous even to mention in a brief notice, but we cannot refrain from remarking on the addresses given by Mr. Bateson, on facts limiting our theories of inheritance; by Prof. C. O. Whitman, on orthogenesis in pigeons and on the relations of ontogeny and phylogeny; by Dr. L. O. Howard, on the recent progress of economic zoology; and by Prof. H. F. Osborn, on evolution from a palæontologist's point of view—all of them very remarkable and memorable expositions.

At the formal close of the congress it was announced that the 1910 meeting would be held at Graz under the presidency of Prof. von Graff. A welcome announcement was made that the committee on nomenclature had at last arrived unanimously at a code of rules which would cover 90 per cent. of all possible difficulties. Dr. Stiles further said that the committee would continue to sit in judgment on the remaining 10 per cent. of intricate difficulties, and that they had resolved to prepare a check-list of some thousands of common animals the names of which were not henceforth to be changed on any pretext whatsoever. As Prof. Agassiz remarked, the only difficulty remaining was the cheque. Prof. Blanchard announced that a third prize had been offered by Russia for adjudication by the congress and by representatives of the Zoological Society of St. Petersburg. It was offered to perpetuate the memory of the great Russian zoologist, Alexander Kowalewsky. In a very neat speech Prof. Hubrecht, of Amsterdam, thanked the local committee, the organisers, and the president for their indefatigable labours in making the congress a conspicuous success, and Prof. Blanchard, of Paris, eloquently expressed the gratitude of the ladies for the hospitality which had been shown them by the ladies of Boston.

NOTES.

THE weather conditions for the three summer months, June to August, have proved very disappointing, and the principal characteristic has been the entire absence of warm days. At Greenwich there have only been forty days during the whole period with a temperature of 70° and above. This is precisely the same number as in the phenomenally wet summer of 1903, but it is very greatly below the average. In 1860 there were only twenty-three days with a temperature of 70° or above, and in 1879 twenty-six such warm days, so that the past summer is not unique. There has not been, however, a single day this summer with a temperature of 80°, whilst in 1903 the thermometer touched that reading on six days. The aggregate rainfall at Greenwich for the three months was 5·29 inches, which is 1·37 inches less than the average of the past sixty years. In 1903 the aggregate for the corresponding three months was 16·17 inches, which is the wettest summer on record. At the London observing station of the Meteorological Office the aggregate rainfall for the three months was 4·76 inches, which is 2·13 inches below the normal, and the only month with an excess so far this year is April. June was generally wet over nearly the whole country, July was mostly dry, whilst in August the rainfall varied considerably in different parts of the kingdom. At Jersey the total measurement in August was 0·60 inch, whilst the average is 2·48 inches; at Valencia the measurement was 5·67 inches. The sunshine has not varied much from the average. In London there was a slight deficiency in each month, but in the aggregate for the three months it only amounts to thirty-eight hours. September has commenced with exceptionally cold weather, and the thermometer for the first four days has averaged about 30° lower than at the corresponding time last year.

A REUTER telegram from Rome states that it is expected that ratifications will be received by the end of the present year from all the Powers of the convention of June 7, 1905, for the establishment of the proposed International Agricultural Institute. If the expectations are realised the committee of the institute will be able to meet early in 1908, enabling the institute itself to assemble in the autumn of that year, and to be in working order in 1909. In connection with the new institute, the Italian Government is taking steps for the scientific organisation of a system of agricultural statistics which existed until about ten years ago, when it was abolished by Count Guicciardini, Minister of Agriculture, on the ground that it did not afford sufficient guarantees of correctness. By way of experiment, agricultural statistics will be collected this year in fifteen provinces of Italy, with the view of extending the new system to the whole of the country, with any reforms that may be suggested by the experiment. At the same time a count will be taken of the livestock in the country, which has not been done for a considerable time. In this way Italy will in 1909 appear before the International Institute with complete agricultural returns.

THE installation of the first electric irrigation system in southern British Columbia has just taken place. It is considered that by this means the problem of the irrigation of several thousand acres of fruit lands will in a great measure be solved.

AN organisation to be known as the Universal Society of the White Cross of Geneva has been formed at Geneva. It has for its object the coordination of the work being carried on throughout the world in combating tuberculosis, cancer, epidemic and infectious diseases, and social evils such as alcoholism, &c.

ACCORDING to the *Engineer*, an Inter-Ministerial Technical Commission has been appointed by the French Minister of Public Works to organise the whole system of wireless telegraphy in all its branches in the country, and it is expected that the commission will be able to arrive at results which will furnish France with a very complete and properly coordinated service of wireless telegraphy for land and sea service, both in peace and war.

IN 1859 Mr. U. A. Boyden, of Boston, deposited with the Franklin Institute the sum of 1000 dollars, to be awarded as a premium to any resident of North America who should show by experiment that light and other rays travel with the same velocity. According to the August number of the Journal of the Franklin Institute, the premium has just been awarded to Dr. P. R. Heyl, who has taken photographs in the blue and ultra-violet of the variable star Algol in the neighbourhood of its minima, and has shown that the time of minimum intensity of the blue photographs is so nearly identical with that of the ultra-violet that the speeds of the two radiations across the space between Algol and the earth cannot differ so much as one part in a quarter of a million.

THE following arrangements have been made for the opening of the winter session of certain of the London medical schools:—at the Guy's Hospital Physical Society, on October 4, Dr. G. A. Gibson will read a paper entitled "Past and Present"; at King's College, on October 1, Dr. W. H. Allchin will give "Some Observations on the Present State of Medical Education in London"; at the Middlesex Hospital Mr. A. G. R. Foulerton will, on the same date, speak on "The Development of Preventive

Medicine in Relation to the Welfare of the State"; at University College Hospital, on October 2, the inaugural address will be given by Sir R. Douglas Powell; and at the Seamen's Hospital Society, on October 21, Sir Lauder Brunton will give the inaugural address. The session of the Pharmaceutical Society will be opened on September 30, when Prof. R. Meldola will speak on "The Scientific Training of the Pharmacist."

PRELIMINARY particulars of the ninth International Geographical Congress, to be held at Geneva from July 27 to August 6, 1908, are given in the September number of the *Geographical Journal*. Ten scientific excursions, some of which will take place before, others after, the congress, have been arranged for, each being conducted by an expert. Dr. J. Früh, of Zürich, will lead a party, of not more than twenty, for the study of the morphological phenomena of the Alps and their foothills. Another party, conducted by Dr. Lugeon, will study the phenomena of inverted folding in various parts of the Alps. An excursion will be devoted to high-level forestry, and will be led by M. Ernest Muret. The structure of the Jura, the plateau, and the Alps will be studied under the direction of Dr. H. Schardt. A botanical excursion will be made under the direction of Dr. C. Schroeter, the well-known authority on the flora of the Alps. A study of vegetation contrasts and the technique of botanical distribution will be undertaken under the guidance of Dr. J. Briquet, and one of glacial morphology under the guidance of Prof. Brückner. Prof. J. Brunhes and others will direct attention to the contrasts between fluvial and glacial erosion, while Prof. Schardt will explain the structure of the southern portion of the crystalline Alps. Lastly, a party under the guidance of Prof. E. Chaix will study the phenomena of chemical erosion, especially as displayed in the surface forms known as *lapiés*, or *Karrenfelder*, and in the Karst. The place of meeting is particularly favourable for the arrangement of instructive excursions, and these may be expected to be one of the most prominent features of the congress.

THE *Philippine Journal of Science* for June (ii., No. 3) is entirely occupied with a paper by Dr. Richard Strong on studies in plague immunity. The author concludes that general vaccination in endemic centres would be a valuable means in accomplishing the extermination of this pestilence, an important pronouncement at the present juncture, when plague is rampant in India.

PREVENTIVE inoculations against hydrophobia were received at the Pasteur Institute of Paris in 1906 by 773 persons, only two of whom died from the disease, and as one of these may be excluded for statistical purposes, seeing that hydrophobia manifested itself in less than a fortnight after the conclusion of the treatment, the results show the low mortality of 0·13 per cent. Only one of the patients came from England. The person who died in less than fifteen days after treatment had received a severe penetrating wound on the face; the other fatal case had been severely bitten on the nose on August 3, was treated at the institute from August 5 to 26, and died from hydrophobia on October 12.

THE second report of the Natal Government Museum—covering the year 1905—has just been published by Messrs. Adlard and Son, and tells of progress in all departments. In the period under review the following additions to the specimens in the museum were made:—in ethnology, 145; mammals, 98; birds, 81; anatomy, 82; reptiles and fishes, 19; invertebrates, 425; palæontology, 4; geology and minerals, 1445. A native blacksmith's complete outfit, including a good specimen of skin-bellows, has been acquired by the ethnology department of the museum through the misbehaviour of its former owner, the police authorities of the colony having acted on the request made to them to forward to the museum all native articles which have been confiscated for wrongdoing.

IN a letter to the *Times* of August 28, Mr. James Brand states that intravenous injections of a mixture of aqueous solutions of methylene blue and corrosive sublimate cure trypanosome infections in horses, and suggests that this may be found to be a remedy for sleeping sickness, a Trypanosoma infection, in man. Prof. Moore and his co-workers have found that corrosive sublimate enhances the curative value of atoxyl, another anilin dye, in experimental infections with the human trypanosome, but it does not follow that methylene blue would be of service in sleeping sickness, since Nicolle and Wenyon have found that an anilin dye which is curative for an infection with one trypanosome is not necessarily curative for other trypanosome infections.

THE fifth annual report of the Imperial Cancer Research Fund, which has been recently issued, contains the reports of the executive committee, of the general superintendent, Dr. Bashford, and of the honorary treasurer. The fund now possesses a capital sum of 118,275*l*. for the purposes of the work, including the munificent gift of 40,000*l*. by Mr. and Mrs. Bischoffsheim on the occasion of their golden wedding. Dr. Bashford gives a *résumé* of the experimental and other researches carried out during the past year. Attention has been given to testing various alleged cancer cures; unfortunately, it is impossible to assign a curative value to any of them. The much-vaunted trypsin is incapable of curing inoculated cancer in mice, or even of influencing the progressive growth of the tumours. The only means capable of freeing the inoculated mice from cancer is the surgical removal of the tumours.

IN an illustrated pamphlet published at La Plata ("La Reforma" Press, 1907), under the title of "El Origen del Hombre," Dr. Florentino Ameghino reiterates his opinion that South America was the birthplace of the human race. Man is traced back to the supposed Cretaceous family Microbiotheriidæ—in other words, to Miocene opossums!

AMONG numerous articles in part i. of the fiftieth volume of Smithsonian Miscellaneous Collections, attention may be directed to a description, by Dr. Leo Walter, of Prague, of the structures by means of which the fore and hind wings of hymenopterous insects are linked together. After pointing out that homologous structures exist in the wings of certain other insects, such as many Lepidoptera, Cicadidæ, and Thricoptera, the author observes that in none of these is the development so full and so complicated as in the Hymenoptera. Strange to say, these structures in the latter group appear never to have been worked out in full detail—an omission which Dr. Walter has endeavoured to supply. Facts of considerable interest have been discovered during the investigation, and it has been found that these organs possess much importance from a systematic point of view. Their object is, of course, to enable the two wings to act during flight as a single unit, and, as might have been expected, it turns out that the strongest flyers among the Hymenoptera are those in which the connection between the wings attains its fullest development. The halting and uncertain flight not infrequently noticeable in individual humble-bees is attributed by the author to damaged wing-connections.

THE rapidly advancing study of spirochætes is at once of practical and scientific interest, of practical interest because these parasites occur in those "gustatory flashes of summer lightning," as Huxley said, which mortals call oysters, and because *Spirochaeta pallida* is believed to be the active cause of syphilis; of scientific interest, because it remains uncertain whether these protists are protozoa or bacteria. In a recent paper (Ann. Nat. Hist., xix., 1907, pp. 493–501), Mr. H. B. Fantham points out that the diffuse nuclei and transverse fission of spirochætes suggest bacteria, while, on the other hand, the presence of an undulating membrane, longitudinal fission, and even definite "chromosomes" suggest protozoa. It is to the latter interpretation that he inclines. Mr. Fantham has made a careful study of living spirochætes—*Spirochaeta balbiani* (Certes) from the oyster, and *S. anodontae* (Keysselitz) from the fresh-water mussel—and gives an interesting account of their puzzling movements. Their motion is resolvable into at least two components:—(1) a vibratory motion of flexion of the body, mainly for progression, and (2) a spiral or corkscrew movement of the body as a whole, due to the spirally wound membrane, which is composed of longitudinally arranged "myoneme" fibrillæ. The myonemes set up transverse movements on the surface of the body, manifested as waves passing down the body in a direction opposite to that in which the organism moves. The spirochætes seem to move more quickly than even trypanosomes, and with an added corkscrew motion. While flagella are present in the case of true Spirilla, they do not occur in spirochætes. What have been described as flagella or cilia by some investigators are really "myoneme" fibrils split off from the membrane during its rupture.

A DOUBLE number of *Le Bambou*, the first issue of this year, comprising Nos. 7 and 8, has been received. It contains a descriptive article on the aërial vegetative structures of bamboos, also notes on their cultivation and resistance to frost.

THE third number of vol. iii. of the Records of the Botanical Survey of India is appropriated to the determinations, by Dr. L. Radlkofer, of new species belonging to the order Sapindaceæ, based on material from India and Malaya.

THE results obtained by de Vries have led botanists to examine closely the so-called variable species, as from such species special modifications or new characters may most reasonably be expected. In the *New Phytologist* (February) Dr. L. Cockayne refers to a New Zealand plant of this type, *Leptospermum scoparium*, with regard to colour modification. Ordinarily the flowers are white, but a pink-flowered form was introduced to cultivation as *Leptospermum Chapmanni*, and recently another plant, bearing rich crimson flowers, has been discovered growing wild. Seedling plants of the latter have been raised, so that from the next generation some idea as to the origin of the plant, whether a mutant or hybrid, may be obtained. In *Science* (April 12) Dr. G. H. Shull notes that he can distinguish four elementary species in the numerous specimens of *Capsella bursa-pastoris* he has cultivated, all of which breed true, and that without geographical or complete physiological isolation they maintain themselves distinct.

AN account in the *Kew Bulletin* (No. 7) of the proceedings in connection with the Linnean bicentenary celebrations at Upsala, Lund, and Stockholm accords with other descriptions in testifying to the enthusiastic and impressive nature of the ceremonies. Correspondence connected with the award of the special Linnean gold medal to Sir Joseph Hooker is also published. An article on new or little-known algæ from eastern Asia is contributed by Mr. A. D. Cotton, in which a new alga from Ceylon, *Euptilota Fergusonii*, is described and figured. Dr. Otto Stapf communicates notes on two rubber plants, *Mascarenhasia elastica*, belonging to the order Apocynaceæ, that grows in British and German East Africa, and *Euphorbia fulva*, a tree known in Mexico as "Palo Amarillo." From the former balls of fair-quality rubber, known as "Mgoa," are prepared; the latex obtained from the latter contains a large percentage of resin, but a process of separation is said to have been devised. Mr. J. M. Hillier has collated information on Guayule rubber, the product of *Parthenium argentatum*, a shrubby composite of Mexico.

ACCORDING to the second part of the *Bergens Museum Aarbog* for the current year, Norway experienced an unusually small number of earthquake shocks in 1906, namely, thirteen, against twenty-three in 1905 and thirty-three in 1904. Mr. C. F. Kolderup, the author of the paper referred to, is of opinion that the comparative frequency of earthquakes in Norway is due to subsidence in the bed of the adjacent sea. In another article in the same issue Mr. J. Rekstad discusses ancient terraces and beach-lines in western Norway, illustrating his account with a number of reproductions from photographs.

IN the *Physikalische Zeitschrift* for August 15, Prof. F. Paschen gives the results of some careful measurements made by his pupil, Miss Stettenheimer, of the Zeeman effect in known magnetic fields for the lines Zn 4680 and Cd 4678 which behave normally. From the results he calculates by the theory of Lorentz the quotient of the electric charge on the ion by its mass, and obtains $1{\cdot}79\times10^7$. This agrees very well with the value $1{\cdot}77\times10^7$ given by Messrs. P. Weiss and A. Cotton in the June number of the *Journal de Physique* as the result of their measurements. The values which have been obtained by different experimenters for the above quotient in the case of the kathode rays differ so much from each other that it is difficult to fix on a representative one for comparison with the above numbers. Prof. Paschen takes the value $1{\cdot}88\times10^7$ given by Profs. Kaufmann and Simon, and is disposed to think that the difference between the values of the quotient in the two cases is due to some difference in the ions.

THE uncertainty as to the melting point of platinum, to which we referred a few weeks ago, is leading to corresponding uncertainties in all high-temperature determinations. Profs. C. E. Mendenhall and L. R. Ingersoll, in their paper on the melting points of rhodium and iridium in the July number of the *Physical Review*, are compelled to give two sets of values, one based on 1745° C., the other on 1789° C., as the melting point of platinum. They use the Nernst glower as a meldometer, place a very small particle of the metal on it, and observe through a microscope for what current through the glower the particle melts. The temperature of the glower is determined by measurement of the isochromatic radiation, assumed to follow a law similar to Wien's, with constants determined from the melting points 1065° C. and 1745° C. or 1789° C. of gold and platinum. With 1789° C. as basis, they give the following melting points:—silicon, 1452° C.; palladium, 1576° C.; rhodium, 1968° C.; indium, 2388° C.; the temperature of the glower at normal brilliancy 2480° C., the melting point of the glower material 2490° C.

THE atomic weight of radium was determined five years ago by Mme. Curie on about 0·09 gram of a highly purified radium chloride. Large quantities of Joachimsthal pitchblende residues have since then been worked up, and from these 0·4 gram of pure radium chloride has been obtained. The method of purification adopted was re-crystallisation from weak hydrochloric acid and fractional precipitation of the aqueous solution by alcohol, the progress of the purification from barium being followed by means of the spectroscope. It seemed desirable to repeat the determination of the atomic weight on the larger quantity now available, and Mme. Curie gives an account of the method adopted in the current number of the *Comptes rendus* (No. 8, August 19). Difficulties were encountered owing to the presence of traces of impurities in the reagents, leading to a gradual loss of radium during the purification, and a detailed account is given of the elaborate precautions found to be necessary for the preparation and preservation of the reagents used. The atomic weight deduced from the ratio radium chloride : silver chloride is 226·2 (Ag = 107·8, Cl = 35·4), or 1·2 units higher than the value found on 0·09 gram in 1902. It is shown that the slight increase of purity of the 1907 over the 1902 preparation is not sufficient to account for the rise of 1·2 units in the atomic weight, the difference being most probably due to the loss of accuracy on the determinations with the smaller quantity and the use of reagents not properly purified.

THE August number of the Journal of the Institution of Electrical Engineers (No. 185, vol. xxxix.) contains, amongst others, a paper on the technical training of electrical artisans, read by Mr. C. P. C. Cummings before the Dublin local section of the institution. The subject is one which is very rarely treated in papers read before the Institution of Electrical Engineers or the branch sections, but, at the same time, it is one which is very important to the future development of electrical work. The term electrical artisan, as referred to by Mr. Cummings in his paper, deals almost entirely with those electrical artisans who are generally classified as "wiremen," and the paper treats of the possibilities of improving the existing methods by which such men are trained at the present day, so that more efficient workmen may be obtainable. Mr. Cummings very rightly points out that there is a very large majority of the "so-called wiremen" obtaining the maximum rate of wages per hour which the highly trained and competent workman is fully entitled to, who cannot be placed in the same class with him, and can obtain this rate without any trouble. This in itself is evidence of the serious defect in the method by which electrical artisans are produced. So long as these methods continue, they will produce a considerable number of men who cannot be considered fully competent, but very few first-class artisans, and from this very fact the really competent men consider themselves so strong by virtue of their minority that their demands upon employers and their general independence greatly reduce their utility. Mr. Cummings describes the present method of training electrical artisans, and points out the faults of the system and propounds a scheme which is well worth the consideration of educational authorities and employers—especially the latter—for until the employers take a practical interest in this matter they cannot hope to obtain the man most suited to their requirements.

MESSRS. JOHN J. GRIFFIN AND SONS, LTD., of Kingsway, have just issued a new edition of "Chemical Handicraft," giving particulars (in many cases illustrated) of the chemical apparatus and reagents manufactured and sold by them. Science teachers will find the volume very handy for reference.

THE lectures delivered under the Silliman foundation at Yale University in March, 1905, by Prof. E. Rutherford, F.R.S., which were afterwards issued in book form under the title of "Radio-active Transformations," have now been translated into German by Dr. Max Levin, of Göttingen, and published by F. Vieweg and Son, Brunswick. Brief reference is made in the volume, in the form of footnotes, to the more important advances in the subject which have taken place since the first appearance of the work in English.

OUR ASTRONOMICAL COLUMN.

DANIEL'S COMET, 1907*d*.—The following is a continuation of the ephemeris for comet 1907*d* given in No. 4196 of the *Astronomische Nachrichten* (p. 337, August 23):—

Ephemeris 12h. (M.T. Berlin).

1907	α (true) h. m.	δ (true) ° ′	log *r*	log Δ	Brightness.
Sept. 9	9 41·5	+11 5·7	9·7250	0·1139	13·7
,, 11	9 53·3	+10 26·0			
,, 13	10 4·7	+ 9 45·9	9·7495	0·1408	10·8
,, 15	10 15·7	+ 9 5·5			
,, 17	10 26·3	+ 8 25·1	9·7818	0·1654	8·3
,, 19	10 36·5	+ 7 44·9			

It will be noticed that the brightness of this object is declining rapidly, and, as the comet rises nearer and nearer to sunrise, it is becoming increasingly difficult to observe. At present it rises about two hours before the sun, and on September 19 it will precede the sun by about 1½ hours, rising about 12° north of east.

Comptes rendus, No. 8 (August 19), contains the results of observations made by M. E. Esclangon at Bordeaux. The head of the comet was extraordinarily bright and of about 5′ diameter on August 1. Seven tails were seen, the extreme streamers being much shorter than the median. A reproduction of the observer's drawing shows the disposition of the tails.

SOLAR OBSERVATIONS AT CARTUJA, GRANADA.—In an extract from No. 3 (1907) of the *Bulletin de la Société belge d'Astronomie*, M. J. Mier y Terán, S.J., publishes an account of the solar observations and reductions now carried on at the Observatory of Cartuja-Granada (Spain).

Solar observations were commenced at the beginning of 1905 for obtaining statistics relating to sun-spots and faculæ. In January, 1906, photography was substituted for eye observations for the purpose of obtaining more precise measures, and photographs have since been secured on each clear day. A more suitable photoheliograph has recently been erected having an objective of 94 mm. (3·7 inches) aperture and 1·50 m. focal length, and fitted with a direct enlarger giving a solar image of about 10 cm. (4 inches) diameter. The areas and positions of the spots, &c., are measured with a Hilger micrometer, the positions afterwards being reduced to heliocentric coordinates in the usual manner, and it is hoped that the results will be found sufficiently precise to supplement the Greenwich measures. As it is proposed to publish these results in the tri-monthly numbers of the observatory bulletin, it may be expected that solar workers will find them available without having to wait for the Greenwich annual publications. Spectroscopic observations of the sun and the stars are also being carried on at Cartuja, and it is hoped that ere long the apparatus for spectrophotography with a large dispersion will be installed.

DISCOVERY OF SEVENTY-ONE NEW VARIABLE STARS.—The wholesale discovery of new variable stars from photographic plates is proceeding at Harvard, and in Harvard College Observatory Circular, No. 130, Prof. Pickering announces the discovery of a further batch of seventy-one new variables. These were found by Miss Leavitt on the Harvard maps Nos. 9, 12, 21, 48, and 51. Prof. Pickering gives a table showing the proportion of newly discovered variables to the total number now known to exist in each region examined, and arrives at the general deduction that about one-third of all the variables in the three northern regions examined, and about one-half of those in the two southern regions, yet remain to be found. The designations, positions, and magnitude ranges of the newly discovered variables are given, and the list includes thirteen probable Algol and seven long-period variables, the proportion of the former being remarkable, as in the case of Region 50 discussed in Circular No. 122.

THE ELECTRICAL ACTION OF THE SUN.—In these columns for March 14 we referred to a discussion, by Dr. Albert Nodon, of the nature and effects of the sun's electrical charge. The whole discussion is now published as an extract from the *Revue des Questions scientifiques* for April and July, and will be found to be of great interest by all workers on solar physics and the allied terrestrial phenomena. In the first part of the paper Dr. Nodon discusses the observations, the apparatus used in making them, and the theories deduced from them. The second part contains a discussion of the application of the results to the explanation of cometary, planetary, and terrestrial phenomena, whilst in the third part of the paper the author discusses the deductions relative to terrestrial physics. The paper is published by J. Polleunis, 45 rue Sans Souci, Brussels.

MICROMETER MEASURES OF DOUBLE STARS.—In No. 4193 of the *Astronomische Nachrichten* (p. 277, July 26) Dr. H. E. Lau publishes a further list of Struve double stars measured by himself, and discusses the mean probable errors of his measurements. In addition to the eighty measures made by Dr. Lau, the list also contains twenty-eight measures made by Herr Luplau-Jannsen.

THE MAY OR GORSEDD YEAR IN ENGLISH AND WELSH FAIRS.

SIR NORMAN LOCKYER has taught us to call the year indicated by alignments of stone monuments in Britain the May year. The quarter days of that year are astronomical, being the half-way stations of the sun between the solstices and equinoxes. In fixing these dates, of course, the solar quarter days were marked as well, which year is conveniently called the solstitial year. It will clear the way for the discussion of some figures bearing on the subject if the two series of quarter days are presented here side by side, as given in "Stonehenge Astronomically Considered," p. 23:—

MAY YEAR ...	Feb. 4	May 6	Aug. 8	Nov. 8
SOLSTITIAL YEAR ...	March 21	June 21	Sept. 23	Dec. 23

The quarter in both series is of the same length, ninety-one days, and the distance from a solstitial quarter day to a May-year one is roughly forty-five days.

Though the name May year is a very happy one, as the May festival was certainly the most popular, it is really the Gorsedd year, the very *raison d'être* for that institution which, in form, purpose, and ritual, is the temple-observatory brought up to date. We know now for what purpose the megalithic monuments were raised, and that knowledge has been acquired by working from the known to the unknown. By assuming that the Welsh Gorsedd is a much truer representation of ancient Druidism than the manifestly inaccurate, second-hand observations of Cæsar and other classical writers, we are able to see at the Welsh National Eisteddfod in this twentieth century the actual use to which the temple-observatory was put. If such a broad assertion causes surprise, that surprise is considerably lessened by what seems to me to be an incontrovertible fact, that, instead of having one Gorsedd, and that in Wales, a true survival from late Neolithic times (to fix an indubitable downward limit), we have in Britain more than one thousand Gorsedds the pedigrees of which are as unimpeachable as that of the Welsh institution. I refer to fairs still held on the quarter days of the May year. To a student of the Welsh Gorsedd this fact at once dispels any *a priori* doubt as to the antiquity of that institution. It is only one among a thousand, though, I would maintain, it is the only one that shows what all the others were at first.

The Gorsedd and the popular fair are one and the same, constituting a true monument as ancient as a temple-observatory in stone. A better way of putting it is, the temple-observatory has survived in (1) stone, in (2) tradition, and in (3) festival. The Welsh Gorsedd presents this triple evidence.

There is, I think, no need for a formal proof of the prevalence of the May year in Ireland, Scotland, and Wales, or the "Celtic fringes." It reigns supreme over still purely Celtic ground. It is when one comes to England proper that even one accustomed to mark time in May-year terms must confess to a feeling of surprise. The evidence from the Celtic fringes is, of course, indispensable to understand and explain the English May-year fairs, but a brief presentation of the English case may be helpful by way of enlisting the cooperation of English archæologists to make that case as strong as possible.

I take Owen's "New Book of Fairs" for 1824 as source. The book was published by Royal licence, but as regards Wales it is incomplete, and I would infer as much as regards England. The following figures, except those given by counties, include the Welsh fairs as given in the list. That inclusion cannot affect seriously the English case, as will be seen.

The relative popularity of the May and of the solstitial years may first be ascertained by comparing the number of all fairs in May with those in June. May fairs, 510; June fairs, 250; 2 to 1 for May.

There are two lists of fairs in Owen's book, one by counties and the other by dates. I take the latter first. The figures in every case are my own. As the book is incomplete, and all lists of fairs I have consulted are so, I have thought it sufficient for the present purpose to make only one rapid reckoning of the fairs. The chief fair days can be easily noted by large groups of fairs. The fairs corresponding to the May-year festivals are to be looked for under several dates. The astronomical day is in many cases observed eleven and twelve days later. Generally, that day has given way to the first of the calendar month. In both cases new and old style dates must be noted. Then there are fairs depending on such dates. All fairs held during the first twelve days of the month should be numbered. In the case of November, the inclusion of Martinmas fairs needs no comment, as November 11 is a Scottish quarter day, and the Scottish quarter days, with the fact that in Gaelic-speaking Scotland the months, as well as the seasons, are still reckoned in the true May-year order, is sufficient formal proof of the predominance of that year on Celtic ground.

February	Fairs	May	Fairs	August	Fairs	November	Fairs
2 ...	8	1 ...	32	1 ...	18	1 ...	10
5 ...	7	4 ...	42	2 ...	29	6 ...	13
13 ...	20	6 ...	38	5 ...	53	8 ...	43
14 ...	12	8 ...	14	10 ...	16	11 ...	17
D. ...	21	12 ...	81	12 ...	26	12 ...	26
—		13 ...	11	15 ...	13	13 ...	14
—		14 ...	42	D. ...	50	17 ...	18
—		17 ...	16	—		22 ...	43
—		18 ...	12	—		D. ...	57
—		D. ...	71	—		—	
	68		359		205		241

D. = Dependent fairs.

Thus we have 873 plain May-year fairs. I claim now the Church-year fairs, which are plainly the old May-year festivals. For February 4 I claim 28 fairs between Candlemas and the beginning of Lent; for May 6, 358 Whitsun and Ascension fairs; and for November 8, 53 fairs at Michaelmas, 71 on October 10 (Old Michaelmas), and 32 on December 11 (Old St. Andrew's Day). Though Michaelmas and St. Andrew's Day are both a month away from November 1, they constantly occur as half-year days corresponding to May Day. It is very likely, however, that some of the August fairs have been absorbed into Michaelmas. As that day occurs so near to the autumnal equinox, some concession must be made also to the solstitial year. There is no need, however, to decide these points at present.

We can now add 542 to our list of May-year fairs, altogether 1415 fairs which may reasonably be claimed as so many Gorsedds or prehistoric monuments, 96 in February, 717 in May, 205 in August, and 397 in November. It is curious to note that the number of plain May fairs and of Church-year May fairs is the same. The ratio for November seems to be too high, and the number for that month has grown evidently at the expense of August. Dividing the total for August and May, we get 301 for each of those months to match the figure for May, which is always at least twice as high as the corresponding figures. For obvious reasons February is a poor time for fairs, and the intrusion of Lent has very generally broken up that end of the May year. A more thorough scrutiny will be the means of recovering many February 4 fairs.

If the above estimate is considered too generous, my estimate of the solstitial-year fairs must err more in that pleasing direction, for I include, against strong reasons, all the Easter fairs in that estimate.

	Fairs		Fairs
March 21	2	June 22	29
April 5...	37	,, 24	35
		July 5	54
	39		118
Easter	231	Trinity	59
	270		177

	Fairs		Fairs
Sept. 19	31	December 21	7
,, 21	20	,, 25	8
Oct. 2	53		
	104		15

There are, then, 276 true solstitial fairs and 347 Church-year fairs to bring the total up to 623; but the figure for Easter shows evident borrowing from February, the vernal equinox, and May. A fair ratio would be obtained by counting sixty Easter fairs for the vernal equinox and the remainder for February.

In claiming the Easter fairs for the May year, I have a larger number of fairs to add to the solstitial estimate. Beside the May year, with the portions of the Church year which are evidently based on it, and the solstitial year as such, there are two other series of dates to consider. The one I would call the Roman year, being important dates in the old Roman year, which were early associated with the names of Christ, St. Mary, and at least six of the Apostles. I refer to groups of fairs on the 25th of the month. There are 25 fairs on March 25 and 43 on September 25, 68 fairs which I would add to the solstitial estimate.

The other series of dates I would call the Petrine year, with groups of fairs on the 29th of the month. When the old Celtic saints of Llandaff Cathedral, Teilo and Dyvrig, May-year saints, were superseded in Anglo-Norman times by SS. Peter and Paul, June 29 was fixed as the beginning of the year in that cathedral. The canons there still mark their time of residence as from that date. The Petrine year is fairly general, though it is altogether subsequent to the middle of the twelfth century A.D., at any rate in South Wales. There are 18 fairs on March 29, 35 on June 29, 45 on July 10 (O.S.), 53 on September 29, and 71 on October 10 (O.S.), in all 251 fairs which I would add to the solstitial estimate, which now stands at 948 fairs.

The May year is still 467 ahead, and the May-year figures are certainly much more satisfactory than the large figures I have juggled for the solstitial estimate. If the latter is fairly correct, I must now add it in a lump to that of the May year, and say that we have still in England and Wales 2363 fairs, relics of festivals held at the same spots or thereabouts when the dates were obtained by direct solar observations by means of aligned monuments. Several capable archæologists have expressed the opinion, anent the astronomical theory, that they admit the solstitial alignments, while doubting the very existence of the May year in connection with the monuments. Such admission is substantially complete. The solstices and equinoxes were of little direct practical use to the ancient farmer as dates to commence farming operations. The Welsh farmer of to-day is finely indifferent to the almanac statements that spring begins on March 21 and winter on December 23. He knows better. The solstitial quarter days were observed as points from which the infinitely more practically important May quarter days could be correctly marked.

So far I have made only a rough preliminary reconnaissance of the list of fairs. I now take up Owen's list of fairs by counties, not to learn more about the relative prevalence of the May and the solstitial year so much as to learn more concerning the May year itself. Except May 6 and November 8, I have counted all fairs in February, May, August, and November. From the Church year I have borrowed only some pre-Lenten fairs for February and the Whitsun fairs for May. The total is just the same, but the analysis is much more to the point. The Welsh fairs are included, though the list is very defective. The letters F.M.A.N., variously grouped, represent May-year quarters:—

	Feb.	May	Aug.	Nov.	May 6	Nov. 8	Fu yea	F. M.	F. M. A.	F. A.	M. A.	M. A. N.	M. N.	A. N.	F. A. N	F. N.	F. M. N.
Bedford ...	3	8	3	7	—	1	2	—	-	—	—	—	1	—	—	—	—
Berks	2	7	2	4	—	1	—	2	—	—	1	—	—	—	—	—	—
Bucks ...	3	11	3	3	3	1	—	1	—	1	—	—	1	—	—	—	—
Cambs ...	—	3	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Cheshire ...	1	9	5	7	2	1	—	—	—	—	2	—	5	1	—	1	—
Cornwall ...	7	27	11	17	2	3	—	—	—	—	2	—	9	1	—	1	—
Cumberland	1	7	5	2	—	—	—	—	—	—	2	—	2	—	—	—	—
Derby ...	4	9	4	8	1	1	1	1	—	—	—	1	—	—	1	2	1
Devon ...	8	25	15	11	2	1	—	1	-	2	4	—	4	1	—	—	—
Dorset ...	2	11	7	5	1	1	—	—	--	1	—	—	1	—	—	—	—
Durham ...	—	8	1	4	1	—	—	—	—	—	—	1	3	—	—	—	—
Essex	—	30	10	8	2	1	—	—	—	—	2	—	2	—	—	—	—
Glouc. ...	1	19	4	8	2	2	—	—	—	1	2	—	5	—	—	—	—
Hants ...	4	21	2	7	2	2	—	—	—	—	—	—	3	—	—	—	1
Hereford ...	5	12	4	6	1	1	—	1	2	-	1	—	3	—	—	—	1
Herts ...	—	10	3	2	—	1	—	—	—	—	2	—	1	—	—	—	—
Hunts ...	5	12	4	6	—	—	—	—	—	—	1	—	1	—	—	—	—
Kent	5	40	20	7	3	2	—	1	—	1	—	—	1	1	—	—	—
Lancashire	2	16	7	11	1	—	—	—	1	—	2	—	3	2	—	1	—
Leicester ...	3	4	3	4	—	—	—	—	—	—	1	—	—	1	—	2	—
Lincoln ...	1	16	11	9	2	2	1	—	—	—	1	2	1	2	—	—	—
Middlesex ...	—	4	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—
Norfolk ..	3	24	11	13	1	2	—	1	—	1	2	—	4	—	—	—	—
Northamptn.	6	11	5	3	—	—	2	—	2	—	—	—	—	—	—	—	—
Northumberland ...	—	9	7	7	—	1	—	—	—	—	2	—	3	2	—	—	—
Notts ...	1	6	2	3	—	1	—	—	—	—	—	—	2	—	—	—	—
Oxford ...	1	7	7	5	1	1	1	—	—	—	1	—	2	2	—	—	—
Rutland ..	—	1	—	1	—	1	—	—	—	—	—	—	1	—	—	—	—
Salop	5	18	9	6	1	—	1	1	2	—	2	—	2	1	—	—	1
Somerset ...	5	27	25	13	2	3	—	1	—	—	5	1	2	—	—	—	1
Stafford ...	8	14	5	10	3	—	—	—	1	—	1	—	3	1	—	—	2
Suffolk ...	2	16	12	4	—	1	—	1	—	—	2	—	1	—	—	1	—
Surrey ...	1	16	5	6	—	—	—	—	—	—	—	1	1	—	—	—	—
Sussex ...	—	51	12	12	2	2	—	—	—	—	8	—	6	—	—	—	—
Warwick ...	4	9	4	4	1	2	3	1	—	—	—	—	—	—	—	—	—
Westmorland ...	—	6	1	1	—	1	—	—	—	—	1	—	—	—	—	—	—
Wilts	1	17	10	2	6	—	—	—	—	—	—	—	—	1	—	—	—
Worcester ...	2	4	4	1	—	—	1	1	—	—	2	—	—	—	—	—	—
Yorks ...	15	42	22	26	5	2	—	6	—	—	1	6	4	1	1	—	3
	111	587	266	254	18	38	12	19	8	7	51	12	77	17	2	8	10

	Feb.	May	Aug.	Nov.	May 6	Nov. 8	Full year	F. M.	F. M. A.	F. A.	M. A.	M. A. N.	M. N.	A. N.	F. A. N.	F. N.	F. M. N.
Anglesey ...	3	2	3	5	1	—	—	1	—	—	—	—	1	3	1	—	—
Brecknock...	—	5	2	3	—	—	—	—	—	—	1	1	2	—	—	—	—
Cardigan ...	4	2	2	2	—	—	1	—	—	—	—	—	—	—	—	—	—
Carm. ...	—	7	6	10	1	1	—	—	—	—	—	—	3	1	—	—	—
Carn.	1	7	8	6	—	1	—	—	1	—	—	1	2	—	1	—	—
Denbigh ...	2	12	9	9	2	1	1	—	—	—	—	3	4	—	—	1	—
Flint	3	5	4	3	—	—	1	—	—	—	1	—	—	—	1	—	—
Glam. ...	2	7	7	5	1	—	1	1	—	—	2	1	1	—	—	—	—
Merion. ...	1	5	7	5	—	—	—	—	—	—	—	1	2	—	—	—	—
Monmouth	—	6	4	3	1	—	—	—	—	—	1	2	1	—	—	—	—
Montgomery	—	5	1	3	—	—	—	—	—	—	1	—	2	—	—	—	—
Pembroke	—	5	1	5	—	—	1	—	—	—	—	—	1	1	—	1	—
Radnor ...	1	5	2	2	1	—	—	—	—	—	—	—	1	—	—	—	1
	17	73	56	61	7	3	5	2	1	—	6	9	20	5	3	2	1
England and Wales ...	128	660	322	315	55	41	17	21	9	7	57	21	97	22	5	10	11

It is curious to note that the total of fairs in February, May, August, and November, with pre-Lenten and Whitsun fairs, is 1425, just ten less than the total of true May-year fairs *plus* all the Church-year fairs which I would claim for that year. I can, therefore, add the Michaelmas and St. Andrew fairs to the last total obtained and make it 1571, or a round fifteen hundred May-year fairs, nearly two-thirds of the total number of solar, as distinguished from mere calendar, fairs.

Wales makes but a very poor show in Owen's list. Instead of five complete May-year series, I have noted ten in North Wales alone; but it serves the present purpose to keep Wales in the background.

It is satisfactory to find seventeen complete series. The case of Weldon, Northamptonshire, is eloquently put as follows :—" First Thursday in February, May, August, and November." There are, however, ten other combinations of May-year quarter days, each of which tells the same tale, and there are 277 places where the May-year seasons are observed by fairs, that is, where more than one May-year fair is held. The relative prevalence of the eleven combinations may be shown as follows :—

	Feb.	May	Aug.	Nov.
17	1	1	1	1
10	1	—	—	1
21	1	1	—	—
9	1	1	1	—
7	1	—	1	—
57	—	1	1	—
21	—	1	1	1
97	—	1	—	1
5	1	—	1	1
22	—	—	1	1
11	1	1	—	1
277	7	7	7	7

Each May-year quarter day enters into seven combinations, which reminds me of the story invented, I believe, to account for the popular name of the parish from which I write, *Yr Hên Blwyv*, the Old Parish. The story goes that a stone-cutter carved the figure 7777 on a gravestone intended to commemorate a man whose age was twenty-eight. By the way, multiplying the May-year sevens together would be a good way to remember the number of solar fairs we have made out, 2303 for 2363, leaving a margin of sixty for possible errors in such a large estimate.

No combination of figures affects the supremacy of May Day. February enters into combination with other quarters at 80 places, May at 230, August at 139, and November at 183. Generally, the ratio seems to be :— February = 1, May = 3, August = 2, November = 2.

But in the two most decisive factors there is not much to choose between May and November. These two factors are the prominence of the summer half of the May year and the fact that the astronomical dates are still observed at ninety-six places in remarkably even numbers—May, 55; November, 41. May 6 is associated with St. John the Evangelist. Such association may have helped to preserve the date; but no such Church sanction, favour, or support has been given to November 8. There are four places in England where both dates are still observed. In several instances where the astronomical dates have been preserved I note a startling parallelism between the dates and the prominence acquired by those places in tradition and archæology.

List of Places where Fairs are held on May 6 and November 8.

Bedfordshire ...	Nov. 8 ...	Biggleswade.
Berkshire	May 6 ..	Abingdon, Aldermaster.
	Nov. 8 ...	Newbury.
Buckinghamshire	May 6 ...	Buckingham, Ivinghoe, Risborough.
	Nov. 8 ...	Buckingham.
Cheshire	May 6 ...	Macclesfield, Frodsham.
	Nov. 8 ...	Knutsford (or Knotsford).
Cornwall	May 6 ...	Treganotha, West Looe.
	Nov. 8 ...	Helstone, Newlyn, Stratton.
Derbyshire ...	May 6 ...	Pleaseley.
	Nov. 8 ...	Ripley.
Devonshire ...	May 6 ...	Chawley, Tavistock.
	Nov. 8 ...	Hatherleigh.
Dorsetshire ...	May 6 ...	Stalbridge.
	Nov. 8 ...	Blandford.
Durham	May 6 ...	Walsingham.
Essex	May 6 ...	Dunmow, Halstead.
	Nov. 8 ...	Dunmow.
Gloucestershire	May 6 ...	Dursley, Winchcomb.
	Nov. 8 ...	Cirencester, Lydney.
Hampshire ...	May 6 ...	Liss, Southampton.
	Nov. 8 ...	Blackwater, Rumsey.
Herefordshire ...	May 6 ...	Wigmore.
	Nov. 8 ...	Leominster.
Hertfordshire ...	Nov. 8 ...	Hertford.
Kent	May 6 ...	Ashford, Groombridge.
	Nov. 8 ...	Biddenden, Chilham.
Lancashire ...	May 6 ...	Newton.
Lincolnshire ...	May 6 ...	Bourn, Holbeach.
	Nov. 8 ...	Alford, Stamford.
Middlesex ...	May 6 ...	Brentford.
Norfolk	May 6 ...	Rudham.
	Nov. 8 ...	Diss, Massingham.
Northumberland	Nov. 8 ...	Hexham.
Nottinghamshire	Nov. 8 ...	Bingham.
Oxfordshire ...	May 6 ...	Chipping Norton.
	Nov. 8 ...	,, ,,
Rutland	Nov. 8 ...	Oakham.
Shropshire ...	May 6 ...	Wem.
Somersetshire ...	May 6 ...	Pensford, Stoke-Gomer.
	Nov. 8 ...	Dulverton, Pensford, Somerton.
Staffordshire ...	May 6 ...	Uttoxeter, Wednesbury, Longnor.
Suffolk	Nov. 8 ...	Newmarket.
Sussex	May 6 ...	Lewes, Bolney.
	Nov. 8 ...	Billinghurst, Forest Row.
Warwickshire ...	May 6 ...	Coleshill.
	Nov. 8 ...	Sutton, Warwick.
Westmorland ...	Nov. 8 ...	Kendal.
Wiltshire	May 6 ...	Amesbury, Colne, Maiden Bradley, Chippenham, Mere, Purten.
Yorkshire	May 6 ...	Hunmanby, Knaresborough, Pocklington, Askrig, Burton in Bishopdale.
	Nov. 8 ...	Leeds, Keighley.
Wales	May 6 ...	Langharne, Llannerchymedd, Nantglyn, Hay, Penrice, Knighton.
	Nov. 8 ...	Aberconway, Llanedi, Llanrhaiadr.

From other sources I find six more May 6 fairs in Wales and three November 8 fairs, in all twelve of the former and six of the latter. Only in one place, Llanfynydd, Carm., I find both days observed.

Pensford, where both dates are retained, is near Stanton Drew, where Sir Norman Lockyer has made out a May alignment. At Lydney, Gloucestershire, a Roman inscription has been found to the Celtic Neptune, *Nudd* or *Lludd*. At Hexham a similar inscription equates Apollo with the Celtic god Maponos. Dunmow's flitch of bacon should be carefully studied.

I think all will admit that the phrase "startling parallelism" is no exaggeration when the case of Wiltshire is considered. When Sir Norman Lockyer ascertained the age of Stonehenge from the alignment of the avenue, he found evidence there of an earlier May-year temple. Geoffrey of Monmouth fixes the earliest festival he mentions as having been held at Stonehenge on the Kalends of May. That must have been against his liking as an ecclesiastic, and the next festival, held shortly after the first, he fixes at Pentecost, the Church equivalent of the May festival; but Geoffrey never fixes a Church festival where and when such a festival was an historical impossibility. Therefore it is practically certain Stonehenge was a May temple pure and simple in the fifth century A.D.

Now Wiltshire heads the record with six fairs on May 6 and its equivalent May 17. So the astronomical, historical, and ferial evidences point clearly to the preeminence of Stonehenge as a May temple. No wonder the Welsh bards claim it as one of the three chief Gorsedds.

But what of the manifestly solstitial character of the present ruins at Stonehenge? In Wiltshire seventeen out of thirty May-year fairs are held in May, but the May year as such is nearly *non est*. May and August combine in one place, that is all. On the other hand, the solstitial year in the county is a fairly well-balanced year. There are five fairs held on the vernal equinox, five on the summer solstice, eleven on the autumnal equinox, and three on the winter solstice, the last figure being quite significant, as definite winter solstice fairs are very rare, though, of course, as Christmas, it has no rival.

Now, the local fairs connect the two series of facts in the most striking manner. "Amesbury, May 17, June 22." So does Owen solve the riddle of Stonehenge. Chippenham, May 17, June 22. Maiden Bradley, May 6, October 2 (O.S. for September 21). Mere, May 17, October 10 (O.S. for September 29, here very likely September 21 at first). Ignoring the date May 6, we have many other like combinations, February 14—October 2, May 14—September 25, July 10—August 1, May 14—October 10, May 12—October 2, May 20—September 23—December 23, May 7—October 8. At Laycock we have only the two solstices July 7—December 21.

Since the foregoing tables were compiled, I have discovered that the estimates for both the May and the solstitial years are much too low, even on the incomplete showing in Owen's list. The astronomical date is to be looked for not only eleven days later, as, for instance, May 17 at Amesbury for May 6, but also eleven days earlier. When immediately before 1752 A.D. the solstice was the eleventh, the date corresponding to our May 6 would be April 26. In 1824 there was a remarkable series of fairs eleven days before the May-year quarter-days proper. This came out while I was searching for some explanation of the strange fact that there is not a single fair on February 4. I find them under January 25. August 5 is the most popular survival of the old August quarter day, and the equivalent of that date is July 25, and that of November 8 is October 29. As the tables given above are sufficient to show the distribution and relative prevalence of May-year fairs, it may suffice to add only the places where the overlooked series of fairs is found.

January 25 (February 4).—Bentham, Bingley, Bodmin, Chesterfield, Churchingford, Derby, Kington (Warwickshire), Weasenham, Whittlesea in the Isle of Ely. (Nine fairs.)

April 23 (May 4).—Bewdley, Billesden, Bruton, Campden, Downton, Finchampstead, Great Bedwin, Hatfield, Hinton St. George, Holywell, Manhineot, Methwould, Norlease, Oakingham, Sawbridgeworth, Stanaway, Tenbury, Yetminster. (Eighteen fairs.)

April 25 (May 6). Ashover, Bracknell, Brigstock, Burnham (Essex), Crowborough, Dronfield, Great Oakley, Holt (Norfolk), Iron-Acton, Llandegla, Llannerchymedd, Llanrwst, Limpsham, Loughborough, Medhurst, Methwould, Parkgate, Stoke-under-Hampden, Toddington, Warkworth. (Twenty fairs.)

April 25 and 26 (May 6).—Kendal, Penrith. (Two fairs.)

April 26 (May 6). King's Norton, Ovingham, Settle. (Three fairs.)

April 27 (May 6).—Axminster, Boroughbridge, Cerrig y Druidion, Dorston (Heref. There is a cromlech there), Holdsworthy, Keynsham, Mortimer, Spalding, South Molton. (Nine fairs.)

April 28 (May 6). Boroughbridge, Cerne-Abbas, Keynsham, Malmesbury, Soham. (Five fairs.)

I claim April 23 because of the popularity of May 4. The two-days' fairs at Kendal and Penrith connect April 25 and 26 with May 5 and 6. I claim April 27 and 28 for a similar reason, namely, that both at Boroughbridge and Keynsham there are two-days' fairs held, which must have been old May festivals. We have the first and the last day of the three-days' festival in the fairs at Methwould on April 23 and 25.

There are only two fairs on August 8, Rhuthin and Shepton Mallet, and there are only two fairs on the equivalent date, July 29, Mountsorrel and Wivelsfield. Mountsorrel is an interesting name, as, I believe, some authorities hold that the wood-sorrel was the original shamrock, which we have reason to claim as a May-year emblematic plant. The great August fair day is the fifth, which we are sure was one day of the August festival because it is coupled with the sixth in two-days' fairs at Ewhurst, Goldsithnay, Louth, and Trowbridge.

July 25 (August 5).—Acle, Alresford, Ashton-under-Lyne, Barnard Castle, Billesdon, Blackboys, Castle-Acre, Little Clacton, Derby, Dunwich, Earith, Gissing, Great Wakering, Hockwold, Ipswich, Leigh (Kent), Lindsey, Liverpool, Middlewich, Milverton, North Down, Reading, Saltash, Seaford, Shoreham (Sussex), Southrepps, Staple, Tiptree Place, Totnes, Tregony, Trew, Wisbech (Isle of Ely), Wells, Yarmouth (Isle of Wight). (Thirty-four fairs.)

July 26 (August 8). Bewdley, Clare, Great Bedwin, Hastings, Horsemonden, Kirby, Lewes, Llanelian, Llansawel, Leighton Buzzard, Malpas, Mattingley, Newnham (Kent), Portsdown, Sherborne, Tamworth (Staff.), Twyford. (Seventeen fairs.)

July 28 (August 8).—St. Kenelm's, Leek, Manhineot, Week St. Mary, Winchcomb. (Five fairs.) (I claim this date on the strength of the correspondence of the Manhineot July fair with that on April 23.)

The fairs in October are very numerous. From the 20th to the 29th I recognise familiar May-year places, such as Cerrig y Druidion, Sawbridgeworth, and Wells on the 20th; Boroughbridge and Llansawel on the 23rd; Leighton Buzzard on the 24th; Bentham and Wells on the 25th.

October 26 (November 8).—Appletreewick (an excellent name), Grantham, Edwinstone, Llandegla, Llansannan, Ovingham, Pen y Bont (Radnor), Spalding, Warminster, Whittlesea in the Isle of Ely. (Ten fairs.)

October 27 (November 8).—Abergwili, Appletreewick, Caergwrle, Cleobury-Mortimer, Darley-Flash, Daventry, March in the Isle of Ely, Nantglyn. (Eight fairs.)

October 28 (November 8).—Alnwick, Askrig, Bangor, East Dean, Llanidloes, Lifton, Linfield, Milbourne-Port, Needham, Plympton, Radnor, South Harting, Thirsk, Totnes, Warminster, Whitchurch (Salop), Wigan. (Seventeen fairs.)

October 29 (November 8 strictly).—Abbey-Holm, Ambleside, Askrig, Bourn, Little Brickhill, Bridgenorth, Broadwater, Burton, Chaford, Charing, Chippenham, Clay, Ely, Ewell, Farringdon, Halstead, Hampton (Gloucestershire), Henley-in-Arden, Highworth, Hindon, Holt (Denbighshire), Horncastle, Hunmanby, Kidwelly, King's Cliff, Kirkby Stephen, Saint Lawrence (Cornwall), Marlow, Midhurst, Mongham, Newcastle-upon-Tyne (nine days), Pamphill, Pleasley, Radnor, Sedburgh, Tenby, Thirsk, Tidswell, Towcester, Tunbridge, Uphaven, Usk, Wellingborough Wigan. (Forty-four fairs.)

Without making any further attempt at estimating the number of May quarter-day fairs, we must count nine fairs on January 25 as February 4 festivals; add 57 to the 38 on May 6, in all 95 fairs which are strictly May 6 fairs; add 56 to the 53 on August 5, and regard them all as strictly August 8 fairs; and add 79 to the 43 on November 8, though there are more fairs in October claiming such recognition.

Our lowest possible estimate of true May-year fairs is now as follows:—

	Feb.	May	Aug.	Nov.	
	77 ...	416 ...	261 ...	321 ..	Total 1074
Astronomical	35 ...	96 ...	109 ..	122 ...	,, 362

The table of the quarter-day groups must likewise be corrected, only to strengthen materially the whole case for the May-year. (Only in a few cases have I been able to correct Owen's spelling of place-names.)

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The Bardic Mystic Sign. (Reproduced from "Barddas." "Morien" quotes Payne Knight's "Symbolical Language of Art and Mythology," pp. 69, 70, where it is stated that the same sign, with a small circle or ring at the converging point of the three lines, is a very ancient emblem in Asia Minor. The angles in Knight's sketch, as reproduced by "Morien," are also exactly 28° each.)

George Meredith makes one of his Welsh characters "think in triads." Here is a new triad:—"The three interpreters of the riddle of the stones: the Sun, the Gorsedd, and the Popular Fair." I have already shown (NATURE, May 2) that the May year is the true basis of the Gorsedd. The bardic *Nôd Cyvrin*, Mystic Sign, which Mr. A. L. Lewis (NATURE, June 6) associates very naturally with the "broad arrow," is really a miniature Gorsedd. I have tested several printed cuts of the sign and find the angles to be 28°, that is, regarding the middle line as an east-west line, the right line points to N. 62° E. and the left to S. 62° E., the only possible emblematic representation, in the simplest form, of the May year in the Gorsedd country.

JOHN GRIFFITH.

KATHODE RAYS AND THE AURORA.[1]

THE idea that kathode rays play a part in aurora has been advanced by several physicists. Prof. Kr. Birkeland ("Expedition Norvegienne," 1899–1900, Christiania, 1901) has described a number of phenomena produced by kathode rays in the neighbourhood of a magnetised sphere, which resemble various types of aurora. He supposed the sun to be a primary source for kathode rays, which might set up secondary rays in the earth's atmosphere. Mr. C. Stormer has carried out elaborate calculations as to the possible ways in which electrified particles coming from a great distance can approach a magnetised "earth"; his

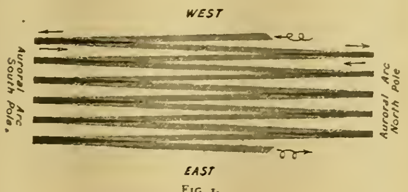

FIG. 1.

results tend to limit the approaching particles to the space near the magnetic poles. Prof. S. Arrhenius has supposed electrified particles to be driven from the sun by the repulsion of light and to reach the earth's atmosphere in about two days, originating aurora and magnetic storms.

M. Villard refers to Arrhenius's theory, but seems somewhat sceptical as to the supposed solar origin of the electrified particles. His own views appear to be a combination of theory and observation as to what happens to ions or electrified bodies of any kind moving in a magnetic field. In a uniform field the ion, when travelling with uniform velocity, describes a regular helix on a cylinder the axis of which is parallel to the lines of magnetic force. The radius of the cylinder varies directly as the component of the velocity perpendicular to the lines of magnetic force, and inversely as the intensity of the field. Suppose, however, that the magnetic field is not uniform, but increases in intensity in the direction in which the ion travels; then, as has been shown by Poincaré, the path forms a curve with diminishing spirals on a cone, and before actually reaching the summit of the cone the particle ceases to advance, and retires, the spirals gradually opening out. If, for instance, the field is that due to two elongated parallel poles, then if the particle gets under weigh between the poles, travelling obliquely to the lines of force, there is a regular game of battledore and shuttlecock, the particle zigzagging to and fro slantwise, reversing its direction whenever it gets within a certain distance of either pole.

M. Villard supposes ions to get in motion somewhere in the earth's atmosphere. As to exactly how this comes about he is not prepared to dogmatise. He is inclined to think that cirrus clouds—which he believes to consist of ice particles negatively electrified—under the influence of ultra-violet light, or less probably under a solar bombardment such as Arrhenius postulates, are probable sources. He also thinks that not improbably a part is played by cosmical dust encountered in the earth's movement through space. Ions starting, say, from a cirrus cloud, and moving obliquely to the lines of magnetic force in the earth's atmosphere, will travel each in a spiral, the whole together forming a sort of luminous spindle, which on getting within a certain distance of, say, the south magnetic pole, turns as if reflected, makes for the north pole, suffers a second reflection there, and so on. Fig. 1, copied from M. Villard's paper, represents the idea diagrammatically. The particles are supposed to come in at the top (answering to the west) and first to travel south. The movement may be supposed to be set up by ultra-violet light from the sun falling on cirrus. The first band or two will thus be in the still illuminated hemisphere, and so invisible; succeeding bands will be overhead in the unlighted hemisphere, and will be visible. Passing further to the east, the energy will be gradually dissipated and the aurora cease to be visible, thus explaining why the late evening, and not the morning, is normally the time of most brilliant aurora.

To fit the theory, the charge carried by the particles must be negative. If it were positive, the motion would be from the east, and the principal aurora would be in the early morning. Fig. 2 reproduces a photograph showing the actual appearance near a magnetic pole from one point of view, in one of M. Villard's experiments. He regards the intensifications of brightness, due to the superposition

FIG. 2.

of the direct and return paths, as answering to an auroral arc. Below the arc there would, he says, be total darkness—answering to the "dark segment" of the ordinary aurora—but for a special form of discharge which he terms "magneto-kathodic" rays; these rays require, he says, a very steep potential gradient, and do not exist in the earth's atmosphere. Changes in the magnetic field or

[1] "Les Rayons cathodiques et l'Aurore boréale." By M. P. Villard. (*Bulletin de la Société d'Encouragement pour l'Industrie nationale*, May, 1907.)

in the velocity of the particles alter the distance between the bright patches in Fig. 2, giving the effect of changes of luminosity running round a circle, a well-known auroral phenomenon. Other phenomena analogous to the "dancing" of auroral rays are easily produced by advancing or withdrawing a bar magnet. M. Villard seems to regard magnetic disturbances rather as agents causing auroral phenomena than the converse, but his theory seems still in a somewhat uncrystallised state. Those actually familiar with auroral phenomena will think of a number of points requiring explanation to which M. Villard does not refer; but his researches, like those of Prof. Birkeland, are at all events highly interesting and suggestive.

C. CHREE.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE proceedings of this year's meeting were largely influenced by the number of foreign visitors, most of whom made lengthy communications to the section. The latter part of the president's address in particular elicited the warmest approval; it was felt that his warning against the danger we now run into of neglecting to cultivate manipulative skill in the young chemist was most timely. The discussions ranged over an unusually wide field; that on valency came first in importance; in its course the new doctrine of Barlow and Pope was subjected to searching criticism, although the general tone was far from hostile. Of deep significance, as illustrating the importance of maintaining the very closest connection between science and industry, was the discussion on the quality "strength" in flour; it was felt by those concerned in the debate that this did much towards establishing clear ideas on this controversial subject.

Prof. Pope opened the discussion on valency with an account of the theory put forward by Mr. W. M. Barlow and himself. Combining chemical with crystallographic data, it is possible to show that the fundamental valency of an element represents, very approximately, the number of units of volume contained in the polyhedral cell which constitutes the domain of its atom in any molecular assemblage. Valency, from this point of view, is primarily a simple volume relation. If the atoms are regarded as centres of attraction and repulsion, a crystalline structure may be considered to be an equilibrium arrangement of such centres. If each atom be allotted its own polyhedral cell or sphere of influence, the simplest assumption that can be made as to the shape of these spaces is that they depart as little as possible from sphericity. The polyhedral cells must fill space without leaving interstices, and the centres of the identical polyhedral cells will be those of the centres of a closest packed assemblage of equal spheres. There are two varieties of homogeneous arrangement of equal spheres in closest packing, distinguished as the cubical and the hexagonal closest packed arrangements.

A crystalline element, in which no molecular aggregation of the single atoms occurs, should thus exhibit holohedral cubic or hexagonal symmetry. Of the forty known crystalline forms of the elements, only six are neither cubic nor hexagonal; in the rest the axial ratios all approximate to the theoretical values calculated on the above hypothesis. The binary compounds can be constructed from spheres of two kinds, but of approximately equal size, present in equal numbers.

This hypothesis has been worked out in detail in the case of the alkali haloid salts and of silver iodide. The assemblages thus constructed present geometrical properties which are entirely in harmony with corresponding physical properties of the crystalline material. The cleavage, twinning, and gliding of the cubic alkali haloid salts and the dimorphism of silver iodide are precisely paralleled by corresponding properties of the assemblages suggested as representing the crystalline structures of these salts.

Each crystalline substance is to be regarded as a close-packed homogeneous assemblage of the spheres of atomic influence.

Prof. Sollas criticised the form of close packing put forward by Messrs. Barlow and Pope, and objected to the structure suggested for silver iodide on the grounds that it did not explain the sudden contraction in volume of this substance when heated to a certain temperature. He described and showed models to illustrate an alternative system. Prof. Miers agreed that the fact that more than 80 per cent. of the elements and binary compounds crystallise in the cubic system was a strong argument in favour of closest packing, yet this principle must be tested by all the physical properties as well as the geometric form of the crystals. Dr. Tutton also criticised the idea of closest packing; he suggested that the topic axial ratios should be taken as an index and measure of the relative closeness of the packing.

Prof. Abegg pointed out that, according to van der Waals, in the liquid state three-eighths of the volume are occupied by matter and five-eighths are free space, and that as substances changing from liquid to solid do not vary essentially in volume, this would seem opposed to the idea of close packing. In answer to the above, Mr. Barlow explained that the spheres were only in reality centres of influence and attraction, and thus there was no real distinction between loose and tight packing. Prof. Tilden remarked that the authors in their explanation of what happens when a change of valency occurs did not appear to recognise that there are two kinds of valency, the one corresponding to the electric charges and the other an extra valency developed under special conditions.

Prof. Larmor thought that the views of the authors seemed to carry weight in their application to the forms of crystals. The approximation that is exhibited by actual crystalline forms to those calculated for dyad molecules consisting each of two equal spheres or nearly spherical domains of influence seemed noteworthy; it gained even more weight when it was remembered that considerable difference in size of the spheres would produce but little difference in the ratios, so that the restriction to equality of the domain of influence could be largely dispensed with and yet the results remain substantially as they are. He hazarded the suggestion that the direct operations of the chemist can grasp only those molecules which have pronounced architectural features, but that there may be whole regions of incipient combinations which do not submit to architectural modification, though they may be recognisable indirectly, as by the spectroscope.

The electrochemical aspect of valency was to associate it with the number of loose and displaceable electrons in the atom. The essential physical features of a metallic atom being generally that a certain number of its negative electrons are thus relatively free, we may imagine that when it is in combination to form a molecule of a salt these electrons are attracted across into the domain of the radicle thus united with it, and when accidental separation occurs in the appropriate way they may remain there. But while something like this is a fact, the mechanism remains largely a mystery, as it has been ever since valency was first connected in this way with electric displacement by Faraday eighty years ago.

Prof. Werner (Zurich) and Prof. Abegg (Breslau) gave descriptions of their views on the broader questions of valency. Prof. Kauffmann (Stuttgart) spoke on the divisibility of valency, and dealt briefly with his own investigations on the colour and fluorescence of organic compounds in connection with structure.

The second morning was entirely given up to a joint discussion with Section G on explosion temperatures, in which Profs. Boudouard, Haber, Smithells, and H. B. Dixon spoke on the chemical side. In the afternoon Prof. Dixon described his observations on the ignition point of various gases and mixtures. In the discussion which followed Mr. Dugald Clerk dwelt on the trouble arising from pre-ignition in large gas engines, and showed that it was important to be able to predict the ignition temperature from the nature of a mixture of gases, and so to allow proper compression space in designing the engine.

Dr. H. O. Jones gave a concise account of work carried out with Sir James Dewar on iron carbonyls. The pentacarbonyl is a yellow liquid, which resembles nickel tetracarbonyl in its properties, but is more stable towards chemical reagents. When decomposed it always gives rise to ferrous salts. On exposure to light it yields carbon monoxide and an orange crystalline solid—diferrononacarbonyl, $Fe_2(CO)_9$. This, when heated alone, gives a dark green liquid consisting chiefly of iron pentacarbonyl, but when hydrocarbons or ether are present in excess and the temperature is maintained below 100° C., an intensely green-coloured solution is obtained, which deposits dark green lustrous crystals of iron tetracarbonyl, $Fe(CO)_4$. This is stable towards reagents, and its dark green solution in organic solvents exhibits a characteristic absorption band in the yellow.

Dr. K. S. Caldwell described his investigations on the conductivity of electrolytes in pyridine carried out in Leipzig in Prof. Hantzsch's laboratory. With the exception of the pyridonium halides, the true acids, compared among themselves, follow approximately the same order in pyridine as in water, and the same applies to the pseudo-acids, which, however, yield much better conducting solutions than do true acids having the same or even greater affinity constants. He further dealt with the influence of temperature on the conductivity of electrolytes in pyridine solution. The temperature of maximum conductivity is well marked, but it is not higher the greater the conductivity as in the case of solutions in liquid sulphur dioxide. Pyridonium salts in pyridine show an abnormally high conductivity.

On Monday Dr. Alex. McKenzie presented a valuable report on the applications of Grignard's interaction. Since the discovery in 1900 that a vigorous action ensues when magnesium powder is added to a mixture of methyl iodide and anhydrous ether, and that this product is extremely active, the Grignard method has been applied with important results in almost every branch of organic chemistry, and the progress made with its help in so short a time as six years is little short of amazing.

By means of it, secondary alcohols are obtained from aldehydes, tertiary alcohols from ketones, acid chlorides or acid anhydrides. Unsaturated hydrocarbons are also obtained from aldehydes, ketones, &c., under suitable conditions. It is also applicable to the preparation of carboxylic, sulphinic and other sulphur acids, of ketones, aldehydes, ethers and esters, and also of alkyl and aryl metallic compounds. Dr. McKenzie dealt at length with the preparation of the agent, and this part of the report should prove of the utmost value to future workers in this field.

Prof. Tschitschibabin, of Moscow, read a valuable paper on triphenylmethyl, in which he discussed the formula of this remarkable substance. Dr. Chattaway described his copper mirrors discovered in the course of an investigation on the oxidation of aromatic hydrazines. When solutions of cupric salts are reduced by these compounds the metal is deposited on the glass in the form of a brilliant coherent film. A number of such mirrors were exhibited; they showed the lustrous red colour of burnished copper, and were perfect in reflecting surface and uniformity. Dr. Boudouard contributed an account in French of the suboxides of carbon.

Dr. Jaeger, of Amsterdam, described the colour changes which occur on melting cholesterol esters, and dealt with the theory of these from the point of view of the phase rule. The colours are due to the formation of doubly refracting layers of liquid crystals and occur at, or a few degrees below, the transition temperatures whilst the two liquid layers are separating from each other. The author gave a striking demonstration of these liquid crystals.

Prof. Phillips Bedson described and exhibited an apparatus for studying the inflammability of mixtures of coal dust and air, consisting of an arrangement whereby the dust was projected by a blast of air through a gap between two platinum wires, and there subjected to a series of electric sparks. A number of interesting experiments were shown with this apparatus; in one instance the flame produced by the ignition of dust at one point was made to ignite a cloud of dust at a point 2 feet or 3 feet distant from the point of inflammation.

Another experimental paper was contributed by Mr. Pratt, who described some properties of metallic calcium, which seems to have industrial possibilities as a reducing agent. In discussing the paper, Dr. F. M. Perkin mentioned his own experiments with turnings of metallic calcium, which has a more powerful reducing action on oxides than aluminium.

The reports of the research committees were as usual of considerable interest. Dr. Lowry, in the report on dynamic isomerism, brought forward very definite evidence in favour of his view that the isomeric change, which usually takes place when nitrocamphor is dissolved in chloroform or benzene, does not occur spontaneously, but is conditioned by the presence of minute traces of alkaline impurities. So sensitive is this change to piperidine that it is complete in ten hours under the influence of so small a quantity as N/1,000,000.

Dr. Orton's report on the transformation of aromatic nitroamines also laid stress on the important part played by the transforming agent in intramolecular changes which, accepting Armstrong's view, is regarded as forming an additive compound with the nitroamine. Dr. Crossley's report on hydroaromatic substances, besides giving an account of the researches made by the committee, included the usual valuable summary of recent work done in this field.

The discussion on the chemistry of flour was opened by Mr. A. E. Humphries with a short paper entitled "The Causes of the Quality Strength in Wheaten Flour." To make bread of the quality required in this country today what are known as strong flours are required, that is, flours which have the capacity of making big, shapely loaves. Most English-grown wheats are deficient in this quality of strength, and give what are known as weak flours. When attempts are made to grow a foreign strong wheat in this country, the yield of grain and straw is, as a rule, too low to make the culture pay. It has been the object of the Home-grown Wheat Committee of the National Association of British and Irish Millers to produce such wheats in England as shall combine strength with maximum crops of grain and straw. In addition to botanical and field work, this problem has demanded the solution of the question, What is the ultimate cause of strength and the nature and source of those constituents which confer on some varieties of wheat the inherent quality of strength and the power of transmitting it?

It has been proved that though climate and soil influence quality, they are not the determining factors in the production of strength, for though the strongest wheats are ordinarily produced in districts where the winters are cold, the summers hot, and the summer rainfall high, certain varieties possess and retain the inherent quality of strength when grown in England. Manuring or early cutting at harvest time has no beneficial effect on quality. Quick growth or rapid maturation is not correlated with strength, nor does the percentage of natural moisture in well-harvested wheat indicate it; indeed, in certain cases the addition of water to wheat materially increases its effective baking strength.

The term "strength" has been loosely applied to cover several characteristics. In the view of the committee it should not be measured by the quantity of water required to make doughs of a standard consistency, nor by the quantity of bread produced per sack of flour used, nor by the way a flour behaves in the dough, but by its capacity for making big, shapely, and therefore well-aërated loaves. This definition covers two characteristics; one, a flour's capacity for making gas in yeast fermentation; the other, its capacity when made into dough for retaining the gas so generated.

The gas-making power will depend largely on the percentage of natural sugar any given wheat contains and its diastatic capacity. These characteristics vary substantially in different wheats. The baker can, and does, influence the quantity of gas generated in baking. The retention of gas when made involves complex problems.

Mr. A. D. Hall pointed out that the old idea that the wheat plant takes definite materials out of the soil to give it strength is incorrect, and emphasised the view that each type of wheat elaborates a mixture of starch, proteins, &c., of definite proportions right from the very beginning, so that the plant as an individual affords a characteristic product. Strength on this assumption is a congenital factor, and probably a "character" in the Mendelian sense.

Prof. T. B. Wood described in detail experimental investigations from which he concludes that two factors are involved in the term *strength*, that of *size*, which is a function of the gas evolved by the flour due to its diastatic capacity, and that of *shape*, which is a function of the proportion of acid and salts present in the flour. Mr. Julian Baker mentioned some determinations of the diastatic power of flours from which he infers that diastase is always present in excess, so that the determination of diastatic power will not be of much value in judging a flour. Dr. E. F. Armstrong alluded to the importance of the gas formed during the early stages of fermentation in distending and affecting the gluten, and pointed out, as also did Mr. Baker, that the enzymes of flour other than diastase should receive the closest attention.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE papers on local geology which followed the president's address were of more than ordinary interest. Mr. Fox Strangways dealt with the district round Leicester as a whole, dwelling specially on those points which are obscure and require further elucidation. Prof. Watts gave an account of his researches in the rocks of the Charnwood Forest. Dr. F. Bennett and Dr. B. Stacey, in describing the felsitic agglomerates occurring at Bardon Hill and in other parts of Charnwood, gave a new reading of some of the features described by Prof. Watts. These questions raised an interesting discussion, which was carried on, not only in the sectional meetings, but also in the field, when the localities were visited in the course of the admirable series of afternoon excursions which had been arranged by the local secretary of the section.

A full day was given to papers dealing with the Triassic rocks. Mr. H. T. Ferrar led off with a description of the features and activities of the desert regions of eastern and western Egypt, and he dealt more particularly with those which have a bearing on the origin of the British Trias. The Libyan Desert presents broad, featureless plains, with no very definite drainage system, and the veneer of waste is protected from removal by wind by layers of pebbles. The Etbai, on the other hand, displays bare hillsides free from débris, aggrading wadis, no sand dunes, and an integrated drainage system.

The origin of the Trias about Leicester was very ably discussed by Mr. T. O. Bosworth. He showed that the Charnian rocks beneath the Keuper were fresh right up to the surface, and when the marl had been denuded, the igneous rocks of Mount Sorrel, Croft, Scapcote, Groby, &c., were smoothed, fretted, and carved by wind action. The beds themselves dip in the direction of the slope of the underlying rocks, and catenary bedding is seen at Croft and Groby. At the base of the marls, too, there are breccias with chemically unaltered stones, and these he considered to be desert screes. Such evidence of subaqueous deposition as there is points to the existence of occasional streams and salt pools rather than the deep waters of one great Keuper lake.

Messrs. Keay and Gimson discussed the relation of the Keuper marls to the pre-Cambrian rocks at Bardon Hill. They showed that the Keuper fills in joints of the pre-Cambrian rocks to a height of 880 feet, which is the greatest altitude yet reached in Britain for any rocks of the Triassic system.

Dr. Cullis, in dealing with the mineralogical constitution of the Keuper marls in the west of England, announced the discovery of minute crystals of dolomite, which he contended were precipitated from the waters of an inland sea. In the discussion which followed, Mr. Lomas showed that dolomite was absent from the Keuper marls of the north of England, and their occurrence in the sands now being laid down by the River Mersey showed that other modes of origin are possible. The exact manner in which limestones become dolomitised and crystals of dolomite are produced in sands is still a matter of great uncertainty, and no satisfactory explanation has yet been offered.

Messrs. Bolton and Waterfall communicated a paper on the occurrence of boulders of strontia in the Upper Triassic marls of Abbots Leigh, near Bristol. This remarkable deposit contains boulders of all sizes from a pea to 100 tons in weight; the yield is about 2000 tons per acre, and it has become the principal world's supply of this mineral.

The fifth report of the committee appointed to investigate the fauna and flora of the Trias was presented by the secretary. To this report Dr. A. Smith Woodward contributed an important paper on a mandible of *Labyrinthodon leptognathus*, Owen, recently obtained from the Keuper sandstone of Cubbington Heath, near Leamington. Its structure confirms the recent conclusions as to the complex nature of the mandibular ramus of Labyrinthodonts, and helps to connect these early amphibians with the Palæozoic Crossopterygian fishes.

Mr. H. C. Beasley has taken advantage of the great find of footprints at Storeton, in Cheshire, last year to re-describe some of the forms hitherto imperfectly known, and Mr. Lomas gave a detailed account of a large slab recently presented to the Liverpool University. This slab gives a track containing fifteen impressions made by the same individual, and the markings are so perfect that the minutest detail of the skin, claws, and movements of the animal which made them, can be observed. It is suggested that Cheirotherium walked erect, and only used the manus to steady itself when bending down to drink or feed. The rocks containing the footprints have been found to contain, besides quartz, felspars, zircon, tourmaline, anatase, rutile, kyanite, staurolite, chert, and numerous black grains not identified.

Mr. A. R. Horwood also contributed to the report an account of the plants and animal remains found in the Leicestershire Trias, and a bibliography of works referring to the flora and fauna of the Keuper of the district.

Mr. L. J. Wills gave an account of a very rich assemblage of fossils he recently obtained from the Lower Keuper of Bromsgrove, in Worcestershire.

Prof. Seeley, in describing the structure of the mandible of a South African Labyrinthodont, pointed out the grea resemblance between the British Triassic fauna and th of the Karroo in South Africa.

A discussion on iron-ore supplies was opened by M Bennett Brough and Prof. Sjögren. Mr. Brough c tended that as the production and consumption of per head of population is increasing year by year, a the world's production in 1905 attained the enormo total of 56,000,000 tons, the outlook for the future disquieting, though not necessarily depressing. The futu of the home demand is likely to be affected by the develc ment of the basic open-hearth process of steel makir which enables phosphoric ores to be utilised. The devel ment of magnetic concentration and of the briquetti of pulverulent ores for furnace use will render possi greater utilisation of poorer ores, and the electric furna will doubtless render it possible to use black sands a other titaniferous iron ores, which cannot be treated pro ably in the blast furnace.

Prof. Sjögren took a more hopeful outlook in deal with the Scandinavian iron ores. These are distributed "ore-provinces" characterised by special geological str tures. While the view that the iron-ore supply is limited is not well founded, the professor estimated t the total supply for the different provinces in Scandina is 1105 millions of tons of ore, equivalent to 582 millis of tons of pig iron. Of these, 60 millions contain a percentage of phosphorus and are suitable for reduc by the Bessemer process, 545 millions are richer in ph phorus and can be worked by the basic-hearth proc, and 500 millions are lean ores only profitable to sm after magnetic concentration.

Continuing the dicussion, Prof. Lapworth congratulated the association upon the importance of the communica tions. He referred to the great changes in the positio of the centre of gravity of the iron industry. Years ag the native forests served for the working of the ore when the Weald was the great centre of output. Whe coal came to be used, the coalfields became the centres, and in later days the ores of the Lias and Oo had come to the front, and probably for some time t would be the chief British sources of supply.

Mr. G. W. Lamplugh said that an important aspect the question was one of cost, and as the first-class ores became exhausted and prices rose, the second-class ores would prove remunerative.

Colonel Parrett took an optimistic view, and referred to the vast quantities of rich ore in Australia and the Transvaal.

The president, in closing the discussion, looked forward to Australia, with its vast coalfields and easy transport, becoming the great centre of iron production.

Mr. W. G. Fearnsides, in describing the pisolitic iron ores of North Wales, showed that they were not, as formerly supposed, characteristic of certain geological horizons.

A paper by Prof. J. Joly, on the distribution of radium in the rocks of the Simplon Tunnel, raised many questions of great interest. From the examination of thirty-six typical samples taken from various points in the tunnel, he showed them to contain varying amounts of radium, and, taken together, they were sufficient to disturb any forecast of the temperature which under normal conditions would be encountered at the level of the tunnel. The presence of radium in the sediments, in hitherto unsuspected quantities, raises the question whether its presence may not be a factor in the events attending mountain building. The shifting of radium and its parent elements by denudation must be regarded as a convection of thermal energy, and result in the shifting of areas of high temperature and crust-weakness from age to age as the site of sedimentary accumulation changes.

The chief papers dealing with palæontology were by Mr. F. Raw, on the trilobite fauna of the Shineton shales and on the development of *Olenus salteri*; the palæontology of the North Derbyshire coalfield, by Mr. A. R. Horwood; and reports from various research committees.

The Carboniferous Zones Committee, after several years of useful work, presented its final report, but the work, which has been carried on with so much vigour and success by Dr. Wheelton Hind and others, will be continued by another committee of which Dr. A. Vaughan is secretary.

The committee appointed to investigate the fossiliferous drift deposits at Kirmington and at various localities in the East Riding of Yorkshire has devoted its energies to a careful examination of the mammaliferous gravels at Bielsbeck, in the Vale of York. The deposits occupy a depression in the Keuper marls, and have accumulated in a boggy hollow on an old land surface. None of the material excavated can be assigned to the direct agency of ice, and there is no evidence available which will definitely fix its age relatively to the Glacial period.

A new section of glacial gravels in Holderness was described by Messrs. Sheppard and Stather. They are considered by the authors to represent part of the terminal moraine of the North Sea ice sheet.

The pre-Devonian beds of the Mendip Hills were reported on by a committee appointed to examine their fossil contents and their relations to a peculiar coarse, ashy conglomerate found in the neighbourhood.

Mr. Lomas described the occurrence of a remarkable bed of peat found during excavations in the Union Dock, Liverpool. The chief interest of the deposit lies in the fact that the peat is composed of marine plants encrusted with polyzoa, hydrozoa, serpulæ, and other marine organisms.

Mr. A. R. Horwood read a paper on a hitherto unnoticed section of the *Amaltheus spinatus* zone in the Middle Lias at Billesdon Coplow, Leicestershire, and some notes on the ancient volcanoes of Basutoland were sent by the Rev. S. S. Dornan.

A catalogue of destructive earthquakes was submitted by Prof. J. Milne. Taking only those which have done structural damage, he finds that between the years 1150 and 1250 A.D. large earthquakes were very frequent, and another great increase commenced about the year 1650, and is still in progress.

Prof. Frech in a subsequent paper showed the part which earthquakes have played in mountain building.

Reports on the Anglesey rocks, by Mr. E. Greenly, and on erratic blocks, by Prof. P. F. Kendall, completed the papers read before the section.

J. L.

ENGINEERING AT THE BRITISH ASSOCIATION.

In accordance with its usual custom, the section did not meet on the opening day until 11.15 a.m., in order that members might have an opportunity of attending the presidential address in Section A.

The proceedings of Section G began with the delivery of his presidential address by Prof. Silvanus Thompson, which dealt mainly with the subjects of the history and development of electric motive power, and the education and training of engineers. After the vote of thanks to the president, Mr. Dugald Clerk read a paper on the present position of gas and petrol engines. The author pointed out that experience in the construction and design of large gas engines is gradually accumulating, but that the conditions of work in this country differ in one important respect from those on the Continent. Practically all the large Continental gas engines are operated with blast-furnace gas, while in this country producer gas has been almost exclusively used, and he was of opinion that until the problem of the bituminous fuel producer was solved, it would be difficult to continue to increase the dimensions of gas engines. Mr. Clerk himself has been working for some years now at the problem of reducing maximum pressures as well as temperatures, without reducing mean pressures, in order that the thickness of the cylinder castings, &c., might be reduced, and that the weight of the engine itself might be made more reasonable for moderate powers; he has been experimenting with a 50 horse-power engine in order to obtain definite data as to the rates of cooling of the working fluid in the actual engine at different temperatures and pressures, and he showed a very interesting diagram illustrating his results, and a table of apparent specific heats of the working fluid at varying degrees of temperature which he had worked out from these experiments. This table showed conclusively a rapid increase of apparent specific heat with increase of temperature. From the values of the specific heat thus obtained, Mr. Clerk was able to obtain a curve of heat loss to the sides of the cylinder both for complete double strokes and for partial double strokes at the inner end of the stroke. The paper concluded with a brief discussion of some interesting points in connection with the petrol engine, and especially with the problem of the exhaust gases. The author showed by results of experiments on his own motor-car that by adjusting the carburetter he was able to reduce the percentage of CO in the exhaust gases very considerably.

In the afternoon the members of the section had an opportunity of visiting the works of Messrs. N. Corah and Sons, hosiery manufacturers, where they saw many examples of the most efficient and up-to-date machinery now used in the manufacture of hosiery. The works are extremely well planned, and reflect the greatest credit upon the proprietors, not only for the skill with which the machinery has been arranged and working costs kept down, but for the great attention paid to ventilation in the workrooms and to the comfort and general well-being of the employees.

Friday morning, with the exception of a short paper by Prof. B. Hopkinson and Mr. L. G. E. Morse on the gases exhausted from a petrol motor, was entirely devoted to a joint discussion with Section B on gaseous explosions with special reference to temperature. Prof. Hopkinson and Mr. Morse in their paper gave an account of experiments which had recently been carried out in the engineering laboratory of Cambridge University on a four-cylinder Daimler engine in order to determine the conditions under which carbon monoxide is formed in an internal-combustion motor, and the relation between the composition of the exhaust gases, the strength of the mixture, the power developed by the engine, and the thermal efficiency. These experiments showed that the curve obtained by plotting the thermal efficiency reckoned on the indicated horse-power to a base of petrol consumption had a sharply defined maximum near the point where the consumption was about 2/10th lb. of petrol per 1000 revolutions, or at the point at which the petrol is just sufficient to be burnt by the available oxygen. The rapid increase in the percentage of carbon monoxide in the exhaust gases as the petrol consumption was increased was shown very strikingly by another curve, and it was apparent that if the carburetter was set in the usual manner in order that the engine might give its maximum power, no attention being paid to petrol consumption, the exhaust was almost certain to contain large quantities of carbon monoxide.

The discussion on gaseous explosions was opened by Mr. Dugald Clerk, who showed a part of the original apparatus used by Bunsen in his classic experiments. Mr. Dugald Clerk then briefly described his own important work in this field of research, beginning with his earlier experiments, in which the pressures reached were recorded by means of a Richard's indicator, down to his latest researches, some of which have been recently described in papers read before the Royal Society in March, 1906, and before the Institution of Civil Engineers at the beginning of the present year, in which optical methods have been used for obtaining records of the variation of pressure with changes of volume and temperature in the cylinder. Dr. Boudouard, of Paris, followed Mr. Dugald Clerk, and described, with the help of blackboard sketches, the apparatus which is being employed by the committee which has been appointed by the French Government to carry out a fresh series of experiments on gaseous explosions, with the object of determining whether the numerical results obtained in the earlier experiments are trustworthy. Prof. Haber, of Carlsruhe, another well-known worker in this subject, dealt very fully in his remarks with the subject of the variation of the specific heat of gases as the temperature of the gas is raised, and Prof. Dixon and Prof. Hopkinson, who also spoke, took up the same point. Prof. Dixon showed by a table of results obtained in his own experiments that, at any rate up to the limit of temperature to which he had at present worked, the specific heat of CO_2 rose very markedly as the temperature of the gas was increased, while, on the other hand, there was very little apparent variation in the specific heat of nitrogen.

During the afternoon the section paid a visit to the British United Shoe Machinery Co.'s works; a very excellent descriptive pamphlet had been prepared in connection with this visit, which was a most enjoyable one, and enabled members to see to what an extent self-acting machinery is now used in connection with the manufacture of boots.

The section did not meet on Saturday, but many of the members spent the day in a visit to the Leicester and Swannington Railway, one of the oldest railways in the kingdom, constructed by George and Robert Stephenson; Mr. Clement Stretton acted as conductor of the party.

Monday, as usual, was devoted to electrical papers, and the first paper taken was by Sir William Preece, on the Pupin mode of working trunk telephone lines. The author stated that he himself had pointed out in 1896 that the effect of electromagnetic induction in telephone wires was in one sense beneficial, and that Prof. Pupin had made it more beneficial in another sense, and had thus been able to reduce the weight of copper used on trunk lines and also to extend the distance to which ordinary speech is practicable. Sir William Preece inspected in April last the very successful work which has been done by the New York Telephone Co. in connection with the adoption of Prof. Pupin's methods. The Pupin coil stores up a portion of the energy, which, like a spring under pressure, is ready to react on the release of the forced condition. The size of the coils and their distance apart on the circuit is a question of experiment; Sir John Gavey has found the best results with coils at every two miles; Mr. Carty, on the other hand, employs them at every $1\frac{1}{4}$ mile on a long line, and at every $\frac{3}{4}$ mile on a short line. The author termed the addition of these inductance coils "loading" the line, and he stated that the use of loaded lines is increasing rapidly. In underground cables the range of a loaded line is found in this country to be 2·4 times that of an unloaded one. The application of this principle to submarine cables is now under investigation, though it has not yet reached a practical stage. In concluding his paper, the author pointed out that telephone troubles in this country often arise from the fact that the subscriber is entirely ignorant of the system of working, and will not take the trouble to make himself familiar with it.

Sir Oliver Lodge read a short paper on tuning in wireless telegraphy, and described the system adopted in the Lodge and Muirhead wireless telegraphy stations.

Mr. J. T. Morris then read a note on an oscillographic study of low-frequency oscillating arcs. The paper collected together a number of observations which had been made both with direct and alternating current arcs, mainly with the object of studying the effect of a change in the medium in which the arc is burning, and also to examine the effect, if any, produced on the arc by the application of a transverse magnetic field. No frequencies of more than 1000 were investigated. The paper was fully illustrated by curves representing the results of the experimental investigations.

The next paper was by Mr. Leon Gaster, on developments in electric incandescent lamps. The author stated that at the York meeting last year he had been able to show a few sample 110-volt metallic filament lamps consuming 1 watt per candle-power; to-day such lamps were ordinary commercial articles. A number of types of metallic lamps were shown by the author, including tantalum lamps, "Osram" lamps, in which tungsten is employed, and a lamp known as the Helion lamp. In the discussion Sir William Preece stated that he had lately equipped his own house with Osram lamps of 105 voltage, and, in order to reduce the pressure from 220 volts to the necessary 105, he had put in an alternating-current transformer, but the cost of this had been more than met by the saving in the payment for current within a year, and that though he had put the lamps in in January, 1906, none of them had so far needed replacement.

The business of the day concluded with a short paper by Prof. E. G. Coker descriptive of the new engineering laboratory at the City and Guilds of London Institute, Finsbury. A new wing has been added to the college, in which accommodation has been provided for an engineering laboratory, drawing offices, lecture rooms, &c. The hydraulic section of the engineering laboratory contains a long cast-iron channel, and all the necessary measuring tanks and other appliances; a number of hydraulic machines have been installed. The engines in the heat laboratory are all of moderate size, and in many cases have been designed with special reference to research work. This new laboratory will bring the teaching equipment at Finsbury well up to date.

Tuesday opened with two papers on ferro-concrete, one by Mr. J. S. E. De Vesian and the other by Mr. W. Noble Twelvetrees. Both authors made extensive use of the lantern, and showed a large number of slides illustrating the kind of work for which ferro-concrete has been so far generally employed. It was interesting to find that this method of construction is now rapidly making its way in this country; Mr. De Vesian showed in his lantern-slides a number of big mills, granaries, &c., which have recently been built in Great Britain on the Hennebique system of ferro-concrete. In the first portion of his paper this author went fully into the specifications which he uses in connection with the materials required in ferro-concrete construction, and explained the tests he carries out in connection with the Portland cement.

Mr. Noble Twelvetrees showed a series of slides to illustrate the use of reinforced concrete for such types of construction as railway sleepers, standards for overhead electric cables, &c., and he advocated the use of concrete for preserving existing steel bridges, especially where they are liable to the corrosive effect of locomotive fumes.

Mr. Worby Beaumont followed with a paper on the origin and production of corrugation of tramway rails; he suggested various causes in explanation of this peculiar phenomenon, but, though the paper led to an interesting discussion, no speaker was able to throw any light upon the real origin of this troublesome problem, which so often worries the tramway engineer.

Two other papers were dealt with by the section on this day, one, by Mr. H. I. Brackenbury, on modern machinery and its future developments, and the other, by Mr. C. V. Drysdale, on resistance coils and their comparison. The latter author exhibited his ingenious apparatus, not only at the sectional meeting, but later on in the evening at the conversazione which was held in the Leicester Museum.

Owing to the very full programme of papers, the section was forced to meet again on Wednesday, August 7, when four papers were discussed. The first, a short paper by Mr. J. F. Brooks, described a machine for weighing the forces on a cutting tool; the author exhibited and explained one of his machines, and the values of the forces on tools with cutting angles of 65° and 70° when cutting cast-iron and mild steel with small cuts at moderate speed were shown by means of diagrams.

Mr. R. S. Ball, in his paper on the governing of hydraulic turbines, dealt with the problems involved in the speed control of hydraulic turbines for a wide range of head. He showed that such regulators may be divided into two classes:—(1) disengagement governors (mechanical), which come into action when an assigned departure from the normal speed is attained, being otherwise out of gear; (2) continuous governors (mechanical and hydraulic), which are always connected to the gate-controlling mechanism, and which begin to operate at the moment the speed rises or falls from the normal. The action of various types of governors was described by figures and diagrams plotted from the results of tests.

Prof. H. T. Barnes, of McGill University, Montreal, then read a paper on the ice problem in engineering work in Canada. He showed that in Canada there is always great steadiness of the temperature of the water throughout the ice season, and that there are three varieties of ice to be distinguished—surface or sheet ice, spicular or frazil ice, and anchor or ground ice. Prof. Barnes explained that by an intelligent use of artificial heat, especially at night time, when super-cooling is most common, the interference of ice with the normal operation of a power-house may be largely prevented. The most favourable condition for a power-house is when it is situated on a river normally frozen over on its surface and with no stretches of open water above.

The section concluded its business with the reading of some notes by Mr. J. Smyth on the application of water-power and how to secure the greatest efficiency in working same.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The sum of 250,000 dollars has been appropriated by the Kansas Legislature for the erection of engineering buildings in connection with the State university.

The Sunderland Technical College is to be extended by the addition of a day training college and engineering laboratories at a proposed cost of 10,000*l*.

Dr. James E. Talmage has resigned the professorship of geology in the University of Utah in order to devote himself to investigation work in mining geology. Dr. F. J. Pack has been appointed to succeed him.

This year's scholarship of the Institution of Naval Architects has been awarded to Mr. A. M. Robb, Glasgow. The scholarship is of the annual value of 50*l*., and, subject to the regulations, is tenable for three years.

Mr. Simon Flexner has been made a member of the Rockefeller Institute for Medical Research, New York, and director of the pathological laboratories; and the following have been appointed members of the institute:—Mr. S. J. Meltzer (physiology and pharmacology), Mr. E. L. Opie (pathology), and Mr. P. A. Levene (biological chemistry).

The calendar of the Manchester School of Technology and Municipal School of Art for the session 1907–8 has just been issued by the firm of John Heywood, Ltd. In it are to be found full particulars of the courses of instruction, and the scholarships, prizes, &c., at the institution. Many of the laboratories and workshops are pictorially represented in the volume.

The following appointments abroad have recently been made:—at the Rush Medical College, Chicago, Dr. Robert R. Bensley to be professor of anatomy, and Dr. Edwin O. Jordan professor of pathological anatomy and bacteriology; Dr. Francis Huber has been elected to the chair of medicine at the New York College of Physicians and Surgeons, and Dr. Frederick Peterson to that of psychiatry in the same institution; at Yale University, Dr. J. M. Flint has been appointed professor of surgery; at Würzburg, Dr. Faust has been made professor of pharmacology.

The remarkable progress accomplished by the Japanese during the last thirty-two years in the field of public education is brought out very clearly in the thirty-second annual report of the Japanese Minister of Public Instruction, which has been published recently. This report deals with the year 1904–5, the date of the war with Russia. It is instructive to note that this time of stress was allowed to interfere in no way with educational activity. The Emperor, indeed, proclaimed it to be a national duty that the zeal and efforts of educational administrators and teachers should be redoubled. Despite the financial difficulties to which a great war gave rise, the expenditure on education was not diminished. While in 1873 only twenty-eight out of every 100 children were under instruction in public schools, the ratio had risen in the year under review to the remarkable one of 97 boys and 91·5 girls out of every hundred, and the number of children in the schools had reached 7,551,445. Higher education, too, was in an equally flourishing condition. For example, the number of students in the University of Tokyo had reached 3500, and in Kioto 1300. Numerous special schools, technical schools for engineers and for agricultural specialists, medical schools, and schools for the study of modern languages, were all in a high state of efficiency. Moreover, a point of special interest in our country to-day, the hygiene of schools, is scrupulously watched, and medical officers are charged specially with the duty of keeping the pupils under examination. Altogether the report provides abundant evidence of the success with which Japan is educating her people.

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 6.—"The Osmotic Pressure of Compressible Solutions of any Degree of Concentration." By Alfred W. **Porter.**

An exact equation is obtained connecting osmotic pressure with the vapour pressures of solvent and solution, viz.:—

$$\int_{\pi_\pi}^{p} s\,dp + \int_{p-P_p}^{\pi_{00}} u\,dp = \int_{\pi_\pi}^{\pi_{00}} v\,dp,$$

where

P_p is the osmotic pressure when the hydrostatic pressure of solution is p;

π_{00} is the vapour pressure of the solvent when under the hydrostatic pressure of its vapour alone;

π_π is the vapour pressure of the solution when under the hydrostatic pressure of its vapour alone.

v and u are the specific volumes of vapour and solvent;

s is the diminution of a very large volume of the solution when 1 gram of solvent is removed.

The equations given by van 't Hoff and the Earl of Berkeley can at once be derived from this general one by taking the liquids as incompressible and considering respectively the cases in which (1) the solvent, (2) the solution, is under the pressure of its own vapour alone.

It is shown that if two solutions in the same solvent have the same osmotic pressure, they have also the same vapour pressure provided the values of these pressures be measured for the same hydrostatic pressure of the solution. They have also the same freezing point.

It is shown that when a solution is in equilibrium with the pure solvent across a semi-permeable membrane the vapour pressure of the solution is necessarily equal to the vapour pressure of the solvent, *each being measured for the actual hydrostatic pressure of the fluid to which it refers.*

The above involves a recognition of the variation of vapour pressure with the hydrostatic pressure of the fluid to which it relates; an equation giving the mode of variation is derived.

A graphical solution of the osmotic-pressure equation is given.

June 13.—"Some Points in the Development of *Ophiothrix fragilis*." By Prof. E. W. **MacBride**, F.R.S.

The paper contained a preliminary report on the result of researches on the development of the British Ophiurid *Ophiothrix fragilis*. The eggs of this species are small (0·1 mm. in diameter) and opaque, and the development until the completion of the metamorphosis occupied twenty-six days. The full account of the research, which will shortly appear in the *Quarterly Journal of Microscopical Science*, will contain the first complete description of the formation of all the organs of an adult Ophiurid from their rudiments in the Ophiopluteus larva. In the preliminary account two points of special interest are emphasised:—(1) the varying character of the early development according to the conditions under which the egg was fertilised; and (2) the indications of metamerism in the cœlomic sacs of the larva. With reference to (1), if the eggs were artificially fertilised, *i.e.* if the ovary were removed from the body and the eggs shaken out and then mixed with sperm, a larva resulted in which there was a precocious formation of mesenchyme, so that the blastula stage was practically solid; this was succeeded by an invagination in which the endodermic plate was many layered. As a result, the gastrula had a wedge of cells projecting into the gut which was slowly absorbed. A similar wedge seems to be a normal feature of the development of *Ophiura brevis*, according to Dr. Caswell Grave. If the animals were allowed to spawn naturally, a hollow blastula was formed, and invagination was normal; in addition, at the anterior end of the larva a vacuolated crest of cells was formed, which later disappeared. With regard to (2), the cœlom on both sides of the larva became divided into three somites. Of these, the middle one on the left side gave rise to the hydrocœle, or rudiment of the water-vascular system; its fellow on the right is the homologue of the "dorsal sac" or "madreporic vesicle" of Asteroidea and Echinoidea, but in *Ophiothrix fragilis* it sometimes assumes a form similar to that of its left antimere, showing that the water-vascular system was originally paired.

PARIS.

Academy of Sciences, August 26.—M. A. Chauveau in the chair.—Study of the spectrum of the comet 1907*d*. Peculiarities of the tail: H. **Deslandres** and A. **Bernard**. The spectrum of this comet has been studied by two methods, with and without a slit. The present note gives an account of the results obtained working without a slit. The spectrum shows bands in the yellow, green and blue corresponding to hydrocarbons, and, in addition, the characteristic ultra-violet band of cyanogen. Differences were observed between the spectrum of the tail and that of the head, but further observations are required to elucidate the exact meaning of these differences.—Parthenogenetic developments in solutions isotonic with sea water: Yves **Delage**. All the principal salts of sea water, employed separately, including the chlorides of sodium, potassium, magnesium, calcium, the sulphates of sodium and magnesium, and magnesium bromide, can determine parthenogenesis of the eggs of sea urchins; these vary greatly in their effects, and the best solutions for each are given in detail. One unexpected result is noted: a pure solution of saccharose sometimes allows of strong development of the egg. As regards the stage to which it is possible to raise the eggs, the author has at last been able to obtain true sea urchins furnished with all the characteristic organs by a purely chemical action.—Propylene oxide: Louis **Henry**. It is known that primary alcohols arise from the action of alkyl magnesium compounds upon ethylene oxide, and in a previous paper the author has shown that the symmetrical dimethylethylene oxide behaves differently. In the present communication it is shown that methylethylene oxide, or propylene oxide, resembles ethylene oxide in its reaction with ethyl-magnesium-bromide, normal methylpropylcarbinol being formed.—The ephemeris for the search for the comet 1907*d* on photographic negatives: P. **Stroobant**.—The root of the least modulus of an algebraic equation: Léopold **Fejér**.—The theory of the radiation of incandescent mantles: M. **Foix**. The conclusion is drawn from the mathematical investigation given that the yield of light may be increased either by diluting the cerium oxide in thorium oxide or by reducing the thickness of the cerium oxide. The latter result has been confirmed by experiment.—The probable formation of thorianite and uraninite: B. **Szilàrd**. The amounts of uranium and thorium in these two minerals are in practically inverse ratios; the proportion of uranium in thorianite is the same as the proportion of thorium in uraninite, and inversely. From this fact hypotheses are deduced as to the mode of formation of these two minerals.—The action of cold in the treatment of coffee trees against the Indian borer (*Xylotrechus quadrupes*): Louis **Boutan**. The momentary cooling of the stem of the tree by such a substance as ethyl chloride presents no inconveniences from the point of view of the life of the plant, and is sufficient to kill all the larvæ in the interior of the wood. The price of ethyl chloride, however, is too high for any practical use to be made of these results.—A newly born hippopotamus at the menagerie of the Natural History Museum, fed by goats: E. L. **Trouessart**. The mother of the infant hippotamus had always on previous occasions refused to feed her young. In the present case the young animal was removed, and has been successfully reared for eleven days by goats, eight of whom serve as foster-mothers.—The mechanism of the closing of the appendicular canal: R. **Robinson**.

CONTENTS.

THURSDAY, SEPTEMBER 12, 1907.

THE PHYSICAL LIFE OF BIRDS.

The Bird, its Form and Functions. By C. William Beebe. Pp. xii + 496; illustrated. (London: Archibald Constable and Co., Ltd., 1907.) Price 14s. net.

MR. BEEBE'S handsome and beautifully illustrated book on the bird forms as charming and interesting an introduction to physical ornithology as the general reader, or the unscientific bird lover, can desire. In his preface, the author points out that too many students of ornithology stop short at the classification of birds, the naming of new species, and the observation of the habits of those that are known; and that not one of an audience of teachers to whom he had lectured, though they could identify fifty birds or more, knew the significance of the scales on a bird's foot. His book is intended to bridge this gap. It is an untechnical study of the bird in the abstract. His aim has been to take a few dead facts and clothe them with the living interest which will make them memorable and full of meaning to any lover of birds, and at the same time to keep them acceptable in tenor and truth to the most critical man of science. Wherever possible, a fact has been illustrated with a photograph from a preparation, or from a living bird, the author's belief being that when verbal exposition fails, pictorial interest will often fix a fact in the memory. How successful he has been in this a glance at the wealth of exquisite illustrations will show. Beginning at the root of all things avian, his first chapter deals with the birds' ancestors, the Ichthyornis, Archæopteryx, &c., both the remains and a "restoration" of the latter being illustrated.

We cannot follow in detail the seventeen chapters in which he deals with the entire structure of birds (treating each part in relation to the various functions it has to perform), their senses, their eggs, and the young in the egg. But we will turn to that on "beaks and bills," as a fair example of the treatment of the subjects. It is illustrated with thirty-three figures, and all the various forms of beak are described with their special adaptation to the wants and habits of the different birds. The beak is all-important to the bird.

"Tie a man's hands and arms tightly behind his back, stand him on his feet, and tell him that he must hereafter find and prepare his food, build his house, defend himself from his enemies and perform all the business of life in such a position, and what a pitiable object he would present! Yet this is not unlike what birds have to do. As we have seen, almost every form of vegetable and animal life is used as food by one or another of the species. Birds have most intricately built homes, and their methods of defence are to be numbered by the score; the care of their delicate plumage alone would seem to necessitate many and varied instruments; yet all this is made possible, and chiefly executed, by one small portion of the bird—its bill or beak."

This picture is hardly overdrawn if we allow a little for feet and spurs and wings, which some birds use for getting food and making homes and fighting. In feeding alone, so many different kinds of beaks are wanted. To pick up small seeds, to probe the deepest calyxes of flowers, catch insects on the wing, and fish in the sea in various ways on or below the surface; to sift the mud and ooze, and skim the surface of the water, to chisel away wood and tear flesh; all these ways of feeding require different beaks, and they are all described in a delightful manner that anyone can understand. So wonderful is their variety and the variety of their functions that this one chapter, like the others, as the author observes, could easily be elaborated into one or more volumes. "A collection of bills of the various wading-birds would look like a complete set of surgical tools."

In the same way the rest of the subject is treated, the chapters on feathers (in which are some most interesting pictures of pelicans in their breeding haunts) and eggs being perhaps the most attractive. The book will take and hold a distinct place in the literature of the subject, for it is quite original and stands alone. Not only is it a most readable and interesting book, but a valuable one to teachers. A short list of books in the appendix indicates sources where much more detailed information may be obtained by those who desire it. They relate chiefly to North American birds, for the author writes from the New York Zoological Park. Nevertheless, his book is of world-wide interest. The wealth of illustration is one of its chief features, and the index is very full and elaborate.

ANIMAL MECHANICS.

Kinematik organischer Gelenke. By Prof. Dr. Otto Fischer. Pp. xii + 261. (Brunswick: Friedr. Vieweg and Son, 1907.) Price 8 marks.

ENGLISH anatomists appear to have taken up the study of the joints and the movements performed by means of them almost entirely from the standpoint of descriptive anatomy, leaving the mathematical and more precise study somewhat severely alone. Proof of this statement is amply afforded by reference to the excellent bibliography which Prof. Fischer has appended to his handbook, the work under review, on the kinematics of living joints. No less than 127 references are given to German or French text-books or papers on the subject, whilst English or American authors are responsible for only nine. Of these, eight are papers to be found in various journals. The only extended mathematical treatment in English is that by Prof. Haycraft, entitled "Animal Mechanics," to be found in the second volume of Schäfer's "Physiology." The combination of a sufficient knowledge of mechanics with the necessary anatomy would therefore appear to be somewhat rare in this country. The subject, however, is one of great interest, and it is treated in a learned and at the same time lucid manner by Prof. Fischer, who has made for himself a considerable reputation in connection with it.

In the first section of this work, a more or less general investigation is made into the mechanical principles which govern the movements of organic joints. This is done by considering first a machine joint, such as an ordinary hinge, and then the points of difference between such a joint and an organic joint. In a hinge the form of the surfaces in contact is practically constant, as the joint moves between its extreme positions. This is rarely the case, of course, in a living joint. The variations introduced by these changes are carefully considered, the diagrams aiding very materially in the treatment. The mathematics employed requires some knowledge of differential and integral calculus, and also of coordinate geometry, but presents no very serious difficulties.

The succeeding part of the book is of great interest, as it contains a description of Prof. Fischer's own methods of showing graphically the movements of single joints and of combinations of joints. There have been many advances in this direction since the Webers, so far back as 1830, investigated the variation in the position of the centre of gravity of the body in walking and running. M. Marey introduced photographic methods, somewhat resembling modern kinematograph work. The method described in the present work is the best yet devised. A man is clothed from neck to feet in black, and a series of Geissler tubes, eleven in number, are arranged symmetrically on his head and limbs. These are joined to the secondary of a Ruhmkorff coil, the primary of which is interrupted about twenty-five times per second. The man's movements are then recorded photographically by means of cameras placed on either side and in front and behind. In this way records in three directions in space were obtained, and these were coordinated by means of networks of squares photographed at the same time. The phases of movement, either of the whole body or of a single joint-system such as the arm, are thus illustrated.

Prof. Fischer brings much originality into his treatment of a by no means easy subject. The publication of this handbook may well direct the attention of English students to a branch of anatomy which has been somewhat neglected, but in which there remains much to be done.

GAS ANALYSIS.

Traité pratique de l'Analyse des Gaz. By M. Berthelot. Pp. ix+483. (Paris: Gauthier Villars, 1906.) Price 17 francs.

IN that branch of chemical analysis dealing with gases there is by no means the superabundance of text-books characteristic of other branches of analytical work, and it is noteworthy that such works as we possess are nearly all memoirs of original work by the author, or have been developed from that form. The names of Bunsen, Winkler, Hempel, and Travers occur in this connection, and the present work is no exception. In some of his earliest researches, M. Berthelot was met with the necessity of devising methods for the analysis of gases, and many of the methods described in this book were used by him as early as 1858. After an introduction, the work is divided into five sections dealing with the collection and storage of gases, methods of qualitative analysis, general methods of quantitative analysis, monographs, and the recognition and estimation of single gases and mixtures.

The whole book is strongly impressed with the author's individuality, and a considerable proportion of the section dealing with qualitative analysis is original, especially the chapters on the pyrogenic analysis of gases and spectroscopy. In the latter connection, a simple apparatus is described by means of which a spectroscopic examination of a gas at the ordinary atmospheric pressure can be rapidly made, and in the section dealing with the properties of each gas in detail a table of the chief lines observed by this method is given. The actions of the electric spark and the silent discharge are also special to the author, and his methods are expounded in detail. The remarks on the use of absorbents are worthy of close attention, it being rightly pointed out that the reduction of volume by treating with a given absorbent cannot be taken as a proof that a particular gas is present: a gas must be isolated in a pure state before its presence in a gas mixture can be taken as proved. On the quantitative side more exception can be taken to the methods expounded, which, indeed, leave much to be desired, both on the score of rapidity and precision. Water jackets are not used for the measuring vessels, the temperature being controlled by immersion in a large mercury trough holding from 16 to 20 litres, and this is described as "the essential instrument in all exact manipulations relating to gases and their analysis." As this trough requires about 600 lb. of mercury to fill it to its working level, exact gas analysis would of necessity be confined to a very limited number of laboratories if this dictum were to be accepted. The sections on mercury pumps, calibration of measuring vessels, and determination of gaseous densities are also entirely out of accord with present-day standards of accuracy. References to other workers in the same field are rare, and the description of their apparatus and methods not always accurate. The account given of Hempel's gas burette and its use on p. 269 is an example of this. The commencement of the description is that of the Hempel burette, but the figure and manipulation correspond to a modified Winkler gas burette, and Prof. Hempel would hardly recognise the description of his pipette as "formed of two bulbs connected by a fine tube and each furnished with a recurved capillary tube."

In the fourth section a monograph is given of each gas, and this section will perhaps be found to be the most valuable part of the work. It is a drawback that no references to original memoirs are given in this section, and for this reason it is difficult to make out whether the densities given are experimental or calculated, or whether such a figure as $-93°$ C. for the boiling point of propylene is the result of a misprint or an inaccurate observation.

The book is one which everyone interested in gases should have on their bookshelves, but, like the classical work of Bunsen on the same subject, it cannot be regarded as of practical service as a text-book at the present day. Its value will be historical and personal as the last published work of a great French chemist.

MOTOR ENGINEERING.

A Manual of Petrol Motors and Motor-Cars, comprising the Designing, Construction, and Working of Petrol Motors. By F. Strickland. Pp. ix+376. (London: C. Griffin and Co., Ltd.) Price 18*s.* net.

Mr. Strickland has produced a very original and useful work on the modern motor-car. There is no padding; the book is filled from cover to cover with the practical remarks of a man who knows his subject. The matter is conveniently arranged, and the reader, whether he be manufacturer, designer, or user, is able to follow the author, and in almost every case to obtain his very decided opinions on many of the controversial points which have arisen during the development of the car of to-day.

First we have a short but very readable chapter on the power required, and a second chapter on the general arrangements of an up-to-date car. Then follow nine chapters on the details of the engine, and the remainder of the book is devoted to the other details taken seriatim.

It is refreshing to find the author in his chapter on general arrangements taking the bold line of prophesying that the present type of motor-car will not long endure. Most thoughtful engineers will agree with him that this is the right view to take, and in spite of the repeated assurances of those who have the car of to-day to sell, that finality of design has already been reached, and that little remains to be done to pleasure cars beyond perfecting details and cheapening modes of manufacture, it is probable that Mr. Strickland is right in saying that the present design, with its long engine sticking out in front necessitating a long wheel base, has been made necessary by the requirements of the engines, which up to the present are found in practice to need frequent attention on the road. He points out that when the engines become more trustworthy they will be relegated to their proper position underneath and nearer to the centre of the car. He gives strong reasons for showing that this position, although it does not give such facilities as at present for the chauffeur to make his repairs in public, will undoubtedly improve the car in many important respects, not least being that of the comfort and ease of the occupier.

The chapters devoted to the consideration in detail of the various parts of both pleasure and commercial motor vehicles are very complete; every important organ is considered and discussed separately, the various modes of construction are clearly explained, the drawings are real drawings and not process blocks, and are consequently far clearer than is unfortunately now too often the case.

The important features of the book are the tables of the principal dimensions of the best known cars of the day. These tables are accompanied by very full notes, which make them additionally valuable. It is the first time that anyone has attempted to collect together such a mass of useful information as is contained in these tables with their accompanying notes.

While there is so much to praise in this book, it is curious to note the peculiar error that the author falls into on p. 309 when he discusses the comparative flexibility of the steam engine and the internal-combustion engine. He seems entirely to ignore the extraordinary range of power without change of gear that has been rendered possible in the steam engine by the use of flash boilers. When with such boilers it is possible to give effective mean pressures varying from 100 lb. up to 1000 lb., it is evident that even for heavy commercial vehicles the use of change gearing is no longer necessary when steam is employed as motive power.

A few other dicta laid down by the author may be challenged in a similar manner to the above, but on the whole his work contains, in addition to the valuable tables and data above mentioned, an unusually large number of carefully reasoned and valuable conclusions which will render it almost a necessity for everyone who is closely interested in the modern motor-car to keep this book in his library.

THE FAMILY AND THE FUTURE.

Population and Progress. By Montague Crackanthorpe, K.C. Pp. viii+131. (London: Chapman and Hall, Ltd., 1907.) Price 2*s.* 6*d.* net.

This volume contains a series of five essays, of which the first three were published originally in the *Fortnightly Review*, the earliest in 1872 and the two later ones in 1906 and 1907. As is stated in the preface, the thread that binds them is the "Voluntary Principle," that is to say, the principle that married people should for the good of society exercise voluntary control over the size of their families. Together they form a connected and forcible argument in support of this principle. The author sees in it, if not a panacea for all social ills, at any rate the most effective of prophylactic measures. Some space is occupied in reasoning, probably without avail, with those who would oppose it on religious grounds; but this we will pass by, mentioning only the very pertinent reminder to those who urge the biblical precept "be fruitful and multiply" that there were at the time at which this injunction was given, according to the very record on which its authenticity is based, only eight persons living on the face of the earth.

Dealing with masses, one may recognise two kinds of limitation of family, the one general or non-selective, the other eugenic or selective; each is regarded by the author as conducive to social sanitation, but the class of disease which may be prevented by the former is somewhat different from that on which the latter puts a check. The possibility and desirability of eugenic limitation of families has been much discussed recently, and most people recognise that society suffers if epileptics, degenerate and feeble-minded persons, or those suffering from inheritable disease are allowed freely to propagate their kind. In this connection Mr. Crackanthorpe does not rely on the "Voluntary Principle" only, but advocates that anti-eugenic marriages should be prohibited by law, and he gives instances, quoted from the writings of Dr. Rentoul, of Liverpool, of laws of this nature in force at the present time in Austria, Servia, and some American States.

The range of evils, which, according to the author, may be met by general limitation of families, is large—embracing prostitution on the one hand, and war on the other. The chief excuse for the former is that many men are prevented by prudential consideration from contracting early marriages; and this he suggests might be removed if it were universally recognised that prudence might be exercised after marriage, and if popular opinion shifted so as to condemn the raising of larger families than could be adequately provided for. With regard to war, we find on p. 128 the following passage:—

"The wars of brutal conquest and plunder, of religion, and of dynastic succession, which have from time to time devastated Europe, are now things of the past. But there remain commercial and colonial laws—wars to procure in old countries fresh markets for manufactures, and to provide in new countries an outlet for their superfluous inhabitants. These are the wars that the future has in store for us, unless we can remove the causes of them."

Of the causes referred to, the most predominant is the numerical increase of the population of the older countries in a ratio disproportionate to their food supply or to the territory at their disposal.

E. H. J. S.

OUR BOOK SHELF.

Temperatur und Zustand des Erdinnern. Eine Zusammenstellung und kritische Beleuchtung aller Hypothesen. By Hermann Thiene. Pp. iv+100. (Jena: Gustav Fischer, 1907.) Price 2.50 marks.

THIS memoir, which was written as a prize essay in connection with the University of Jena, is an admirable *résumé* of the various memoirs dealing with the nature of the earth's interior. The first twenty-eight pages contain a slight sketch of the literature of the subject from the earliest times down to the year 1870, beginning with Plato's "Phaedon" and ending with Delaunay and Sterry Hunt. The work done since 1870 is treated in somewhat greater detail in the second part of the memoir. For the chemical composition of the earth's crust the author adopts the average calculated by Clarke from the analyses of American rocks. He then discusses the determinations of the mean density of the earth, concluding that it must lie between 5·4 and 5·7, while for the density of the crust he argues that the specific gravity of diorite (2·8) may be accepted as an average. On the problem of the distribution of density within the globe, the author cites the views of Lipschitz, Sir George Darwin, Stieltjes, Callandreau, and Radau, and proceeds to consider the very problematic views that have been enunciated concerning the chemical constitution of the earth's interior.

On the question of the temperature of the earth's crust the author finds himself on safer ground, and he gives a summary of the evidence derived from the observations carried on in tunnels, mines, wells, and bore-holes, which is fairly complete and up-to-date. With speculations on the limits of temperature in the earth's interior, the author returns to more debatable problems, and in the absence of exact knowledge concerning the effect of enormous pressures on materials at high temperature can only cite the guesses that have been made upon the subject. The discussion of the question of the condition of the earth's interior, to which the latter part of the memoir is devoted, contains a very useful *résumé* of the views of various authors upon the subject, the important bearing of recent discoveries concerning radio-activity upon the question of the source of the internal heat of the globe and upon the age of the earth being kept in view. No fewer than one hundred and fifty-eight authors are cited, and the catalogue of works and memoirs numbers one hundred and seventy-seven. A few, not very important, omissions may be noted, but the summary, on the whole, is fairly complete and judicious, and it can scarcely fail to be of great service to those interested in the important questions with which the author deals.

The Garden Anthology. Edited by Rose Gardner. Pp. xiv+313. Price 2s. 6d. net.
The Voice of the Sea. Edited by Ingram Swale. Pp. x+163. Price 2s. 6d. net.
The Wayfarer. Edited by Claude E. Benson. Pp. xv+252. Price 2s. 6d. net. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co.)

THESE three volumes contain good selections of prose and verse. In each case the respective editor has brought together a very interesting collection. Those fond of flowers and gardening will be attracted to the first book named. The poems have been classified, so that it is possible to refer to gardens of various kinds and to their aspect at the different seasons of the year. Some of the references to plant-life exhibit a very accurate knowledge of the less obvious changes it undergoes.

"The Voice of the Sea" is chiefly of interest as a collection of poems dealing with the sea in its many changes and phases; objects of marine interest are in some cases referred to, but in few instances is expression given to more technical thought in connection with them.

"The Wayfarer" is a miscellaneous collection referring to the seasons, the times of day, and touching on many things dealing with wild life and nature. The poems are brought together under various headings, and the book should be of interest to many readers.

The Relation of Man to the Animal World. By Sir Samuel Wilks, Bart. Pp. 34. (Hampstead: The Priory Press, 1907.) Price 1s. net.

WE find ourselves somewhat at a loss to discover the object and aim of this "booklet," which is based on an address by the author delivered some few years ago before the Church Congress at Folkestone. The subjects discussed, or rather, perhaps, mentioned, include the killing of animals for food, clothing, &c., and sport, their maltreatment for the sake of fashion, the use of eggs and milk as nutriment, castration and vivisection, and the rearing of animals in domestication. Although incidentally recording his objection to some of our methods of treating animals, the author (who is an eminent medical man) is in no sense a fanatic or a faddist, taking up for the most part what may be best described as the equivalent of an "agnostic" position. He remarks, for instance, on the concluding page that "if anyone should ask what position I adopt myself towards the animal world, I can say no more than that I submit tacitly with others to the present arrangement, which our forefathers have made for us." Such a very tame conclusion seems to cut away the whole *raison d'être* of the book, which is neither a stalwart defence of present conditions such as can be used against the ultra-humanitarian school, nor an advocacy for reform. On the whole, it seems to us likely to do more harm than good.

R. L.

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 intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Regnault's Experiments on the Joule-Thomson Effect.

THAT Regnault made a number of experiments similar to some of those described by Joule and Kelvin in their papers on the thermal effects of fluids in motion does not seem to be commonly known; at all events, the numerical results of his work on this subject are not often mentioned. After experimenting on the flow of gases through small holes in thin plates, and through long capillary tubes, he followed the example of Joule and Kelvin in using porous bodies, especially discs and tubes of soft, unglazed porcelain. He found great difficulty in getting definite results, especially in the regard that the temperature observed in the stream of gas issuing from the porous wall depended on the position of the thermometer. He concludes the account of his experiments in the following words:—"Après ces tentatives infructueuses et beaucoup d'autres dont je ne parlerai pas, j'ai renoncé à l'espoir d'obtenir quelque chose de précis, d'expériences fondées sur la mesure de températures dans les courants gazeux, et il ne m'est resté que le regret d'avoir consacré beaucoup de temps à des recherches stériles" (Regnault, "Relation des Experiences," vol. iv., p. 707, 1870).

At the present day we can see that Regnault's experimental method was not in this case the best that might have been devised, but in spite of his dissatisfaction with the results of the work, his most definite numerical values are not very different from those of Joule and Kelvin. Air under pressure was forced through the wall of a porous porcelain tube from the outside. The tube was 20 cm. long and 2·8 cm. in diameter, the thickness of the wall not being stated. The fall of temperature Δt was found in two ways. In the first method, one mercury thermometer was placed in the axis of the porous tube, while a second thermometer was immersed in the large water bath containing the worm for leading in the compressed air. In the second method an iron-copper thermocouple was used, one junction being in the axis of the porous tube and the other in the compressed air just outside. The results of the thermoelectric measurements are somewhat irregular, and it seems probable that the fault was mainly with the imperfect electrical instruments of the time. The two series with the mercury thermometers are more satisfactory.

In one of these, the mean of eleven measurements in which the fall of pressure, Δp, at the porous wall was between 4·9 metres and 3·9 metres of mercury, gave $\Delta t/\Delta p=0{\cdot}293$, the separate values ranging from 0·285 to 0·303. Nine subsequent measurements in the same series gave values ranging from $\Delta t/\Delta p=0{\cdot}407$ for $\Delta p=3{\cdot}1$ metres up to 0·685 for $\Delta p=0{\cdot}65$ metre and then down to 0·312 for $\Delta p=0{\cdot}30$ metre. In the other series, made with a somewhat thinner-walled tube, the mean of the twenty-two measurements, in which the fall of pressure was between 6·6 metres and 3·4 metres, gave $\Delta t/\Delta p=0{\cdot}255$, the extreme values being 0·234 and 0·313, while twelve of the twenty-two values are between 0·250 and 0·260.

It is interesting to compare the mean of these values, $\Delta t/\Delta p=0{\cdot}27°$ C. per metre of mercury, with the value obtained by Joule and Kelvin. Their results may be represented sufficiently well, in the same units, by the equation

$$\Delta t/\Delta p=0{\cdot}36-0{\cdot}0017t,$$

which gives for $t=20°$ C. $\Delta t/\Delta p=0{\cdot}33$. Regnault does not state the temperature at which his experiments were made, but it was probably not far from 20°, so that in reality his work agreed fairly well with that of Joule and Kelvin.

EDGAR BUCKINGHAM.

Bureau of Standards, Washington, August 27.

Genetics.

IN a recent review of the report of the third International Conference, 1906, on Genetics (NATURE, August 22, p. 417), the following sentence occurs:—"Mendel's peas have already been called classical; and it is a very remarkable fact that no one has repeated Mendel's experiments with the deliberate intention of testing the Mendelian interpretation of the results." This statement is misleading, for in the following five instances many of Mendel's experiments on the pea have been repeated and confirmed:—

Correns, C., *Deutsch. Bot. Gesellsch.*, 1900.

Tschermak, E., *Zts. f. d. landw. Versuchsw. in Osterr.*, 1900 (and later).

Hurst, C. C., Journ. R. Hort. Soc., 1904.

Lock, R. H., Ann. R. Bot. Gard., Peradeniya, 1904.

Bateson, W., and Miss Killby, Rep. II. to Evolution Committee of Roy. Soc., 1905.

In each case the experimental results have led the author to accept Mendel's interpretation of the phenomena.

R. C. PUNNETT.

Gonville and Caius College, Cambridge, August 30.

THE sentence which Mr. Punnett quotes from my review is not in the least misleading. I did not say that Mendel's experiments had not been "repeated and confirmed"; I said that they had not been repeated with the deliberate intention of testing the interpretation which Mendel put upon them. This statement I repeat, and shall shortly prove to be correct. I am familiar with the work of the five authors in Mr. Punnett's list (which surely should have included a reference to de Vries's papers), and, what is more, I have a first-hand acquaintance with the facts themselves.

I do not doubt for one moment the correctness of Mendel's results, as my critic implies in his sentence which follows the quotation from my review. I do not doubt, as Weldon did, the validity of the generalisation that yellowness of cotyledons in peas is dominant over greenness, or that these characters segregate in Mendelian fashion in F_2. I do not doubt the reality of the phenomena in any of the cases described by the authors whom Mr. Punnett cites any more than I doubt the reality of the results which I have myself obtained; but does that mean that I must accept the Mendelian interpretation of them? Certainly not. The Mendelian phenomenon is a fact; but the Mendelian interpretation is an inference, and it is dangerously misleading not to lay stress on the distinction between the two.

What I mean by "testing the interpretation" is the carrying out, by one who is actively sceptical of Mendel's hypothesis, of an experiment of such a kind that the result can leave no doubt in the mind of the experimenter as to the validity, or otherwise, of the hypothesis tested. I will suggest an experiment. The proportion 75 per cent. yellow, 25 per cent. green, holds good for F_2 from crosses between pure strains of yellow-seeded and pure strains of green-seeded peas; but does it hold good for F_2 from crosses between a pure yellow *and an extracted green in* F_5, *i.e.* a green with all its parents yellow, and with all its grandparents yellow, and with all its great-grandparents yellow, and with all its great-great-grandparents yellow, and with half its great-great-great-grandparents yellow? If Mendel's interpretation of the proportion he obtained in F_2 (75 per cent. yellow, 25 per cent. green) is correct, that proportion must hold good for F_2 from such a cross as I have suggested.

When I say that "no one has repeated Mendel's experiments with the deliberate intention of testing the Mendelian interpretation," I mean that crucial experiments on the lines of that which I have suggested have not been carried out by sceptical observers. I know perfectly well that Mendel's experiments have been repeated on a large scale, that alleged exceptions have been satisfactorily disposed of, and that a number of new Mendelian characters have been discovered, not only in peas themselves, but in a host of other plants and animals. But that is not testing the interpretation; it is witnessing the phenomenon. "In each case," says Mr. Punnett, "the experimental results have led the author to accept Mendel's interpretation of the phenomena." Surely he must follow willingly who can be led by so slender a thread.

THE REVIEWER.

ARCHÆOLOGICAL DISCOVERIES IN EGYPT.

THE progress of archæological discovery in the Near East goes forward steadily without halt. Every year more is added to our knowledge of the ancient peoples of Greece, Egypt, and western Asia; with each year we have only to await the surprises that the excavators have in store for us. Egypt has contributed some very important results this season, in two remarkable discoveries at Thebes. One of these is a find of the highest interest which will appeal to the minds of all, even those entirely ignorant of archæological science; this is the discovery of the actual body of Tii, one of "the most famous of Egyptian queens," lying in her tomb, with her funeral pomp around her. The other is a discovery which will appeal more to the architect and the student of Egyptian religion than to the layman—the uncovering of the subterranean "tomb-shrine" of King Mentuhetep, and the pillared halls above it, at the western end of his funerary temple, the excavation of which has been brought to a close by this final discovery.

Both these discoveries were announced in the *Times* some time ago, but readers of NATURE may like to hear further details.

Thirty years ago nobody would have thought it possible that we should eventually recover and place in one central museum the actual bodies of all the most powerful Pharaohs of Egypt, the actual mummies of three whole dynasties of kings. But this is now the case. With but few exceptions, the mummies of all the monarchs of the eighteenth, nineteenth, and twentieth dynasties, the most imperial period of Egyptian history, now rest within the walls of the Cairo Museum. Some have been unrolled, others have not. It seems doubtful whether the actual features of these dead princes should be exposed to the gaze of every vulgar tourist, who very often has no appreciation whatever of the wonder of the sight which he is beholding; and very probably a more reverent taste will eventually withhold these august bodies from the indignity of public exhibition in glass cases. But at present those that have been unrolled may be seen by all for a shilling.

The chief discovery of royal mummies was the well-known one of 1881. In 1898 a further series was discovered in the tomb of Amenhetep II. (the only king who rests, as all should do, still in his own sepulchre). Of late years the systematic exploration of the Valley of the Tombs of the Kings has been undertaken by an American, Mr. Theodore M. Davis, who has each year made some discovery of importance. To him is due the opening of the tombs of Thothmes IV., with its interesting funerary furniture, of Hatshepsu, of Siptah, of Iuaa and Tuaa, the parents of Queen Tii, and, lastly, of Queen Tii herself. In the discovery of the first two tombs mentioned above, Mr. Davis was assisted by Mr. Howard Carter, then chief inspector of antiquities at Thebes; the discovery of the tomb of Iuaa and Tuaa was effected with the cooperation of Mr. J. E. Quibell, Mr. Carter's successor at Thebes; while in the discovery of the tombs of Siptah and Tii Mr. Davis had the help of Mr. Edward R. Ayrton, who had previously assisted Prof. Petrie at Abydos and Ehnasya and Prof. Naville at Deir el-Bahari.

Of all Mr. Davis's discoveries, that of the tomb of Iuaa and Tuaa, the parents of the queen whose grave was found this year, is the most important from the scientific standpoint. Not only were the mummies in absolutely perfect condition, but the tomb was found full of an incredible treasure of funerary furniture and other work in wood, ivory, and gold, which has become well known from various popular publications during the last two years, and has already provided many new models to our cabinet-makers. But a greater personal interest attaches to the tomb of their daughter, the Queen Tii, and more general attention has been directed to this discovery than to the former one, although, alas! the body of the queen has decayed, and nothing but the grinning skull remains which once was clothed with the most beautiful features and contained the cleverest brain in Egypt about 1400 B.C. The furniture, too, of the tomb is not in such good preservation, and, indeed, never was so fine, as that in the tomb of Iuaa and Tuaa. But personal interest is great nowadays, and Tii is more interesting than her parents.

Like the rest of the royal tombs, that of Tii was found in the Valley of the Tombs of the Kings at Thebes, "the Place of Eternity" as the Egyptians called it, where, in his "August Habitation of the West," a deceased king was laid to rest, "no man seeing, no man knowing," that tomb-robbers might not find the position of the grave and despoil it of

FIG. 1.—The Valley of the Tombs of the Kings, taken by moonlight.

its treasures (Fig. 1; photograph taken by moonlight).

But neither Tii nor, possibly, her parents had originally been buried in the Theban valley. Tii belonged, as is well known, to the heresy of the Disk-worshippers, of which her son Khuenaten was so vigorous an adherent. To her more than to any other person was probably due the introduction of this heresy as the fashionable religion of the royal court, and she instilled the principles of her peculiar belief into the mind of her son, who became a fanatical persecutor of the national orthodox religion, so much so that he removed his court from Thebes, the headquarters of the orthodox priests of Amon, to a far distant spot, the modern Tell el-Amarna. Here Tii lived and died, and was first buried. But after the fall of the Disk-worship and the re-migration of the court to Thebes under King Tutankhamon, these royal bodies were taken from their tombs and re-interred in the King's Valley at Thebes. Queen Tii, like her parents, was placed in a small private tomb of older date, hardly consonant with her royal state, and contrasting greatly with the magnificent royal hypogæa close by (Fig. 2). Here she was hurriedly laid in some confusion, her funerary furniture being incomplete and its parts improperly fitted together. Before leaving the mummy, thus transferred to its final abode, careful erasure was made of every occurrence of the name and figure of the heretic Khuenaten, who had laid his mother to rest at Tell el-Amarna, and had dedicated in her tomb funerary furniture bearing the record of his filial piety. That the transference took place in the reign of Tutankhamon is shown by the discovery in the tomb of seals bearing his name.

Such are the conclusions to which Mr. Ayrton has been drawn by the study of the condition of the tomb, and there is little doubt that they are correct.

The funeral pomp of the queen had been of great splendour and unusual design, but has most unhappily been damaged by water, which at some period unknown has penetrated into the tomb. The result is that most of the woodwork will not bear handling; much, however, including the skull and bones of the queen, has been preserved by means of boiling paraffin wax, which soaks into the porous substance to which it is applied and solidifies it. Of great splendour must undoubtedly have been the

FIG. 2.—The Tomb of Tii.

great catafalque, in the form of a shrine, which covered the coffin of the queen instead of a sarcophagus. This, on which are delicate reliefs, was entirely overspread with thick gold, the remnants of which filled the tomb, so that everywhere the excavators trod upon gold when they entered. Of unusual design was the actual coffin, the woodwork of which was covered by a frame of gold, inlaid with carnelian and with blue and green glass in scale patterns and the forms of hieroglyphs recording that Khuenaten had had it made for his mother. The mummy itself, the lamentable condition of which contrasts so strongly with the splendid preservation of the mummies of Iuaa and Tuaa, was wrapped in sheets of gold. On the head of the mummy was a golden diadem in the form of a vulture with wings spread round to embrace the head. The workmanship of this diadem shows that it is merely a funerary object, and was not an actual crown worn by the queen in life.

Of the other objects found in the tomb, the most important are the "canopic jars," which contained the mummified viscera of the deceased. Usually the lids of these jars are formed in the shape of the heads of the "four genii of Amenti" (the underworld); but in this case the heads are those of the dead queen herself, beautiful portraits in alabaster, with the eyes and brows represented in lapis-lazuli and obsidian. As portraits, these heads are remarkable, and evidently are accurate likenesses of the queen.

Of other funerary furniture there was little, the reason being that it had been left behind at Tell el-Amarna.

Such is the most remarkable discovery of the year in Egypt. The completion of the excavation of the funerary temple of King Mentuhetep at Deir el-Bahari, not far off, naturally makes a bad second in point of view of general interest, but is of much greater scientific importance to the student of Egyptian architecture and religion.

The explorations which have been carried out during ten seasons at Deir el-Bahari by Prof. Naville for the Egypt Exploration Fund have now been brought to an end with the completion of the excavation of the Eleventh Dynasty temple (see NATURE, vols. lxx., 1904, p. 155; lxxiii., 1906, p. 468). Four seasons have been occupied with this work since the discovery of this temple by Prof. Naville and Mr. H. R. Hall, of the British Museum, in 1903. For part of each season Mr. Hall has been associated with Prof. Naville as his principal assistant and coadjutor, while Mr. C. T. Currelly has also assisted during the whole of the last two seasons' work, taking the place of Mr. E. R. Ayrton, who assisted during the second season, but has since transferred his energies to the work of excavating the royal tombs, as we have seen above. During the fourth season Mr. M. D. Dalison also worked as a regular member of the Fund's staff, having in the preceding year worked as a volunteer. In the second season Mr. H. Garnett-Orme, and in the third and fourth Mr. J. T. Dennis, also volunteered their assistance. The preparation of the plans has been carried out by Messrs. C. R. Peers and Fatio, under the supervision of Mr. Somers Clarke; and Madame Naville has specially undertaken the work of piecing together the fragments of sculpture, a task which demands much study.

The work of the third season (1905–6) was chiefly notable for the discovery of the remarkable Cow of Hathor in her shrine, now in the Museum of Cairo. This was the most sensational archæological discovery in Egypt last year, as the find of Tii's tomb is the most sensational discovery this year. Nothing so sensational has been discovered in Mentuhetep's temple this year, though the results of the work are archæologically important. At the extreme western end of the temple, immediately beneath the cliffs of Deir el-Bahari, is a pillared hall, of ten rows of eight columns each, at a slightly higher level than the rest of the temple. Within this is a small *cella* or *sekos*, which contains a white limestone altar, of unusual form—square, with a circular depression on its surface, on to which libations were poured. This altar is placed in front of a niche in the rock, which formerly contained a stone shrine.

The whole of this Western Pillar Court, with the *cella*, is placed above the most remarkable feature of this part of the temple—the Tomb-sanctuary of the *ka* of King Mentuhetep. This is to all appearance a rock-cut royal tomb, like those of the Valley of the Kings. It descends in the regular way at a gentle slope for a distance of 450 feet until a chamber is reached, faced with splendid granite blocks like those of the Pyramids, and containing an alabaster shrine in which once stood a statue of the king. In M. Naville's view the monarch himself was not buried here; this was a sort of imitation tomb, made for the statue of his *ka*, and perhaps commemorating his deification at the time of his jubilee, the "Festival of the End," or *heb-sed*; when, before he could be regarded as a god, the king had to be temporarily regarded as dead, in which case a funerary chamber might be built, and

FIG. 3.—West End of the XIth Dynasty Temple, Deir el-Bahari, showing descent to tomb-sanctuary.

even an elaborate tomb constructed, long before his real death, when the real tomb would be built. The real tomb of King Mentuhetep seems to have been within the bounds of the temple. In the south-west corner of the western hall was excavated a small tomb containing a great alabaster sarcophagus which probably once contained the body of King Mentuhetep. This may have been the real tomb, in an in-

FIG. 4.—The two Temples of Deir el-Bahari, from the south.

conspicuous spot. The imitation tomb descended with a great open dromos in the sight of all men in an open court between the Western Hall and the Pyramid (Fig. 3).

All this constitutes a considerable addition to our knowledge of Egyptian architecture and archæology, and the authorities of the Egypt Exploration Fund are to be congratulated on having brought their great work at Deir el-Bahari (Fig. 4) to a successful conclusion.

Of other work in Egypt, the most successful seems to have been that of the Oxford archæologist, Mr. Randall-Maciver, for the University of Pennsylvania. Mr. Maciver has been excavating town-ruins of the XVIIIth and XXVIth Dynasties near Amada, in Nubia, and in the XXVIth Dynasty town has found remains of a peculiar art, very un-Egyptian in type, and showing points of contact with that of Greece. The painted pottery is especially remarkable. This art would seem to be of native Nubian origin, influenced perhaps by Naukratis; Naukratite wares could easily be sent up the Nile into Nubia. We await further details of this discovery with interest.

Excavations at Alexandria have resulted in the discovery, near Pompey's pillar, of some fine sphinxes; one, headless, of the reign of Horemheb (XVIIIth Dynasty), and two others, made of fine white limestone, of the Ptolemaic period (Fig. 5).

At Asyût Mr. D. G. Hogarth has discovered and excavated many new tombs of the XIth and XIIth

FIG. 5.—Sphinx discovered at Alexandria.

Dynasties, with the usual funeral furniture, of model boats, granaries, and so forth, like those found by Prof. Garstang a few years ago at Beni Hasan.

Prof. Garstang and Mr. Harold Jones have been exploring cemeteries of the XIIth Dynasty and the Roman period at Abydos with success.

Outside Egypt, the chief discovery of the past year of interest to Egyptologists has been Prof. Winckler's find at Boghaz Köi, the ancient Pterion, on the Halys, of cuneiform tablets containing the records of diplomatic intercourse between the kings of the Khattê or Hittites, whose capital Pterion was, and King Rameses II. of Egypt. We already knew from the Egyptian records that Khetasil of the Hittites and Rameses of Egypt made an extradition treaty according to which criminals of either country were to be given up by the other, but now we have some of the correspondence between the two courts, found on the Hittite side. In these tablets the Egyptian king is spoken of as "*Ramases mai-Amana satep-ni-riya.*" This transcription of the Egyptian name is interesting, as giving us an approximate idea of how the Egyptians pronounced the name which we conventionally write "Rameses meri-Amen setep-en-Rā." This find is a second discovery of Tell el-Amarna letters, and may prove equally important!

In connection with the relations between Rameses II. and the Hittites, an interesting little discovery may be chronicled. Last year Prof. Breasted, copying the inscriptions of the temple of Abu Simbel in Nubia, read through again the inscription which records the marriage of Rameses with the daughter of the Hittite king, contracted in order to cement their alliance. In the course of reading he came across a new word, which he identified as the Egyptian expression for *snow*; this word reads *selg*, which is evidently the Semitic *telg*, "snow" or "ice," which we have adopted to express the substance *talc*. Rameses is speeding the Hittites on their homeward way, and hopes that they will not be troubled by snow in the Lebanon passes. Hot Nubia was a curious place in which to find and first identify the hieroglyphic word for "snow"!

SCIENCE AND GOVERNMENT.

THEORETICALLY at least most observers admit that the adoption of the scientific method in the management of the affairs of State is a preliminary necessity if national efficiency is to be secured. The Secretary of State for War notably has urged again and again that we cannot expect as a people to compete successfully with other nations, whether in peace or war, unless like them we learn to take advantage of the assistance which science and men of science are able to offer.

It is only in recent years that it has begun to be understood in how many directions the methods of science are applicable. No longer is it imagined that the plan of inquiry which has proved so successful in probing the mysteries of the material universe is suitable only in the laboratory and observatory. The adoption of similar lines of approach in the study of history, language, economics, education, and other subjects at one time thought to have nothing in common with science has resulted, indeed, in unprecedented progress in all of them. So, too, in recent times industry and commerce have come under the same influence with beneficial results. The spirit of scientific research, in fact, is beginning to dominate most forms of intellectual activity.

There is growing evidence, also, that politicians in most countries are beginning to realise that statesmanship is no exception to this rule, but, like other skilled labour, is most satisfactory when conducted on scientific principles. But whether British statesmen appreciate this truth to the same extent as those of other great nations is a matter of grave doubt. Their education generally has been of such a character as to leave them with a colossal ignorance of science and scientific methods; and it is only by overcoming the bias received at the public school and university that most of them come to understand the modern outlook. One of the results of the regard in which science is held by legislators is to be found in the amount of money they vote from the public funds for scientific purposes, and it is consequently possible to institute a comparison between the importance attached to scientific investigation by statesmen in the United States on one hand, and in the United Kingdom on the other.

"The Digest of Appropriations for the Support of the Government of the United States for the Service of the Fiscal Year ending June 30, 1908," recently published in Washington, provides detailed information as to the amounts voted by Congress to enable American statesmen to secure the best scientific assistance in the different Government departments. Similarly, the various estimates—for the Army, Navy, Civil Services, &c.—ordered to be printed by the House of Commons, and procurable from Messrs. Wyman and Sons, Ltd., give full particulars as to the provision made by the House of Commons, at the suggestion of the Chancellor of the Exchequer, for similar help during 1907–8 for the British Government.

In the following comparison no reference is made to educational establishments for the technical training of soldiers and sailors or to the grants made to colleges and universities. This subject has been exhaustively treated in these columns on more than one occasion. The intention here is to compare the amounts set aside in the two countries for scientific investigation with a view to the application of the results to matters of national importance. Some amounts may have been overlooked, but it is believed that every sum of importance, so far as the comparison is concerned, has been included.

To begin with the United States, it will be best first to state simply, under the headings as they occur in the official volume from Washington, the amounts voted for various purposes, and then to explain more fully the specific purpose of the grant in cases where it seems necessary.

Table I.—United States.

	£
Under Smithsonian Institution.	
International Exchanges	6,400
American Ethnology	8,000
Astrophysical Observatory	2,600
International Catalogue of Scientific Literature	1,000
Building National Museum	250,000
Preservation of Collections	38,000
National Zoological Park	22,000
Navy Department.	
Hydrographic Office...	27,900
Naval Observatory	12,540
Nautical Almanac	4,250
Surveying Public Lands.	
Surveying Public Lands	87,000
Geological Survey	83,000
Surveying Forest Reserves...	20,000
Analysing and Testing Coals, &c. ...	50,000
Testing Structural Materials	20,000
Department of Agriculture.	
Salaries, Library, Contingent Expenses...	206,900
Bureau of Animal Industry	189,400
Eradicating Cattle Ticks	30,000
Bureau of Plant Industry:	
General Expenses...	117,000
Grain Investigations	8,000
Distribution of Valuable Seeds... ...	47,600
Cotton Boll-weevil Investigations ...	22,000
Forest Service:	
General Expenses	351,400
Bureau of Chemistry	130,000
Bureau of Soils	34,000
Bureau of Entomology:	
Entomological Investigations	22,800
Cotton Boll-weevil Investigations ...	8,000
Preventing Spread of Moths	30,000
Bureau of Biological Survey:	
Biological Investigations	8,880
Bureau of Statistics:	
Collecting Agricultural Statistics ...	44,580
Office of Experiment Stations:	
Agricultural Experiments...	213,400
Nutrition Investigations	1,000
Irrigation Investigations	30,000
Weather Bureau	280,710
Department of Commerce and Labour.	
Coast and Geodetic Survey	198,000
Bureau of Fisheries	134,000
Total	2,740,360

Most of the items included under the Smithsonian Institution explain themselves, but it is worth while to say that the grant to American ethnology is "for continuing ethnological researches among the American Indians and the natives of Hawaii." The grant of a quarter of a million pounds sterling to the National Museum is stated to be for the completion of the construction of the building.

As regards the last two items under "Surveying Public Lands," the first is explained to be for "the analysing and testing of the coals, lignites, and other mineral fuel substance belonging to the United States, in order to determine their fuel value," and "for the purpose of increasing the general efficiency or available supply of fuel resources in the United States." The grant for testing structural materials is similarly "for the investigation of structural materials belonging to and for the use of the United States, such as stone, clays, cement, and so forth."

The Bureau of Animal Industry was instituted "to enable the Secretary of Agriculture more effectually to suppress and prevent the spread of contagious and infectious diseases of live stock, and for other purposes." The duties of the Bureau of Plant Industry cover every part of scientific agriculture so far as plant life is concerned. In the same way, the Forest Service includes every aspect of scientific and economic forestry; and each of the departments under the heading agriculture deals in a like comprehensive spirit with the branch of science with which it is identified. The other items are sufficiently explained by their titles.

TABLE II.—UNITED KINGDOM.

	£
Board of Education.	
Museums Purchase Grant (Science Grant in Aid)	1,800
Geological Museum	3,894
Geological Survey	18,072
Solar Physics	1,901
British Museum.	
Natural History Museum	53,724
Scientific Investigation.	
Royal Society	16,750
Meteorological Office...	15,500
Royal Geographical Society	500
Marine Biological Association	1,000
Royal Society of Edinburgh	600
Scottish Meteorological Society	100
Royal Irish Academy	2,000
Royal Zoological Society of Ireland ...	500
Edinburgh Observatory	1,600
International Geodetic Association ...	419
North Sea Fisheries Investigation ...	12,500
International Seismic Association... ...	210
Public Education, Scotland.	
Royal Scottish Museum, Edinburgh, Science Side (estimate)	1,500
Temporary Commissions.	
Sewage Disposal Commission, Scientific Investigations	3,750
Tuberculosis Commission, Scientific Investigations	7,673
Epizootic Abortion Committee, Scientific Investigations	1,110
Mines Commission, Scientific Investigations	1,000
Army.	
Inspection of Warlike and Engineer Stores: Seven Chemists	2,340
Ordnance Research Board: Fourteen Chemists and one Chemical Engineer	4,140
Navy, Scientific Services.	
Royal Observatory, Greenwich	9,709
Observatory at the Cape of Good Hope...	8,218
Photographic Mapping of Heavens ...	1,580
Hydrographic Department...	£38,506
Coast and other Surveys	22,280
Naval Museum, Greenwich...	703
Compass Department	1,897
Nautical Almanac	4,369
Chronometers	2,393
Contributions to Scientific Institutions...	625
Total	242,863

The second table will explain itself to most readers of NATURE, but one or two variations in the amounts which have been introduced during the year deserve a few words of comment. The Royal Society grant is 425*l.* less than in 1906–7, and the reason is chiefly that the grant in aid of new buildings and equipment for the National Physical Laboratory was this year reduced by 5000*l.* The grant-in-aid of salaries and other expenses of the laboratory was increased by 750*l.* The grants to the society for scientific investigations undertaken with the sanction of a committee appointed for the purpose and for scientific publications has undergone no change, and remains at 5000*l.*

The grant towards the expenses of the Meteorological Office shows an increase of 200*l.*; that towards the expenses of the Royal Society of Edinburgh an increase of 300*l.*, or, in other words, the grant was doubled this year; that to the Royal Irish Academy an increase of 400*l.*, the increase being intended to provide for the cataloguing of Celtic MSS. now in the custody of the Academy; that to the International Geodetic Association an increase of 119*l.* to pay the expenses of the British delegate in respect of his attendance at the conference of the association held in 1906. The contribution to the International Seismic Association, however, shows a decrease of 40*l.*

As regards the grants enumerated under the heading "Temporary Commissions," the detailed estimates show that the amount received on behalf of the Commission on Sewage Disposal shows an increase for the year of 250*l.*, and that the total sum of 3750*l.* is expended in the remuneration and expenses of bacteriological and chemical experts and their assistants, apparatus, and so on. The amount voted for the Tuberculosis Commission represents a decrease of 675*l.* on the amount of the grant for the previous year, though why the "expenses of experimental farms, buildings, and laboratories, the remuneration of scientific experts, &c., should be less this year is not made clear. The Committee on Epizootic Abortion received an increased grant of 260*l.* this year towards its work of inquiring, "by means of experimental investigation and otherwise, into the pathology and etiology of epizootic abortion," and this year's grant of 1110*l.* covers the expenses of the experimental farm, buildings, and laboratory. The Mines Commission, which was appointed on June 6, 1906, receives its grant of 1000*l.* for experimental work.

To sum up, the State grant for the current year towards scientific research in the United States amounts approximately to two and three-quarter millions sterling, that in the United Kingdom—allowing generously for items which may have been missed in examining the estimates—reaches a quarter of a million sterling. The revenue of the United States for 1906 reached the total of 152,477,381*l.*, and that of the United Kingdom 143,977,575*l.* In broad terms, therefore, it may be stated that with approximately the same revenue the United States attaches eleven times as much importance to scientific assistance as the mother country of Newton, Darwin, Maxwell, Kelvin, and a great host of other scientific pioneers. Who shall say that there is to-day no need for missionary enterprise on the part of the British man of science?

A. T. S.

NOTES.

Successful trials were made with the British military airship at Farnborough on Tuesday. The airship is cylindrical in shape, its length being about 100 feet and diameter 30 feet. Four bands which encircle the cylinder support a light framework under which the car of the balloon is suspended. The motor driving the propellers is fixed in the forepart of the car, and in the stern of the framework there is a large six-sided rudder, which is controlled by rudder lines from the car. Above the car are six aëroplanes, three over the bow and three over the stern. The trials on Tuesday demonstrated that the airship could be controlled and steered in a very satisfactory manner; and the success attained shows that real advance has been made in aëronautics during the past few years.

Official announcement is made that on and after September 26, the colony of New Zealand and the territory belonging thereto will be called and known by the title of the Dominion of New Zealand.

Science states that Prof. J. J. Stevenson, of New York University, and Prof. W. M. Davis, of Harvard University, are among the Americans who will attend the celebration of the centenary of the foundation of the Geological Society of London at the end of this month.

It is stated in the *Engineer* of September 6 that the deepest bore-hole put down for coal in Great Britain has just been completed at Cameronbridge, Fifeshire. The bore-hole attained a depth of 4534 feet before the mountain limestone was reached. At the instigation of the Scottish Geographical Society, steps are to be taken to ascertain the earth temperature at the bottom of the bore.

A Reuter message to Winnipeg from Athabasca Landing reports the loss near Fort Anxious of the *Duchess of Bedford*, the vessel of the Anglo-American Polar Expedition under Captain Ejnar Mikkelsen. The expedition sailed from Victoria on May 20, 1906, with the object of exploring the unknown regions lying to the west of the Parry Archipelago, and of discovering whether there was land to the north of the Beaufort Sea. Though the vessel is lost, a message received on September 7 from Mr. V. Stefansson, the ethnologist of the expedition, reports "Expedition all safe." The telegram was sent to the U.S. National Geographic Society from Eagle City, Alaska, on the Upper Yukon River.

A committee to inquire into and report upon certain matters relating to the improvement of forestry in Ireland has been appointed by the Vice-President of the Department of Agriculture and Technical Instruction. The committee consists of the following members:—Mr. T. P. Gill (chairman), Lord Castletown, Mr. W. Redmond, M.P., Rev. D. Kelly, Lord Bishop of Ross; Mr. H. de Fellenburg Montgomery, Mr. W. F. Bailey, Mr. W. R. Fisher, and Prof. J. R. Campbell. The terms of reference are to inquire into and report upon the following matters relating to the improvement of forestry in Ireland, viz.:—(1) the present provision for State aid to forestry in Ireland; (2) the means whereby in connection with the operation of the Land Purchase Acts existing woods may be preserved, and land suitable for forestry acquired for public purposes; and (3) the financial and other provisions necessary for a comprehensive scheme of afforestation in Ireland.

The Rome correspondent of the *Times* states that the palace which is being erected for the International Agricultural Institute in the gardens of the Villa Borghese is rapidly approaching completion, and before the end of September will be roofed in. Invitations for the meeting of the permanent committee and for the inauguration of the institute will probably be issued in the course of November next, and with the first meeting of the committee in the spring of next year the institute will enter upon its career of activity. The Italian Royal Commission has appointed Prof. M. Pantaleoni to superintend an inquiry for the purpose of ascertaining exactly the extent of the information which the different countries that have adhered to the convention are in a position to supply with regard to their agricultural production. Prof. Bodio, of the General Bureau of Statistics, has been entrusted with a mission to Germany and Austria to study on the spot the systems pursued by those countries for the collection of agricultural reports.

The latest example of the close connection between science and industry in Germany is afforded by the foundation of an institute for milling research in the Seestrasse, Berlin, adjoining the two already well-known institutes for research in the sugar and fermentation industries. The new institute was formally opened on July 30; it consists of a main building containing the administrative offices and laboratories, together with an experimental granary, a wheat and rye mill, and a bakery. The granary has a storage capacity of more than one million kilos., and the dimensions of the elevators, conveyors, and other apparatus and machinery are such that 17,500 kilos. of grain per hour can be dealt with. The mill is electrically driven throughout, and fitted with the most modern machinery; it contains two complete separate plants, each capable of milling two tons of grain every ten hours. The bakery is similarly fitted with the latest improvements of bakehouse machinery, and contains a laboratory. The institute was built out of a grant of nearly 30,000*l.* from the Minister of Agriculture, who also gives a yearly subsidy; it is carried on and maintained jointly by the Prussian Chamber of Agriculture, the German Millers' Union, and the Central Bakery Union of Berlin. The objects of this research institute as set forth in the contract with the Minister of Agriculture are of interest. It is proposed to carry out practical research and scientific investigation on grain during storing, milling, working up and baking; to experiment with the baking of home and imported grain; to conduct research work for the Government, and to carry out official and private analyses of grain, flour, fodder stuffs, &c., thereby supplementing the income. Everything has been done to ensure a proper and complete investigation of the many problems which the milling and baking industries present. It is of interest to contrast this new sign of German thoroughness with the state of things in this country, where it is left to private enterprise to initiate research. Thanks, however, to the work of the Home-grown Wheat Committee of the National Association of British and Irish millers, in cooperation with the Rothamsted Experimental Station and the Agricultural Department of the University at Cambridge, much valuable work on problems connected with wheat and flour has been and is being carried out in this country.

We have received the report of the meeting of inspectors of apiaries (U.S. Department of Agriculture, Bureau of Entomology, Bulletin No. 70). It contains much information respecting the diseases of bees; in particular, the American and European foul broods are discussed as regards ætiology and prevention.

FROM the Economic Proceedings of the Royal Dublin Society (vol. i., part ii., August) has been reprinted, as in previous years, a very valuable report on some of the injurious insects and other animals observed last year in Ireland, and reported on by Prof. Carpenter. The report consists of only thirty-one pages, and yet is full of new, interesting, and important matter, and such that one can thoroughly rely upon. Amongst the thirty pests reported on, the most interesting is the cabbage stem-borer (*Psylliodes chrysocephala*, Linn.), of which an excellent account of the larva is given, of scientific as well as practical value. Another new pest is dealt with, the long-horned barley-fly (*Elachyptera cornuta*, Fallen) attacking barley in Ireland. A willow beetle (*Phyllodecta vulgatissima*, Linn.), as yet unrecorded as a pest in England, where its place is taken by *P. vitellinae*, is also dealt with, owing to the harm caused by it in Lurgan. Amongst the parasites of domesticated animals, notes are given on the sheep louse (*Trichodectes sphaerocephalus*), known also as the red louse. Prof. Carpenter wisely recommends dipping twice at an interval of ten days to clear the sheep of these pests. We hope he will insist on this necessary treatment also in sheep scab, for just as in red lice so in the sheep Acarus, eggs hatch out some days after dipping, not having been affected by it, and thus the disease is carried on, and dipping "orders" lose much of their value. Amongst other pests mentioned we note the lackey moth in the south of Ireland, small ermine moths in Waterford County, mussel scale attack, the turnip moth (*Agrotis segetum*) feeding on mangolds in Queen's County, the beet carrion beetle in County Wicklow, and the pine bark beetle in County Dublin. There are eleven figures in the text, three being original, and six plates, two excellent ones giving details of the larval *Psylliodes chrysocephala* and damage caused by it. A plate (xli.) showing the life-history of the lackey moth is given, photographed from a museum preparation; this does not seem to us to give a natural representation of the larvæ feeding, &c.

ACTING on the instructions of M. Maspero, Directeur général du Service des Antiquités, Prof. Elliot Smith removed the wrappings from the mummy of Ménephtah—the Pharaoh engulfed in the Red Sea while in hot pursuit of the Egyptians. From the writing on the shroud, the process of embalming, the resemblance to Rameses II. (Ménephtah's father) and to Seti the Great (his grandfather), there is every reason to believe that M. Maspero is right in the identification of this as the mummy of Ménephtah. From a very thorough examination of the mummy, Prof. Smith infers that Ménephtah at the time of his death was "a somewhat corpulent old man of rather more than medium height (1·714 m.), almost completely bald, with only a narrow fringe of white hairs," with calcareous patches in the walls of his arteries, calcified costal cartilages, and with few remaining teeth. The mummy had suffered much at the hands of plunderers, while there is also evidence that the embalmers had taken liberties with the Pharaoh of the Exodus. Prof. Smith's report appears in the *Annales des Antiquités de l'Egypte*, 1907.

THE first Bulletin for the current year of the Société d'Anthropologie de Paris contains the annual address of the president, M. Zaborowsky, which is mainly devoted to a review of the work in recent years, and to an appeal for the recognition of anthropology as an exact science by "the official hierarchy" of the Académie des Sciences. The most important contribution is that of M. E. T. Hamy, on representations of the human figure in the monuments of ancient Egypt, supplementary to other studies by the author on the same subject. He discusses the influence of the system of hierographs on the attitudes of the figures, which usually face the right, and he reviews the characteristics of the persons depicted by comparison with existing races. Incidentally, he criticises the classification adopted by Prof. Flinders Petrie in his communication on the same subject published in vol. xxxi. of the Journal of the Royal Anthropological Institute. The committee appointed to allot the Broca prizes has conferred the first on M. A. M. Lapique, for his researches on Negro races, and awarded medals and honourable mention to M. A. M. Choquet, for his contribution on teeth with reference to sex and race, and to M. A. M. Fischer, for his investigation of the variations of the radius and ulna.

THE Linnean bicentenary was celebrated in Washington, U.S.A., by a joint meeting of scientific societies, at which Mr. E. S. Greene delivered a Linnean memorial address. In the address, published in the Proceedings of the Washington Academy of Sciences, vol. ix., the author presents a description of Linnæus's chequered career and his associations with contemporaneous European botanists and physicians.

As a method of stocking forest land in dry districts of the Deccan, Mr. L. S. Osmaston recommends a combined system of agriculture and tree planting, which he describes in the June number of the *Indian Forester*. The land is let out to cultivators for two years; after the preliminary clearing, the lessee is allowed to plant the whole area with his crops during the first year, but in the following year is required to sow a proportion of seed for trees. In the case of the experiments quoted, the trees planted were *Melia azadirachta*, *Hardwickia binata*, *Albizzia Lebbek*, and *Tamarindus indica*; the crops cultivated were sesamum, cotton, and Indian hemp. An interesting experiment of planting live teak stakes is recorded by Mr. T. R. Singh. Shoots from the buds developed favourably for two or three months, but subsequently died, as the stakes became rotten before roots were developed.

DR. J. C. WILLIS takes the opportunity afforded by the completion of ten years' service as director of the Royal Botanic Gardens in Ceylon to review the work of that period in his annual report for 1906. In 1897 he discovered the "wound response" of Para rubber trees, that the first tapping leads to an increased yield of latex, and Mr. J. Parkin introduced the system of preparing rubber in biscuit form. Impetus was given to camphor cultivation by Mr. K. Bamber's work on the distillation of camphor. Green manuring and treatment of cacao canker have been profitable subjects of investigation at the experiment station. Cotton cultivation has been tried with some measure of success in the north of the island since 1903. The advances made in these subjects and in the exploitation of numerous minor products, the preparation of practical leaflets, and a considerable amount of scientific research furnish a remarkable record of material progress.

THE methods and objects of keeping land in good tilth are explained in *Irish Gardening* (August), to which Mr. A. D. Hall contributes a practical article, and Prof. J. Wilson also writes on the same subject. The editorial article refers to the passing of the Destructive Insects and Pests Act, and the speedy issue of an order applying to the counties of Gloucestershire and Worcestershire compelling growers to take measures against the gooseberry mildew disease.

In the *Agricultural News* (July 27) particulars are given regarding the efforts that are being made to establish an industry in Sea Island cotton in Tobago; with this object in view seed has been distributed, and a ginnery is in course of erection at Scarborough. In connection with the disinfection of cotton seed with corrosive sublimate in wooden vessels, experiments have shown that the mercury salt is absorbed, so that it is recommended to give the vessels a preliminary soaking before disinfecting the seed with a fresh solution. A note on the exhibition of limes from Dominica records the award of a gold medal at a recent show of the Royal Horticultural Society.

The Engineering Standards Committee has issued the British standard specification for steel castings for marine purposes (No. 30, price 2*s*. 6*d*. net). The present specifications of the Admiralty, the Board of Trade, and the three leading registry societies were carefully compared, and from these the specification has been prepared.

A special number of the *Far Eastern Review* (vol. iv., No. 1) has been published devoted to the mining industries of the Philippine Islands. The important part played by the mineral industry in the American development of the Philippines is clearly shown. In at least one district gold has been taken out in payable quantities, and the development of the coal deposits is making satisfactory progress.

A lengthy paper on the origin of the gold in the Witwatersrand banket, by Prof. J. W. Gregory, is published in the Bulletin of the Institution of Mining and Metallurgy (No. 35). He considers that the theory in best agreement with the facts appears to be that which regards the banket as a marine placer in which gold and black sand (magnetite with some titaniferous iron) were laid down in a series of shore deposits. The gold was in minute particles, and it was concentrated by the wash to and fro of the tide, sweeping away the light sand and silt, while the gold collected in the sheltered places between the larger pebbles. The black sand deposited with the gold has been converted into pyrites, and at the same time the gold was dissolved and re-deposited *in situ*. The absence of conclusive evidence of any considerable impoverishment in depth is an argument in favour of the alluvial origin of the gold, and is favourable to the further extension of the banket in depth.

The facilities provided by liquid air are leading to a rapid extension of our knowledge of the properties of substances at low temperatures. Mr. H. G. Dorsey, of Cornell University, is at present engaged in investigating the coefficients of expansion of solids, and gives in the August number of the *Physical Review* an account of the results obtained for quartz glass, ordinary glass, and several pure metals and alloys. For quartz glass the coefficient is negative below and positive above 190° absolute, remaining very small throughout, while for all the other substances tested it is positive, and increases with rise of temperature. In the case of gold, the curve connecting temperature and coefficient is undulating. The method used by Mr. Dorsey is a modification of Fizeau's, the interference taking place between rays reflected at the top surface of a sheet of black glass, on which a hollow cylinder of the material to be tested stands, and those reflected from the under surface of a sheet of clear glass supported on the cylinder. Temperature corrections are obviated by placing the apparatus in an exhausted chamber.

The merits of aluminium conductors are likely to be freely discussed, owing to the fact that insulated aluminium cables have recently been placed on the market by one of the well-known cable companies. Bare aluminium conductors have been used already in this country and largely used in America, but insulated aluminium cables have up to the present been practically unknown. The difficulty of making sound joints has been the trouble which has prevented a larger use of aluminium for commercial purposes, but this difficulty, it is stated, has been overcome, and both mechanical and "sweated" joints can be made as desired, and the makers claim that the electrical and mechanical properties of the joints are superior to those of the wire itself. Owing to the conductivity of aluminium being only 60 per cent. that of copper, the diameter of the cable carrying the same current is, of course, greater. How this will affect the cost when insulated aluminium conductors are employed still remains to be seen, as no figures are given as yet as to the price as compared with insulated copper cables. A 50 per cent. saving in weight is claimed over copper conductors of the same capacity, with an increase in diameter of 28 per cent. The insulation used is vulcanised bitumen, as being lighter than paper, for the same degree of insulation. Doubtless practical experiments in the use of these cables will now be made, since the jointing difficulties have been overcome, and the commercial utility of insulated aluminium cables will be tested.

The *Electrician* for August 30 contains a note on a new system of wireless telephony described by the inventor, Prof. Majorana, at a recent meeting of the Associazione Elettrotecnia Italiana, which is based on the use of a spark gap. For generating the spark a special rotating arrangement is used, and it is claimed that 10,000 single sparks per second can be obtained. These conditions entailed a special microphone, and the Majorana hydraulic microphone, which depends on the capillary action of fluid jets, answers this purpose. With this microphone Prof. Majorana has obtained telephonic currents of very great clearness and strength. The microphone consists of the usual mouthpiece and of a membrane fixed to a glass tube which moves freely under the oscillations of the membrane, and through which slightly acidulated water flows. A special opening in the tube allows the liquid to pass out and strike the upper surface of two cylindrical pieces of platinum which are insulated from each other. This is called the "collector." On striking the middle of the "collector" the fluid spreads over the surface, making contact permanently between the two halves. If a battery is connected in circuit with a telephone and the "collector," so long as the membrane is not disturbed by sound waves, a constant current will flow. As soon, however, as the membrane vibrates the aperture oscillates and varies the flow of drops, so that the thickness of the fluid on the collector is always altering. Prof. Majorana conducted his experiments with a spark gap, and got some satisfactory results, but at the same time he found that by using the Poulsen arc in nitrogen certain advantages accrued.

The report of the Meteorological Committee for the year ended March 31, 1907, recently presented to Parliament, records great activity in all branches of the useful work of the office, and is more than usually interesting from various points of view. Both the daily and weekly weather reports have been improved; the maps of the former now include *in situ* observations from Iceland and the Azores, and the statistical portion contains observations by wireless telegraphy from commanders of His Majesty's ships. The Icelandic reports are of the greatest value for weather prediction, and the successful inauguration of the service is due in a great measure to the exertions of the Danish Government and the Copenhagen Meteorological Office. The most important change in the weekly report is the inclusion of a table in which the week's warmth, rainfall, &c., for districts are characterised verbally; to obtain this result the weekly values of the various elements for the years 1881–1905 have been re-examined from the point of view of their frequency distribution. The committee notices with satisfaction that the weather forecasts for the year show a considerable increase of accuracy; the percentage of complete and partial success for the whole of the British Isles of the forecasts published in the morning newspapers was ninety-one, or 3 per cent. higher than in any year since they were first issued in 1879. The operations of the marine branch are carried on with great vigour; we have before us the monthly pilot charts of the North Atlantic and of the Indian Oceans for September, 1907, both issued about the middle of August. These charts afford an amazing amount of useful information brought down to the latest time, and although they represent but a small part of the work of that department, their publication monthly at a regular date is of itself a very onerous piece of work. The committee, recognising the importance of observations made in British colonies and dependencies, fully supports a proposal, emanating, we believe, from correspondence between Dr. Shaw and Mr. R. F. Stupart, of Canada, for holding a meeting of colonial meteorologists at Ottawa in 1908, with the view of promoting mutual cooperation in dealing with meteorological questions generally.

THE third volume (pp. x+528), which deals with linguistics, of the Reports of the Cambridge Anthropological Expedition to Torres Straits has now been published by the Cambridge University Press. The volume is by Mr. Sidney H. Ray, and consists of four parts, dealing respectively with the languages of Torres Straits, the languages of Cape York Peninsula, North Queensland, the languages of British New Guinea, and the linguistic position of the languages of Torres Straits, Australia, and British New Guinea. These reports will occupy six volumes, of which the fifth—the first to be completed—dealing with sociology, magic, and religion of the western islands, was noticed in NATURE of June 23, 1904 (vol. lxx., p. 179). The following general linguistic summary gives the results of Mr. Ray's work on the material collected by himself and Dr. A. C. Haddon with the assistance of numerous other workers:—(1) The western language of Torres Straits is Australian. (2) The eastern language of the Straits is morphologically related to the Papuan of New Guinea. (3) There is no genealogical connection between the two languages of the Straits. (4) There is no evidence of an African, Andaman, Papuan, or Malay connection with the Australian languages. There are reasons for regarding the Australian as in a similar morphological stage to the Dravidian, but there is no genealogical relationship proved. (5) The Papuan languages are distinct from the Melanesian. They are in some respects similar to the Australian, but their exact positions are not yet proved. (6) Languages of the Papuan type are found in German New Guinea. There is no direct evidence of their existence in Netherlands New Guinea. (7) There is insufficient evidence to connect the Papuan with the Andaman or Halmaheran languages. (8) In the northern Melanesian Islands a few languages are found which have Papuan characteristics. (9) Differences of grammar and vocabulary which appear in other island languages appear to be remains of an archaic Melanesian speech. There is no grammatical evidence to connect them with the Papuan, but they show the Papuan diversity of vacabulary. (10) The Melanesian languages of New Guinea and those of the islands are closely (genealogically) related in grammar and vocabulary. (11) The Melanesian languages of New Guinea and the islands stand in the same position with regard to the Polynesian. Both the former represent an older and fuller form of speech of which the Polynesian is a later and more simplified descendant.

WITH reference to a note in NATURE of August 29 (p. 449), Prof. B. Brauner asks us to say that the penultimate sentence should read:—"The atomic weight of nitrogen cannot be higher than 14·01 (*not* 14·10) and lower than 14·008 (*not* 14·08), and so the atomic weight of silver must lie between Ag=107·880 and 107·883."

FROM the author, Mr. Angel Gallardo, we have received a copy of a paper from the *Revista de la Universidad de Buenos Aires* devoted to a discussion of the methods of zoological teaching in that University.

WE have received a copy of vol. v., parts xvii. and xviii., of Prof. G. O. Sars's "Account of the Crustacea of Norway," dealing with a section of the copepod family Canthocamptidæ.

THE July number of the *Trinidad Bulletin* contains several notes on cacao, in which varieties, diseases, and pruning are discussed. On the subject of varieties, Mr. J. H. Hart affirms that clear distinctions exist between Venezuelan and Trinidad Criollo, both in the matter of shape and toughness of skin, and refers to the inconstancy of colour inheritance in cacao pods. With regard to the raising of new seedling varieties of sugar canes, the opinion is expressed that it is more advantageous and quite suitable to make a first selection according to the results of cultivation, and subsequently to test the canes so selected for sugar content, thereby saving extensive chemical investigations.

WE have received from Messrs. R. and J. Beck their illustrated catalogue of microscopical apparatus. It should be useful to microscopists, as hints are given on the use of the apparatus figured.

STUDENTS of the mollusca will be interested in the description, by Dr. W. Gadzikiewicz, of the biological station at Sevastopol, in *Biologisches Centralblatt* of August 1, of a new species of doris (*Staurodoris bobretzkii*) from Sevastopol Bay.

THE ovaries of Hemiptera (by Mr. A. Köhler), the nervous and excretory systems of various fresh-water planarians (by Mr. H. Micoletzky), and the tracheal muscles of ephemerids (by Mr. E. Dürken), constitute the contents of vol. lxxxvii., part iii., of *Zeitschrift für wissenschaftliche Zoologie.*

IN vol. lxiii., part ii., of *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande und Westfalens*, Dr. O. le Roi completes his synopsis of the birds of the Rhine province.

AMONG others, the *Bio-Chemical Journal* for August (ii., No. 9) contains a paper by Dr. MacLean on safranin as a test for carbohydrates. It is concluded that this is one of the most suitable reagents for determining the presence of traces of carbohydrates in liquids.

OUR ASTRONOMICAL COLUMN.

SEPTEMBER METEORS.—September has long been known for the abundance of fireballs which it supplies, and apparently the present month will justify this reputation. On September 3 a large meteor was observed from Redruth and Falmouth, in Cornwall, falling among the stars in the south-east region of Pegasus. On September 7 two fireballs were seen from near Bishop's Stortford. The first of these was observed at 8h. 56m. descending almost vertically a little to the right of the planet Saturn. The other made its appearance at 11h. 22m., but details are wanting.

DANIEL'S COMET, 1907*d*.—Numerous reports of observations and photographs of Daniel's comet are now coming to hand, and show this object to be one of unusual interest.

The *Comptes rendus* for August 26 (No. 9) contains a preliminary description of spectrograms obtained by MM. Deslandres and Bernard. The chief bands shown are those typical of the hydrocarbons and of cyanogen, but there are other, fainter bands which are unfamiliar. An as yet inexplicable difference is noted between the spectrum of the comet's head and that of its tail. A multiple tail 6° in length was shown on a photograph obtained by Mr. Plaskett at the Dominion Observatory, Ottawa, on July 20.

As reported in the *Observatory* for September (p. 364, No. 387), Mr. Melotte photographed the comet with the Greenwich 30-inch reflector on August 10, 11, 12, and 13, and the photographs show a tail some 100′ long with fifteen to twenty streamers. On a small-scale photograph secured with the Dallmeyer R.R. lens on August 13, the tail can be traced for about 7° from the head, its general direction being west. The streamers curve to the south and spread out in a fan-like form.

In No. 4198 of the *Astronomische Nachrichten*, Herr H. H. Kritzinger points out that the earth will, on September 12, pass through the straggling portions, if there be any so far behind the main body of the comet, and that any meteors occasioned by the collision will have as their apparent radiant $\alpha = 23h.\ 8m.$, $\delta = +3°$.

COMET 1881 V.—A note by Mr. Denning, published in No. 387 (p. 363, September) of the *Observatory*, recalls the fact that the return of the periodical comet discovered by him on October 4, 1881, is due this year.

According to Dr. Matthiessen's elements, the period is 8·68 years, and it therefore returned in 1890 and 1899, but its position rendered it invisible. This year its position indicates the same favourable conditions as obtained in 1881, when it was calculated to have been visible to the naked eye in August, before its discovery. The comet is of interest from the fact that at one point in its orbit it approaches to within 3½ million miles of the earth. The following is from a search-ephemeris calculated by Dr. Smart on the assumption that perihelion passage will take place on October 6 next:—

Ephemeris 12h. (G.M.T.)

1907	R.A. h. m.	Dec. ° ′	log Δ	Brightness.
Sept. 12	7 44·7	+17 50	9·897	1·71
,, 16	8 13·6	+17 28	9·912	1·74
,, 20	8 40·8	+16 50	9·930	1·72
,, 24	9 6·6	+15 59	9·951	1·67
,, 28	9 30·9	+14 58	9·973	1·58
Oct. 2	9 53·7	+13 49	9·995	1·47
,, 6	10 15·3	+12 33	0·017	1·34

From this it will be seen that the comet should now (September 12) be about 21m. west of ζ Cancri, and should rise, about 30° north of east, some 5 hours before the sun. On October 3 it will pass a little to the north of Regulus.

THE PARIS OBSERVATORY.—The annual report, for 1906, of Prof. Lœwy, the director of the Paris Observatory, is full of interesting items, of which only a few may be given here. After outlining the present state of the Eros work, the director mentions some instrumental alterations and improvements, and states how satisfactorily a registering micrometer has been found to work used in connection with the Cercle meridien du Jardin. Five hundred and eighty plates of the moon were obtained with the large equatorial *coudé*, and a number of enlargements of other plates have been made for the tenth section of the *Atlas photographique de la Lune*. A number of photometric observations and experiments on atmospheric absorption were carried on by M. Nordmann with interesting and important results, whilst M. Bigourdan continued his researches on the nebulæ. The work on the *Carte du Ciel* proceeds steadily, and 116 enlargements for the chart were prepared during the year; forty-one of these were from Paris, the others from Algiers, Bordeaux, and Toulouse.

THE LATE PROF. S. P. LANGLEY.—No. 1720 (vol. xlix.) of the Smithsonian Miscellaneous Collections is devoted to three interesting addresses delivered, respectively, by Messrs. White, Pickering, and Chanute, at the memorial meeting held on December 3, 1906, "to commemorate the life and services of Samuel Pierpont Langley, secretary of the Smithsonian Institution from 1887 to 1906." Dr. White's address dealt with Langley's work in general, dwelling especially upon his invaluable services to the institution and his ever-readiness to promote the cause of scientific research in every direction. In Prof. E. C. Pickering's address one finds a brief *résumé* of Langley's contributions to astronomy and astrophysics; whilst Mr. Chanute dealt with his work on aërial navigation. An apparently complete bibliography of Langley's published works from 1869 to 1905 is also included in the publication.

THE DISTRIBUTION AND CONTROL OF STANDARD TIME.—A paper of general interest on the subject of time-control is reproduced as an extract from the *Bulletin astronomique* (vol. xxiv.) for May. In it M. Jean Mascart describes the apparatus and method employed for this purpose at the Paris Observatory, discussing each operation separately, and illustrating the text by diagrams of various parts of the system. The causes of accidents and the special artifices adopted for eliminating their possibility form an important part of the paper.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE geographical section of the association met at Leicester under particularly favourable conditions, the quarters provided being the airy and spacious assembly rooms in Hotel Street. The meetings were generally well attended, and only in a few cases was any serious falling off in the audience noticeable. The papers were, so far as possible, grouped under the broad subdivisions of the subject, but as some deviations from this arrangement were necessary, in order to suit the convenience of the readers, it will be well here to disregard the strict order, and bring together the subjects of a more or less similar character.

Besides the opening address of the president, Mr. G. G. Chisholm, which has already been printed in full in these pages, several papers dealt with the specially human and economic aspects of geography, which it had been felt desirable to emphasise as suiting well with the industrial activities of the place of meeting. Communications had been received from distinguished exponents of this side of geography both in France and Germany. Prof. Vidal de la Blache, of Paris, whose writings are noteworthy for the admirable way in which they apply the geographical method to the consideration of human relations, was unfortunately unable to be present in person, but his paper, on the geographical evolution of communications, was read in his absence. Starting from the earliest devices evolved by primitive man as aids in the movement of loads, it traced their gradual improvement under varying conditions of local environment, and especially through the adaptation of animal power to purposes of transport; showing how the vast open plains of Central Eurasia, with the peculiar facilities they offered for the employment of the horse and wheeled vehicle, encouraged the movements of peoples, and brought about the development of long-distance traffic, in which the internal commerce of modern States may be said to have itself originated. While the early beginnings of commercial activity were especially dealt with in this paper, the most recent developments of economic geography were the subject of the communication by Prof. Max Eckert, the author of one of the best treatises on that subject which has appeared in Germany. Prof. Eckert pointed out that the geography of mankind, understood as the study of the relations of man to his environment, had really only come into existence within the last few decades. While supplying the one adequate bond of union between the natural and moral sciences, it bases all its considerations on the physical conditions of the earth, and evolves general laws regarding the influence of the soil on man and of man on the soil. Commercial or economic geography, which was more specially considered in the latter part of the paper, was defined as a study in which the earth is viewed as the theatre of human production and commerce, one of its most important tasks being the determination of the factors which govern the occurrence of industrial products, though the methods and apparatus of traffic fall also within its purview.

A third paper on the economic side supplied an example of the application of such general principles to a special problem. It was by Mr. J. McFarlane, of Manchester, who set himself the task of determining the limits of the area served by the Port of Manchester, and the character of the trade so carried on. The inquiry had involved much laborious research, the necessary data being obtainable, if at all, only through correspondence with a large number of individuals or bodies engaged in such trade. The material collected, while not permitting a complete answer to the question, was enough to give some indication of the influence exercised by the ship canal as a factor in the commercial relations of the region behind Manchester—an influence which the reader considered likely to increase with time.

One of the afternoon lectures, that by Mr. Mark Sykes, also dealt with the human side of the subject. The attendance was, unfortunately, somewhat small, owing to the counter-attraction of a social gathering, but those who were present listened to a most graphic account of the Kurdish tribes of Asiatic Turkey, among whom Mr. Sykes has travelled very extensively, and whose intricate subdivisions and varying characters he has studied with great care. The number of the separate tribes is astonishingly great, and they differ, not only in religion and language, but in physique, character, and mode of life. The lecturer traced the regional distribution of the principal main groups, and brought home to the audience the physical characteristics of the people by a striking series of photographs. One other short lecture, by Mr. J. D. Rogers, should be mentioned here. It was entitled "Explorers and Colonists," and traced in an instructive way the various motives which have led men to explore—exploration for exploration's sake being, as the lecturer pointed out, a thing of quite modern growth, unless we go back to the first beginnings of travel, and place men like Ulysses in the category of explorers pure and simple. Mr. Rogers spoke of the influence exercised by the imagination in sending the early explorers into remote corners of the world, and traced the connection which in later times grew up between exploration and colonisation.

The mathematical side of geography, which had received attention, outside Section E, both in the address of Sir David Gill and in that of the president of Section A on the figure of the earth, was represented within the section by two papers, both dealing with survey work in Africa. Major Close, R.E., gave a lucid outline of the present state of the official surveys in the several British possessions, showing what a large amount of excellent work is being carried out, often under great difficulties. Captain Behrens, R.E., spoke more especially of the methods of survey adopted, illustrating his subject by instances from special surveys, particularly that of the southern frontier of Uganda, in which he had himself taken part. He also showed upon the screen a number of views in the Ruwenzori range, taken during the expedition of the Duke of the Abruzzi.

Three papers only were concerned with physical geography pure and simple, which it is the modern tendency to leave more and more to the geologist, so far as studied independently of its bearing on man's activities. Prof. J. W. Spencer, who for many years has devoted his attention to the recession of Niagara, put before the meeting the results of his latest survey, carried out some two years ago on behalf of the Geological Survey of Canada. This has permitted conclusions as to the rate of recession since the date of earlier surveys, and Prof. Spencer finds that this rate is more variable than has been supposed, much depending on the shape of the crest at the time and the varying manner in which the rock is worn away. He has endeavoured to trace the state of affairs in the days of the early visitors to the falls, such as Hennepin, and has found what he considers must have been an old channel of the river in their time. He also spoke of the results of his soundings of the river below the falls. The physical geography of the Etbai desert of Egypt was spoken of by Mr. H. T. Ferrar, of the Geological Survey of that country, who exhibited a large-scale map specially drawn to bring out the physical characters of the country. He discussed various morphological features in regard to their mode of origin, and explained the meanings and mode of use of a number of Arabic geographical terms. Lastly, Mr. M. Allorge described the recently discovered cave of Atoyac, in Mexico, paying special attention to the relation borne by the passages and chambers to the structural planes of the limestone formation in which the cave occurs.

An afternoon lecture by Dr. Vaughan Cornish, on the Jamaica earthquake and its effects as witnessed by himself and Mrs. Cornish, dealt with a physical phenomenon, though much of its interest lay in the vivid way in which the effects of such a catastrophe on the life of the people were pourtrayed. A thrilling account was given of the personal experiences and sensations of the lecturer and his wife during the earthquake, and the effects on the buildings of Kingston were well illustrated by photographs. Dr. Cornish investigated the place of origin of the earthquake, the character of the shock, and the effects on buildings of different kinds, and he briefly described the methods by which these researches were carried out.

An interesting paper by Mr. R. B. Woosnam described briefly the recent British Museum expedition to Ruwenzori, giving a general account of the features of the range, and especially of the life-zones upon it. The differences between the east and west sides, due to the greater humidity of the latter, were explained, and the question of the modifications or variations of type with change of altitude was briefly touched upon. Nothing very remarkable in the way of special adaptation to the wet and cold of the mountain slopes was noticed, and it was pointed out that the bird most commonly met with in the wettest and coldest zone is a sun-bird of brilliant colour. On the other hand, a species of sun-bird which occurs below 7000 feet is represented above 10,000 feet by another twice the size, though otherwise an exact facsimile; and a similar case occurs among the plants.

Two papers presented detailed studies of special regions from the all-round point of view. Mr. O. J. R. Howarth described the district of Jæderen, in southern Norway, which he showed to possess special characteristics separating it entirely from the typical scenery of that country. The hills rise in partially isolated groups, the whole forming a practically unbroken tract of naked rock, which reveals, to an extent dominating every other feature, the work of the glacier which once covered it. The coast presents exceptionally clear evidences of the upward movement of the land, in the form of old fjords and islands, as well as an old beach, dating from a period of subsidence following that of glaciation, in which last the land stood even higher than at present. The paper indicated briefly some ways in which the distribution of the population had been influenced by the diverse physical characters. The other paper, by Mr. A. W. Andrews, described the Land's End peninsula, an isolated area of old rock separated from the rest of Cornwall by a neck of low land, and thus presenting characteristic features of its own. This granite plateau forms in its higher parts a bare and wind-swept moorland, with undulating hills rising above it. The coast is, as a rule, lofty, with striking granite and greenstone cliffs, and is almost harbourless. The whole area is but little inhabited, though mining was once more actively prosecuted, and there are some signs of a resumption of activity in this direction.

Mr. Andrews showed a number of views illustrating the structure and other features of the district and its coastline.

On one afternoon the section joined with Sections C and K to listen to an illustrated lecture by Prof. Conwentz on the need of preserving what may be called "natural monuments" (typical scenery, flora and fauna, &c.), and the measures adopted or to be recommended to this end. Another lecture, by Mrs. Leonidas Hubbard, presented a graphic account of a journey in Labrador, during which the lecturer completed the work begun by her late husband in the survey of two previously unexplored rivers, the navigation of which is rendered difficult and dangerous by the many falls and rapids. Lastly, a short extempore account of the general and economic characters of British New Guinea was given by Dr. W. M. Strong, a Government official who had just arrived in England on furlough.

Reports were presented by the committees for investigations in the Indian Ocean (Mr. J. S. Gardiner); for the study of the relations between rainfall and river discharge (Prof. McCallum and Dr. Herbertson); and for that of oscillations of land-level in the Mediterranean (Mr. R. T. Günther); and grants were obtained for the further prosecution of the work of the two first.

EDUCATION AT THE BRITISH ASSOCIATION.

TWO joint conferences were held, the first with Section H, on *Anthropometrics in Schools.* The report of a committee of Section H on anthropometric investigation in the British Isles was presented by Mr. J. Gray (secretary). The anatomical subcommittee reported on methods of taking chest measurements, on hair colours, and on iris colours. A series of schedules of proposed anthropometric measurements for the use of schools has been drawn up, suggestive as to what could be done with limited opportunities. A psychological subcommittee has drawn up a list of thirty-four mental characters, on which they suggest observations on a scale indicating average or more or less marked over or under development of each character. The educational subcommittee (Mr. E. N. Fallaize, convener) states some of the aims of anthropometric observations in schools as the determination of averages and standard deviations, the correlation of physical and mental growth, the detection of the unfit, and the testing of the efficiency of different systems of education. Mr. J. Gray recommended that measurements and observations in all schools should be made in accordance with the scheme of the Anthropometric Committee of the British Association, that the data obtained should be entered on the card schedules, and each subject's dossier kept in an envelope as recommended by the committee. Dr. F. C. Shrubsall showed some lantern-slides of the results already obtained by anthropometric methods, including a comparison of the relative statures of Jewish and British children, the Jews leading at first, but both alike at age twenty-two; the heights of the professional, commercial, and artisan classes, the professional always leading: the percentage distribution of stature in Scotland, Liguria, and Sardinia, showing the Scottish stature as taller than the Sardinian; a map showing the average statures in different counties of the British Isles; the range of variation at different ages in schoolboys, showing that the tallest aged five was taller than the smallest aged ten. This demonstration was most impressive, indicating both the importance of the results already obtained and the risks of generalising from imperfect statistics or with inadequate knowledge.

The discussion thus begun was adjourned and continued throughout the afternoon. Sir Victor Horsley read a resolution already accepted in the committee of Section L:—"Resolved that, in view of the national importance of obtaining data on the question of physical deterioration, this association urges upon the Government the pressing necessity of instituting, in connection with the medical inspection of school children, a system of periodic measurement which will provide definite information on their physical condition and development." This resolution was afterwards adopted by the general committee of the association, and, pending further consideration by the council in November, it was agreed that it should be communicated to persons interested without delay.

Prof. M. E. Sadler hoped that a medical bureau would be instituted, preferably by the Board of Education, but with the cooperation of the medical staff of the Local Government Board and of the Home Office. It was desirable that the central authority should give supervision in order that observations may be made on a uniform basis. Mr. J. Ramsay Macdonald, M.P., regarded anthropometrics in schools as a necessary scientific basis for social legislation and educational policy. Mr. E. Meyrick, F.R.S., of Marlborough College, spoke on the practical difficulties in obtaining measurements of growth in schoolboys, perturbations and inaccuracies being so considerable that the final results were nearly valueless. Subsequent speakers, thinking perhaps of height rather than of growth (or difference of consecutive heights), freely declared that the accuracy of the measurements did not much matter so long as there were plenty of measurements used in the average, but no one indicated exactly what standards of accuracy were possible or desirable. Mr. Cecil Hawkins, of Haileybury, read a paper on types of physical development in schools. A series of diagrams was distributed having in each case age as the abscissa, and for ordinate either height, weight or girth. Across each of these a series of nearly equidistant curves was drawn to show the progressive development of twenty different grades of boys (each equally probable). This system makes it easy to plot the course of any individual boy and to compare him, not merely with the average, but also with his own type, and to see how his height, weight, and girth are losing or gaining relatively to each other. Prof. Findlay referred to the suggestions of Prof. Armstrong that more might be done to interest the scholars themselves in these measurements and in the necessary calculation of results.

The discussion on *The Scholarship System* afforded a full day's work, the morning being devoted to the transition from the primary school to the secondary day school, and the afternoon to the preparatory school, public school, and university. The opening paper, by Prof. M. E. Sadler and Mr. H. Bompas Smith, greatly assisted the discussion by focusing attention on points raised by their recent inquiry, the results of which will be most welcome on fuller publication. New sections of the community are demanding access to secondary schools, and it has become necessary either to extend the scholarship system or to embark upon a policy of free, or nearly free, secondary education under public control. Maintenance allowances are also necessary. The demand for secondary education has been accelerated by new regulations for the training of pupil-teachers. A scholarship system must give the opportunity of long training for individuals of unusual capacity, and not merely brief but widespread encouragement to average ability. The records kept of the later careers of scholarship holders are at present inadequate, but the evidence points to an overwhelming majority passing into literary, clerical, and other non-industrial callings. The scholarship question should be looked at from a national point of view, not only from the standpoint of the personal advantage and preferment of the individual scholar. Ability should be directed towards those callings in which the individual, by natural aptitude and by physical stamina, can best render valuable service to the nation. Hitherto preferential treatment has been given to the recruiting of the more literary professions. At present special advantage is given to urban districts. The fixed values of the scholarships at public schools and universities might well be reduced, but ample supplementary allowances should be given to those scholars who need them, after private inquiry into the circumstances of each case. The best examinations now conducted for junior scholarships are confined, so far as written tests are concerned, to papers in English and arithmetic. A simple oral test is desirable. The examiners should also have access to the pupil's school record. Stress should always be laid upon physical fitness; this would be an incentive to the healthy up-bringing of children and discourage neglect of the candidate's health. Mr. R. Blair, executive officer L.C.C., reported that the 2000 scholars selected annually were about the number who were fit to take advantage of secondary education, but this number was much less than the 25 per cent. of free places which secondary schools, aided by the Board of Education, were required to provide. He agreed to the principle of an oral examination and to making a fair standard of physical development a condition of eligibility, but he warned the audience as to the difficulties in applying such tests; for instance, a missing limb was an obvious defect, but doctors might differ as to disqualifying for anæmia. Mr. H. Bompas Smith said that we needed scholarships to train girls for callings other than that of primary teaching, and a greater variety of secondary schools to meet different needs.

In the afternoon Mr. G. Gidley Robinson spoke on the scholarship system as affecting preparatory schools. The Rev. A. A. David, headmaster of Clifton College, thought that the money value of all scholarships might be reduced to something quite nominal, but sufficient to serve as a symbol of the intellectual distinction; the remainder of scholarship revenue might then be converted into augmentation funds. Dr. H. B. Baker, F.R.S., reported that at Cambridge about 17 per cent. of scholars could have resided at the University without their scholarships, while at Oxford the proportion was only 6 per cent. There might be a voluntary relinquishment of the emoluments of a scholarship by a wealthy parent, the other privileges of the scholar being retained. Not infrequently a former scholar, on attaining to fatter fortune, has paid back in some way the money that was the foundation of his fortune. Prof. H. A. Miers, F.R.S., thought that scholarships should be awarded by examinations of a less special character, and should be administered by the university. The present system of grouped colleges is a step in this direction. Any exhibitions given otherwise than by examination should be administered by the colleges. Scholarships are required for advanced and post-graduate work. The whole discussion indicated a marked advance of thought on the scholarship question. The difficulties were clear, especially the poverty question. Suggestions were numerous and helpful. The general agreement on the proposals made was very clear, and was emphasised by other speakers.

Sir Oliver Lodge read the report of the committee, consisting of Sir Oliver Lodge (chairman), Mr. C. M. Stuart (secretary), Mr. T. E. Page, Profs. M. E. Sadler, H. E. Armstrong, and J. Perry, Sir Philip Magnus, Principal Griffiths, Dr. H. B. Gray, Prof. H. A. Miers, Mr. A. E. Shipley, Prof. J. Findlay, and Sir William Huggins, appointed to consider and to advise as to the *Curricula of Secondary Schools*; in the first instance, the curricula of boys' schools. "The committee submit for consideration the following conclusions which they have reached as the result of their debates:—(1) There is need for secondary schools of different types, with different curricula or combinations of curricula, because (*a*) all boys are not suited to the same course of study; (*b*) the requirements of the various callings upon which the boys will subsequently enter differ considerably; (*c*) the needs of the schools differ in a considerable degree according to the economic conditions of the districts in which they are situated. . . . (2) The committee consider that one modern foreign language should in all cases be begun at an early age, but are of opinion that it would be a wise educational experiment to postpone the *systematic* teaching of Latin as an ordinary school subject until twelve years of age, and that such a change will prove sufficiently successful to warrant its adoption. . . . The committee also desire to record their opinion that the continued teaching of either of the two dead languages to boys who after serious trial have shown little or no progress in, or capacity for, such linguistic study, has little or no educational value; and that, though the mental training afforded by such study is of great value in the case of many boys, yet in the case of others such study not only produces no good results, but does positive harm to their mental and moral progress by reason of their incapacity to grapple with its difficulties. The committee go further, and express their doubt whether the authorities in some secondary schools have sufficiently recognised this fact or have provided sufficient alternatives to such linguistic study. (3) The committee deprecate any form of early specialisation in the education of children, and therefore regard with grave concern the fact that the entrance examinations at the great English public schools give undue prominence to the study of Latin (and Greek) in the course of education at the preparatory schools, the result being that too little time is available for (*a*) the teaching of the mother tongue, (*b*) manual training, (*c*) science and mathematics. (4) The committee would deprecate anything like State-imposed rigidity in the organisation and studies of secondary schools. . . . (5) The committee are of opinion that the curriculum in secondary schools suffers gravely from the number of subjects which have been crowded into it. . . . (6) The committee desire to see a great simplification in the arrangement of examinations for secondary schools, and they strongly recommend that examination and teaching should go hand in hand, the examiners cooperating with the teachers and acting in conjunction with them in order to further the interests of real education. The committee would urge upon the universities and professions to accept as qualifying for entrance the leaving certificates granted by each university to the schools which submit to its inspection. . . . The committee particularly deprecate any uniform or centrally administered examination applied to all the schools of the country. . . . (7) The committee feel that no scheme of secondary education can be satisfactory unless it is carried out by teachers of learning and force of character, and they would urge that every effort should be made, by conditions of appointment, by scale of salaries, and by retiring allowances, to attract a high class to the teaching profession, which should be regarded as a very laborious, but very honourable, form of public service. . . ."

In this and other discussions there was much keen criticism of the Board of Education. The burden of it was distrust in matters which could be put on a scientific foundation. A subcommittee of the curriculum committee has been appointed at the request of Mr. G. F. Daniell to report on the sequence of scientific studies. Prof. Armstrong directed attention to the dangers of State control, to the importance of manual training as a branch of intellectual education, and to the administration of the examination system, not with altruistic motives, but as a lucrative business. A committee of Section L has been appointed to watch legislative and administrative action. Dr. Anderssen, of Christiania, reported the gymnasium for boys of fifteen to eighteen years as divided into three branches, one with mathematics and science as the centre, one with modern languages, chiefly English and history, as the centre, and one with Latin as the centre. Prof. L. Morel, of Paris, spoke of France as a field for experiments. For the years fourteen to seventeen, boys are grouped in four sections. Section A is characterised by Latin and Greek, B by Latin and foreign languages, C by Latin and sciences, and D by sciences and foreign languages. The last is the normal course for those who learnt no Latin before fourteen or who choose to abandon it.

Mr. R. E. Thwaites reported the results of his inquiry into the *Conditions of Science Work in Secondary Schools*. The average number of boys in a class is twenty-one or twenty-two, but twenty should be the maximum for a laboratory class. The average expenditure per boy on apparatus and chemicals is about *1l.* per annum in public schools and *8s. 6d.* in secondary day schools. From two-thirds to three-quarters of the schools are satisfied with the number of the science staff, the laboratory accommodation, and the equipment of apparatus, but little more than half have any laboratory assistant, the more expensive time of the science master being spent on details which could be performed less expensively by an assistant.

A joint meeting was held with Sections D and K on *The Teaching of Biology in Schools*, introduced by a paper from Mr. O. H. Latter, of Charterhouse. In the preparatory school and lower forms of public schools the standard indicated as "nature-study" seems the best form of science training. Common animals involving direct personal observation were more suitable in the next stage than the "type-method" with its underlying idea of evolution. A year of chemistry and physics might be interpolated before physiology. With older and cleverer pupils pure nature-study methods become insufficient. As the mind matures it must have more solid matter to digest. The theory of evolution was beyond the grasp of any but the best class. Prof. Hickson agreed that the ordinary course of biology was unsuitable for schools, but possibly best for the teachers. Prof. Marcus Hartog advocated accurate detailed descriptive and systematic work in botany as the remedy for a certain fluffiness of observation and description in nature-study.

The report on curricula deals in the first instance with boys' schools. The girls' schools had their turn when Prof. H. E. Armstrong addressed the section on *The Need of a Scientific Basis to Girls' Education from a Domestic Point of View.* Women should cease from competing with men to the neglect of their own interests and natural duties. A scheme of scientific education for girls might radiate from the household. Instead of chalk and salt, the common materials of the household, flour, starch, coal, meat, sugar, &c., might be used as starting points for a girl's study of science. The science of bread-making would lead to a general cooperation of all studies helpful to that end. The committee of Section L would like Prof. Armstrong's paper to have been published in full. It was a powerful enforcement of ideas advocated by Prof. Smithells in York.

The remaining hours were devoted to a discussion on *Types of Specialised Teaching.* Mr. J. H. Hawthorn, of Leicester, spoke on the teaching and the teacher in evening technical schools. The type of evening student has been changing, there are fewer adult workmen, and the average age is lower than ten years ago. No student should take a trade class until he has laid a foundation of pure science. Good results were obtained by a science teacher with a competent artisan demonstrator. The teacher keeps abreast of the trade when he is known to local factory owners, appreciated by them, and encouraged to visit factories. Mr. C. T. Millis, of the Borough Polytechnic spoke on problems of trade education considered in relation to our school system. Reforms are needed in our elementary-school education to make it an effective preparation for the battle of life, especially for those children who will take up industrial work. Too much attention has hitherto been given to those going into clerical occupations. The types of schools required are specialised trade schools for boys and girls of fourteen to sixteen years of age teaching definite trades, and also preparatory trade schools teaching practical mathematics, drawing, and science. The course must be planned to fit the elementary school at one end, and also to fit the system of apprenticeship followed in each trade. The labour market must be watched to guard against mistaken specialisation. The teacher of trades must have had trade experience in the factory. Cooperation of parents, teachers, employers, and trade-union leaders was necessary. Mrs. J. Ramsay Macdonald described the day trade schools for girls in greater detail. Women's work is double, wage-earning in factory and responsibility at home. To look upon the former as unimportant is disastrous to women wage-earners. There are now day classes in waistcoat-making, dressmaking, corset-making, and ladies' tailoring. The pupils mostly hold scholarships with maintenance grants. Six half-days are devoted to trade teaching, four half-days to general instruction. The trade teachers have come straight from good positions in the workroom. The pupils' development, not customers' convenience, is the first consideration.

An excellent paper on technical training of the rank and file, by Mr. J. C. Legge, of Liverpool, was in reserve, but under pressure of time and in his regretted absence it was distributed in abstract and taken as read.

It was most gratifying to have so good a discussion on these matters of technical and industrial training, which have been a special interest to the president, Sir Philip Magnus. Although not referred to in Section L, no account of technical education at the British Association would be complete without mention of Prof. S. P. Thompson's suggestions in Section G for the abolition of premium apprenticeship, and the opening of the best opportunities in engineering works to merit and not to wealth. From Section D we cull another pregnant idea. The little procession of blue-eyed and brown-eyed school children brought by Mr. Hurst from Burbage inevitably suggests the possibility of our pupils having Mendelian minds as well as Mendelian eyes.

The brief interim report on the conditions of health essential to the carrying on of the work of instruction in schools, presented by Sir Edward Brabrook, may seem inadequate to represent the interest of the association in such matters. But papers on school hygiene were deliberately avoided this year as the most effective method of supporting the simultaneous congress in London.

Two exhibitions were organised, one an exhibition of work representing practical and observational studies collected from the Leicester Council Schools by Mr. Charles Bird. The exhibition of school-science apparatus collected from several important schools by Mr. R. E. Thwaites was conveniently adjacent to the section room.

H. R.

LOCAL SOCIETIES AT THE BRITISH ASSOCIATION.

THE number of delegates from the local scientific societies which are in correspondence with the British Association was exceptionally large at the conference held during the Leicester meeting. Mr. H. J. Mackinder opened the session, in the council chamber of the municipal buildings, by an address on the advancement of geographical science by local scientific societies. He pointed out that in France there are about twenty local societies devoted to geographical study, each taking a region nearly corresponding with one of the old provinces, whilst in Germany there are many societies working specially for the furtherance of local geography. In this country each provincial scientific society should seek to correlate, from a geographical point of view, all the facts obtained by specialists in its own locality, taking as a basis a natural area rather than a county boundary. From such correlation, if undertaken by a person of special training, deductions could be drawn which would be of great value to specialists in the future. Until systematic work of this kind is accomplished on uniform principles throughout the country, no complete geographical conception of our land is possible. Captain Dubois Phillips, representing the Liverpool Geographical Society, referred to the stimulus which should be given to the rational study of geography by local societies through the influence of the British Association; and Dr. H. R. Mill bore testimony to the inspiriting character of the discourse, but feared that the complete realisation of Mr. Mackinder's scheme must be far distant.

At last year's conference of delegates it was suggested that the British Association should be asked to appoint a committee to organise a general photographic survey of the country, county by county. The suggestion was carefully considered by the Corresponding Societies Committee, but it was felt that the scheme was too vast to be taken up by the British Association. At the same time, it was considered that some section of the suggested work, such as archæology, might perhaps be advantageously undertaken. A discussion was therefore initiated by the Rev. R. Ashington Bullen, who read a paper at the Leicester conference on the advisability of appointing a committee for the photographic survey of ancient remains in the British Islands. The anthropological section held, however, that such work might be fairly undertaken by the committee which already exists for the collection and registration of anthropological photographs. As the result of much discussion the following resolutions, on the motion of Mr. W. Jerome Harrison, of Birmingham, were sent up to the Committee of Recommendations and ultimately referred to the Council:—That it is advisable to obtain information as to the present state of things in Britain, in connection with photo-survey work; to publish instructions, or give advice, for the execution of a scientific photographic survey; and to endeavour to found or promote a photo-record of the town and district in which the British Association holds its annual meetings.

At the second meeting, presided over by the Rev. J. O. Bevan, the local societies were urged to give greater attention to the study of the fungi occurring in their districts. The subject was introduced by Mr. Carleton Rea, of Worcester, at the instance of the British Mycological Society. It was pointed out by Mr. Rea that British botanists generally omit fungi from the county floras, or give lists that are compiled without the necessary local knowledge. Yet the group ill deserves neglect, for it is one of great economic importance. It is said that the cereal rusts cost Prussia in one year 20,000,000*l*. To encourage the study of British fungi, the Woolhope Naturalists' Club in 1868 instituted a series of autumnal forays, and some other natural-history clubs, like the Essex Field Club, have followed the example; but this occasional study is insufficient. The fungi should be studied throughout the year, and specimens displayed for exhibition at all times in the society's rooms or in the local museum. In the course of the discussion, Prof. J. W. Carr, of Nottingham, and some other naturalists, dwelt on the difficulty of working out the fungi of a given district in consequence of the general lack of expert knowledge. Mr. Rea, however, considered it the duty of each society to be able to determine the fungi of its own area, without submitting them, except in difficult cases, to a mycological referee. A large collection of hand-coloured photographs of fungi, taken by Mr. A. Wallis, of Kettering, was exhibited by Mr. H. N. Dixon.

Several delegates from the sections explained in what way the local scientific societies might aid the sectional committees. Mr. Wilfrid Mark Webb appealed for specimens of centipedes in illustration of a work on which he was engaged, but the Rev. Thomas Stebbing explained that his repeated request for well-shrimps had met with no response from any of the local societies through their delegates.

HEALTH AND EDUCATION.

THE Health Education League of Boston, Massachusetts, U.S.A., has issued a series of small pamphlets dealing with the common aspects of our daily life from a health point of view. Mrs. Ellen H. Richards appears to be the moving spirit in this useful sanitary campaign, and with her are associated as writers of pamphlets and directors of the league several medical men. The usefulness of the hints contained in these tiny publications is undoubted, all the more so because they are tiny, and because the facts they set forth are stated in terms readily to be understood by everyone.

The first of the series gives "Hints for Health in Hot Weather." In it we find sensible remarks, under the heading of "Rules for Children," "Cleanliness," &c., concerning the general bringing up of children, but, except the benefits of sunshine and the use of wire screens to keep out mosquitoes, we are told all too little about bodily protection in hot weather.

No. 2 of the series deals with milk. The story of milk as a food and as a vehicle of disease is admirably told. The meaning of unwholesome milk, how it is brought about, and how prevented by chilling and sterilising, is described and fully explained; the information contained in this pamphlet is an education to the public in the very best sense.

"Colds and their Prevention" is dealt with in series No. 3. Under this heading the subject of ventilation is skilfully introduced. The care of the skin and of the feet is also incorporated in the text.

No. 4 of the series is concerned with "Meat and Drink." Good nutrition is held to be of vital importance to our courage, cheerfulness, and physical efficiency, and the meaning of cooking and the effects of boiling, roasting, frying, &c., scientifically yet simply explained.

"Healthful Homes" is the subject of No. 5. The moral atmosphere of family life is dwelt upon as an important factor in national life, and the practical details of elementary hygiene and sanitation are here collected and set forth in admirable fashion.

"The Successful Woman" (series No. 6) pamphlet tells the business woman how to keep well, and good and sensible rules and suggestions are laid down for her guidance. Most of us would hesitate to stamp a business woman, that is, one whose chief ideal is to keep well, so "that she may earn a full salary," as one of nature's successful productions. That women should be compelled to, or by choice, take to business cannot but be regarded as one of the blots of our civilisation of which we ought to be heartily ashamed. To stamp a woman so engaged as a successful woman is rather encouraging woman along a side-path of doubtful benefit to the race.

"The Boy and the Cigarette" (series No. 7) should be read by everyone, and the recommendations against this poisonous and harmful practice should be stringently enforced by law in the case of boys. Women are warned that neither their brothers nor their admirers think better of them for smoking cigarettes. A woman who smokes is spoken of in a ribald manner, did women but know it, by men in private, and their morality made a subject of question and banter.

"The Care of Little Children" (series No. 8) is replete with good advice, and can be heartily commended; and the fact that the future health and welfare of the individual is mostly determined by the wisdom or folly bestowed upon the infant during the first few weeks of life pointedly brought home.

"The Plague of Mosquitoes and Flies" constitutes the subject of series No. 9. It is a timely contribution, and contains the most recent lessons we have learned concerning the spread of disease. We know within recent years that our household pests and pets, the flies, fleas, bugs, and other vermin which inhabit our houses, and our dogs, cats, fowls, mice, rats, &c., are frequent media of the transmission of diseases. It is a great advance in knowledge, one of the greatest hygienic advances since Parker first brought the subject systematically before the world. This pamphlet should be distributed broadcast, and the subject it deals with taught in every school.

No. 11 of the series points out, under the title of "Tonics and Stimulants," the necessity for temperance in the use of alcohol, tea and coffee, and drugs. The lessons in this short pamphlet are well taught, and the advice wise and wholesome.

The series as a whole is an unfortunate necessity. It implies that mankind, in modern days, has so lost touch with nature and nature's ways that the instinct of the care of the young, which belongs in common to all animals, is a lost attribute of modern men and women. Perhaps it is wise to recognise the fact; and being recognised, we can conceive no better method of repairing the loss than by the publication and wide distribution of information such as we find in the series before us.

THE INSTITUTION OF MINING ENGINEERS.

THE annual meeting of the Institution of Mining Engineers, held at Sheffield on September 4, 5, and 6, was attended by a large number of members. Cordial addresses of welcome were delivered by Mr. J. R. R. Wilson, president of the Midland Institute of Mining Engineers, by the Lord Mayor of Sheffield, and by Mr. A. J. Hobson, speaking on behalf of the Chamber of Commerce and of Sheffield University, who kindly lent the Firth Hall for the occasion. Mr. C. E. Rhodes was elected president for the ensuing year, and the report of the council, read by the secretary, Mr. M. Walton Brown, recorded a year of satisfactory progress. The institution is a federation of seven local mining societies, and its membership has grown from 1239 since the foundation in 1889 to 3100 at the present time. During the past year sixty-eight papers of a varied nature were published in the Transactions. Mention was made of the efforts being made, in conjunction with the British Science Guild, to secure a reduction of postage on the publications of scientific societies, and of the reports submitted by Mr. J. A. Longden, representative of the institution at the British Association, and by Mr. Bennett H. Brough, representative of the institution at the testing congress in Brussels. It was also noted that Mr. Arthur Sopwith, senior past-president, represented the institution on the governing body of the Imperial College of Science and Technology.

Three papers were read and discussed. The first, by Mr. J. W. Fryar and Mr. Robert Clive, described the sinking of two shafts through 100 feet of quicksand at Bentley Colliery. In the second Mr. H. T. Foster dealt with the subject of roof weights in mines, his views being deduced from observations in long-wall workings. Lastly, Mr. H. St. John Durnford described a deep boring put down on the Earl of Londesborough's estate, near Selby, in the hope of finding a workable seam. Although some 1060 feet of Middle Coal-measures strata were proved, boring was continued to a depth of 2371 feet without any good seam being encountered. It is probable that the bore-hole passed down through the limb of a fold where the seams had either thinned or pinched out altogether. In the afternoon of September 4 the members visited the Tinsley steel, iron, and rope works, and the East Hecla works of Hadfield's Steel Foundry Company, Ltd. At the dinner in the evening Sir William Clegg, in proposing the toast of the Institution of Mining Engineers, incidentally referred to the new Imperial College of Science and Technology, and stated that a deputation from Sheffield had waited upon Lord Crewe to urge that mining and metallurgy should be taught at Sheffield in the centre of mining and metallurgy, rather than centralised in London.

On September 5 the members visited the Clyde Steel Milling Works, Bentley Colliery, and Silverwood Colliery; and the meeting concluded with a drive, on September 6, to the Derwent Valley waterworks.

METEOROLOGICAL OBSERVATIONS.

SEVERAL reports of meteorological observatories have recently been received, and four of them are of noteworthy interest. The report of the observatory department of the National Physical Laboratory for 1906 shows that the value of the instrumental certificates is very generally appreciated; the increase in the number of instruments verified during the year amounted to more than 2900, the total being 29,567. There was a marked increase in the number of marine chronometers submitted to trial, more than 20 per cent. of which failed to pass the test. In the magnetic department the curves were free from any large disturbances. The largest movements of the seismographs occurred on January 31, April 18, and August 17, the dates of the Colombian, Californian, and Chilian earthquakes. The meteorological observations show that shade temperatures exceeding 80° were recorded in each of the four months June–September, the extreme reading being 91°.8 on September 1. Rainfall amounted to 23·68 inches (nearly half an inch below the average for Greenwich for the sixty-five years 1841–1905); the greatest daily fall was 2·36 inches on June 28, and was within half an inch of the total amount for that month.

The report of the director of the Bombay Government Observatory for 1906 gives room for little comment, excepting that the operations, which deal especially with terrestrial magnetism, meteorology, and seismology, were carried out with the usual care and punctuality. The maximum temperature was 94° on October 23, being only about 2° higher than the extreme reading recorded at the Kew Observatory. Owing to concussion from exceptionally heavy gun-firing at Colába the dry-bulb thermograph was broken in June. The yearly rainfall amounted only to 56·3 inches, being nearly 19 inches below the normal of twenty-four years (1873–96). Milne's seismograph registered fifty-nine earthquakes during the year; of these three were very great disturbances, viz. January 31, August 17, and October 24; the two first mentioned correspond to the dates of the Colombian and Chilian earthquakes.

The fiftieth year-book of the Austrian Central Meteorological Office, for 1905, contains hourly and daily observations at some selected stations, as before; the results at other stations are arranged either according to the international scheme or in tables showing monthly and yearly means and extremes. The stations number 412, of which fifty are more than 1000 metres (3280 feet) above sea level; this number in no way represents the whole of the valuable Austrian meteorological work, as there are several independent organisations dealing more particularly with rainfall and temperature, the principal of which is the hydrographic department, with more than 1000 stations, for eighty of which the observations are printed *in extenso*. The Hungarian and other meteorological services also issue separate year-books. The Vienna Meteorological Office deals specially with earthquake phenomena and with the collection and discussion of thunderstorm observations, the results of which are printed separately; it also publishes a daily weather report, and takes an active part in the investigation of the upper air by means of balloons.

In the annual report of the meteorological department of the Transvaal for the year ended June 30, 1906, the results of observations are well arranged in appendices, as before; the hourly readings at Johannesburg are not now printed *in extenso*, but MS. copies are available, on loan, for special inquiries. The stations have increased in number to 376, most of which record rainfall only; all the observers are volunteers, or are attached to other departments. The rainfall was considerably below the average in all parts except in the S.W., where the defect was only slight; no snowfall was reported during the year. A forecast of the weather for the ensuing twenty-four hours is now exhibited at every postal telegraph station in the Transvaal. The director (Mr. R. T. A. Innes) seems dissatisfied with the Campbell-Stokes sunshine recorder, which only shows the time during which the sun is sufficiently powerful to burn the cards; in future reports both the duration and burning times will be given.

RUSSIAN SCIENTIFIC WORKS.

THE Imperial University of Kazan, with its society of naturalists, is noted for excellent work in many departments, and we are greatly impressed with the magnitude of Mr. M. Ruszky's volume "The Ants of Russia" (*Formicariae Imperii Rossici*), of which the first part lies before us. It consists of 800 pages, with 176 sketches, comprising an introduction, bibliography, systematic examination of Russian ants, list of collectors to whom the author is indebted, and indexes. Mr. Ruszky began the study of Russian myrmecological fauna in 1892, when he undertook a zoological excursion in the Kazan and Simbirsk governments on behalf of the Society of Naturalists. He was induced to take up this investigation partly because Russian ants had been very little studied, and partly for the collection of materials for the solution of biological and zoo-geographical questions. This work is to be understood as a preliminary array of results, being an attempt at a description of Russian ants in systematic geographical and biological respects. The author anticipates criticism for omission of questions of internal morphology and embryology, and observes that such exhaustive treatment of the Formicidæ by a single investigator would occupy, not one, but many decades. In the important bibliography of writings on ants, occupying with addenda about seventy pages, very few works are devoted to Russia, chief among the number being twelve by the author. Mr. Ruszky estimates the approximate total of species and subspecies known at the time of writing at 3500, and groups Russian ants under the subfamilies Camponotinæ, Dolichoderinæ, Myrmecinæ, and Ponerinæ. Representatives of Dorylinæ, principally found in the tropics, have not been seen in Russia, though one species (*Dorylus juvenculus*) is European, being found in southern Italy, Sicily, &c. After some useful preliminary notes and tables of species of Russian ants, the author proceeds to detailed descriptions of smaller groups. In all, 258 forms are described (155 species and races, 103 varieties), of which sixty are new and treated for the first time (subfamilies, Camponotinæ, 109; Dolichoderinæ, 7; Myrmecinæ, 138; and Ponerinæ, 4). The regions richest in myrmecological fauna are the Caucasus, with 130 forms; Russian Central Asia, about 112; European Russia, 92; Siberia, 71; Crimea, 43; and Finland, 32. All these figures are approximate, and it is probable that since this work appeared more results have been recorded. This first part gives geographical distribution, locality, and biological information, and in the second Mr. Ruszky proposes to deal with this fauna from the bio-geographical point of view.

Vol. xxxiv. of the Transactions of the St. Petersburg

Society of Naturalists, edited by Mr. J. Borodine, is devoted to botany. Mr. Y. N. Voronoff describes his botanical excursion in the summer of 1902 in Abhasia (Caucasus). The whole region is rich in Alpine flora, of which the writer collected thousands of specimens and hundreds of species. Mr. Voronoff supplements Alboff's work on the flora of Colchis, and gives a list of 129 plants, of which four are newly described. Mr. E. Ispolatoff's article on the vegetation of the eastern portion of the Novgorod government contains descriptions and lists of that found in forest, marsh, and meadow land respectively, with observations on the influence of man upon local vegetation. He notes that localities suitable for human habitation are also favourable to vegetation. The presence of primitive Siberian flora in certain districts is accounted for by the wild, sparsely populated nature of the country, as contrasted with the more cultivated areas of western Russia. Mr. Ispolatoff gives a list of local names of plants, *e.g. Cypripedium calceolus* (Adam's head), *Aegropodium podagraria* (bear's paw), Ranunculus (jaundice, hen's blindness). The bulk of the journal is occupied with Mr. Leonid Ivanoff's papers on phosphorus and its relations to plant life, with results of experiments. Mr. J. L. Serbinoff furnishes preliminary notes on water plants and fungi of the Crimea, a field scarcely studied. The mountain districts are poor in water plants, while there are more in the south, but on account of their comparative rarity considerable time must elapse before a complete list can be compiled.

There is a wealth of interest for the geologist in part v. of vol. xxxiii. of the Transactions of the St. Petersburg Society of Naturalists, devoted to geology and mineralogy. Mr. W. Lemann writes on the Jurassic deposits of Orlovka, and furnishes a plate of fossils. Mr. B. Popoff describes a new method of investigating spherolithic formations, with diagrams. Besides notes on diabasic rocks on the shores of Lake Onega, by Mr. S. A. Jakovleff, and on the island of Pargas, by Mr. Sustchinsky, Mme. Jeremina and Mr. Loewinson-Lessing describe expeditions in the Mugodjaren (Ural) mountains, and the former writes on the spherolithic formations in this range, with numerous illustrations. *Résumés* of the articles appear, mostly in German.

In part ix. of vol. xxxvii. of the Journal of the Physicochemical Society of St. Petersburg University appears a list of minutes and papers, the volume containing more than 1300 pages. Mr. V. Menschutkin writes on the action of water on etherates and combinations with ether-salts, and Mr. A. Gorboff on the static character of the equilibrium of physicochemical systems. Mr. E. Orloff furnishes a new synthesis of benzylideneimides, and a lengthy paper on the phosphorescence of some organic compounds between $+100^\circ$ and -190° appears from the pen of Mr. P. Borissoff. The purpose of Mr. Borissoff's work was to examine the influence of temperature on the phosphorescence of certain organic compounds, and to determine the relation of fluorescence to phosphorescence. A memoir of Mr. V. A. Mokievsky, a promising laboratory worker cut off all too soon, is given by Mr. S. Lebedeff.

In part ii. of vol. xxxv. of the Transactions of the St. Petersburg Society of Naturalists, Mr. V. N. Tonkoff describes experiments in embryology in connection with dual formations, and gives a bibliography of works on embryology, development, abnormal formations, &c. The writer appears to be of opinion, judging by results of experiments by pressure and osmosis on the eggs of frogs, fish, and medusæ, that similar results would be produced in the case of other ova. This article is illustrated by two plates. Mr. A. V. Zhuravsky contributes notes of a zoological journey in the Siberian tundra. This region, largely volcanic, has been summed up as "dead land (*i.e.* clay) and lakes." For the naturalist there is abundant material for study in the lakes and on the sloping shores. Of the fauna, *Mus amphibius* is very prevalent, and finds its way on board steamers and other craft as an emigrant. A list of mollusca occupies several pages. A short *résumé* in German follows each article.

Vol. xxxv., part iv., of the Transactions of the St. Petersburg Society of Naturalists, devoted to zoology, is chiefly taken up with articles by Mr. W. M. Schimkevitch, one of the editors. He is responsible for notes on the development of Thelyponus, experimental observations of the eggs of *Philine aperta*, and a preliminary article on the theory of mutation. His paper of more general interest is that on the instincts of domestic animals, in which certain well-known habits of the dog are discussed, as burying of bones, &c., without apparent reason. Most of these are followed by a German *résumé*. The concluding article, by Mr. S. Susloff, treats of phagocytes in relation to insects, with diagrams and a bibliography.

Mr. N. Andrussoff has issued part i. of his material for the geology of the Aralo-Caspian region (Transaction of the Aralo-Caspian Expedition), which he has studied for twenty years at intervals. The places covered in this part include the Krasnovodsk peninsula, Great and Little Balchan, Djanak, and Ustiurt. Notwithstanding its proximity to Krasnovodsk and the railway, the geological features of the Kubadagh have been very little studied. In his first chapter Mr. Andrussoff summarises the work of previous explorers since Eichwald visited the neighbourhood in 1825. The work is illustrated with plans, sections, and views.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE professor of mechanical engineering at the City and Guilds Technical College, Finsbury, is about to appoint a chief assistant to take charge of the new engineering laboratory. Particulars of the appointment will appear in our advertising columns.

THE question of the extent of the training in science, and especially in physics, which one who intends ultimately to become a physics teacher should receive at the high-school stage of his career, is treated with great insight by Dr. K. T. Fischer, of Munich, in a recent article in *Natur und Schule*. It will be remembered that Dr. Fischer spent some time in this country investigating our methods of teaching science, and that his observations are embodied in his book "Der naturwissenschaftliche Unterricht in England." His present article is largely a plea that even at this stage the future teacher should be brought into close contact with physical apparatus, and should be taught to handle simple tools and fit together apparatus. Dr. Fischer's ideal of a teacher is one who by the end of his training has not only learnt to read with understanding the original work of the great masters, but has carried out a piece of research himself. He recognises, however, the difficulty of his last demand even in his own country, and we in this country must, we fear, look on it as a counsel of perfection for many years to come.

THE new syllabus of classes at the Sir John Cass Technical Institute, Aldgate, shows that the work of the various departments has been considerably re-organised since last year. Apart from systematic courses in physics, mathematics, and chemistry, special courses of instruction are now given in physical chemistry, brewing and malting, and in several branches of advanced physics, including radio-activity. The course in physical chemistry includes general physical chemistry, electrochemistry, and a laboratory course of practical work; the instruction in brewing and malting also includes laboratory work of a technical character in addition to a course of lectures designed for those engaged in the brewing and malting industries. The teaching in metallurgy, which for the past four years has formed a distinctive part of the work of the institute, has now been established as a separate department, and a full graded curriculum extending over three years is provided.

THE London County Council desires to direct attention to the facilities offered for evening instruction in the various institutions maintained by it or under its control. In the various polytechnics, technical institutes, and schools of art situated in the county, classes in science, art and technology, music, artistic handicrafts, &c., will be re-opened towards the end of the present month. These institutions provide instruction of an advanced or technical character. The council offers annually scholarships and exhibitions to the total value of 1500*l.* for competition among students of polytechnics, technical institutes, and art schools. In thirty-six London County Council schools, centres for instruction in commercial and science and art subjects will be opened. These centres are in a degree contributory to the polytechnics and technical institutes mentioned above and are primarily intended for students not sufficiently advanced for the polytechnic classes. Advanced work, however, is taken in many of the subjects. In 237 London County Council school buildings situated in every part of London, ordinary evening schools will be opened this session. The instruction will, as a rule, be of a character preparatory to that given in the centres.

THE educational demands of the organised workers of this country are expressed in the following points of a resolution adopted at the Trade Union Congress at Bath last week:—(1) The State maintenance of school children. (2) Scientific physical education with individual medical inspection, and records of the physical development of all children attending State schools, and skilled medical attendance for any requiring it, and in order to secure this:—(*a*) The formation of a properly staffed medical department at the Board of Education, the head of which shall be directly responsible to the Minister of Education, to whom he shall report annually. (*b*) The payment of an adequate grant from the Imperial Exchequer for purposes of medical inspection. (*c*) The establishment under every education authority of scientifically organised open-air recovery schools, the cost to be borne by the community as a whole, and not in any part by charitable contributions. (3) The complete dissociation of reforms (1) and (2) from Poor Law administration. (4) A national system of education under full popular control, free and secular from the primary school to the university. (5) That secondary and technical education be an essential part of every child's education, and secured by such a reform and extension of the scholarship system as will place a maintenance scholarship within the reach of every child, and thus make it possible for all children to be full-time day pupils up to the age of sixteen. (6) That the best intellectual and technical training be provided for the teachers of the children, that each educational district shall be required to train the number of pupil teachers demanded by local needs, and to establish training colleges, preferably in connection with universities or university colleges. (7) That the provision of educational buildings and facilities be obligatory upon the local authority, who shall always retain administrative control of the buildings and facilities so provided. (8) That the cost of education shall be met by grants from the Imperial Exchequer, and by the restoration of misappropriated educational endowments. (9) That it be an instruction to the Parliamentary Committee of the Trade Union Congress to formulate these proposals in a Bill to be laid before Parliament during the forthcoming session.

FROM tables published in *Science* of August 30, it appears that the total number of degrees of doctor of philosophy and doctor of science conferred by the universities of the United States this year was 327, which is almost exactly the same as in 1905 and 1906, when the numbers were, respectively, 325 and 326. The average number for the past ten years is 271. Of 2715 doctorate degrees conferred during the past ten years, 1232, somewhat less than half, have been in the natural and exact sciences. The relative proportion of degrees in the humanities and in the sciences has not altered appreciably in the ten years covered by the statistics. The Johns Hopkins has conferred more degrees in the sciences than any other institution, but is closely followed by Chicago, and at a not very considerable distance by Harvard, Columbia, and Yale. Fifty-five per cent. of the degrees conferred at the Johns Hopkins have been in the sciences, and 57 per cent. at Cornell, whereas in the other leading institutions the percentage is decidedly less—46 at Chicago, 42 at Harvard and Columbia, and 40 at Yale and Pennsylvania. Of the 1232 degrees conferred in the sciences during the past ten years, chemistry leads with 320 doctorates; then follow in order of numbers, physics, 155, zoology, 147; psychology 134; botany 126; and mathematics 121. The remainder of the degrees are divided among fourteen other sciences, meteorology and geography being at the bottom of the list with one doctorate each.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 27.—"On the Force required to Stop a Moving Electrified Sphere." By G. F. C. **Searle,** F.R.S.

If F be the force which must be applied to the sphere at any time t, after it has been brought to rest at $t=o$, the positive direction of F being opposite to that of u, the initial velocity, the momentum given up by the electromagnetic field from $t=o$ to $t=t$ is

$$\int_0^t \mathrm{F}dt.$$

During this period the force F does no work, since the sphere is at rest, and hence the energy is unchanged during this period.

At the time t let the sphere be restarted with the same velocity u without change of direction, and let G be the force which must be applied to the sphere at any subsequent time in the direction of u in order to maintain the velocity u. This force lasts from $t=t$ to $t=t'$, where $t'-t$ is determined by the condition that in the time $t'-t$ the pulse formed on restarting the system has completely passed over the sphere. During the interval $t'-t$, the momentum is increased by

$$\int_t^{t'} \mathrm{G}dt,$$

and hence the total gain of momentum is

$$\int_t^{t'} \mathrm{G}dt + \int_0^t \mathrm{F}dt.$$

During the interval $t'-t$, the energy has been increased by

$$u\int_t^{t'} \mathrm{G}dt.$$

The stopping and the restarting of the sphere each give rise to a pulse, and the compound pulse so formed carries off energy W′ and momentum P′. Before the system was stopped the energy of the electromagnetic field was U+T and its momentum was M, and at an infinite time after the stopping and restarting the energy is U+T+W′ and the momentum is M+P′, since the energy and momentum in the parts of the field outside the compound pulse ultimately vanish.

Equating the two expressions for the gain of momentum, we have

$$\int_t^{t'} \mathrm{G}dt + \int_0^t \mathrm{F}dt = \mathrm{P}'.$$

Similarly,

$$u\int_t^{t'} \mathrm{G}dt = \mathrm{W}'.$$

Hence

$$\int_0^t \mathrm{F}dt = \mathrm{W}'/u - \mathrm{P}', \qquad (1)$$

and thus we find that the force required to stop the system is given by

$$\mathrm{F} = \frac{d}{dt}\left(\frac{\mathrm{W}'}{u} - \mathrm{P}'\right). \qquad (2)$$

This force will become zero as soon as $\mathrm{W}'/u - \mathrm{P}'$ becomes constant, which will occur as soon as t is so great that the two pulses due to the stopping and restarting do not overlap.

It follows from (2) that, if F_0 be the force required to stop a sphere of radius a with a uniform surface charge Q,

$$\mathrm{F}_0 = \frac{\mathrm{Q}^2}{2\mathrm{K}a^2}\left(\frac{v}{u} - \frac{v^2-u^2}{2u^2}\log\frac{v+u}{v-u}\right),$$

where v is the velocity of light. When the sphere has a uniform volume-charge

$$\mathrm{F} = \tfrac{3}{8}a^{-4}(16a^3vt - 12a^2v^2t^2 + v^4t^4)\mathrm{F}_0.$$

PARIS.

Academy of Sciences, September 2.—M. A. Chauveau in the chair.—Caryolysis in the nidorian glands of *Genetta senegalensis*: Joannes **Chatin.** A study of nuclear degeneration in the perineal glands. It is shown that this is a case of true caryolysis, exactly corresponding to the disappearance of the nucleus in the true sebaceous cell.—Physically similar fluids: M. **Jouguet.** The action of gravity on the deposit of induced radio-activity: Mme. **Curie.** Metallic plates were submitted to the action of a fixed amount of emanation for a fixed time, and the induced radio-activity measured. The results obtained were as if the induced radio-activity suspended in the gas surrounding the plates behaved as solid particles, possessing weight, and falling through the gas. The activity of plates turned towards the top of the vessel was always greater (two to five times) than that of those turned towards the bottom or hanging vertically. The presence of a gas was found to be indispensable to this phenomenon, the effects not being observed when the pressure was reduced below 2 cm. of mercury. The presence of water vapour was also a necessary condition.—The radio-activity of uranyl molybdate: B. **Szilárd.** In a recent note M. Lancien stated that he had prepared a uranyl molybdate the activity of which was much higher than that of the original uranyl nitrate. In all previous researches on the subject the activity of uranium preparations has always been found proportional to the amount of uranium present in the salt, and less than that of pure uranium. The author has therefore repeated the experiment of M. Lancien, preparing the molybdate in the same manner, but with opposite results. The activity found was about 0·3 that of metallic uranium, a normal figure for the amount of uranium present in the salt.—The effect of metallic wire screens on the secondary radiation of induced radio-activity: Ed. **Sarasin** and Th. **Tommasina.**—*Cyperus tuberosus* in the auriferous strata of Madagascar: H. **Jumelle** and H. Perrier **de la Bathie.**—Intra-organic oxidation and the electric charge of leucocytes as important agents of immunisation: Alexandre **de Poehl.**—The relation which exists between the distribution of petroleum-bearing regions and the distribution of seismic zones: L. C. **Tassart.** A comparison of the seismic maps of M. de Montessus de Ballore and the map of the petroleum-bearing regions of B. Redwood shows that all the petroleum deposits which are found in relatively recent strata are situated in the maximum seismic zones or in their immediate vicinity. In these seismic zones there may be petroleum deposits in relatively ancient strata, but this is exceptional. Petroleum deposits which are found outside the seismic zones are situated in ancient strata, and in regions which at some time or other have been the seat of important seismic disturbances.

New South Wales.

Royal Society, June 5.—Mr. H. Deane, president, in the chair.—Some peculiarities in our coastal winds and their influence upon the abundance of fish in inshore waters: H. C. **Dannevig.** Careful comparison between the catches of fish in certain coastal waters and the number of men employed has shown that the average catch per man in each locality is greater in some years than others. Also it is apparent that this fluctuation in abundance of fish is uniform all along the coast; thus in 1898 there was a general scarcity of fish; each man then captured less than during previous and succeeding years. This was followed by a gradual increase until 1901, when a climax was reached; a gradual decrease in the catches followed, until in 1905, when the results were as poor as in 1898. Last year shows a tendency to improvement. These periodic increases and decreases in the abundance of fish all along the coast at the same time are not traceable to the action of the fishermen, but can alone be due to certain climatic changes. A careful examination of the wind records from this coast for the last twenty-four years has furnished important evidence in explanation; it is this: by measuring the winds' influence by the number of *inches* they blow from each point during a twelvemonth, it is found that almost every year the atmosphere is on this coast pushed *northwards* to the extent of many thousands of miles, and not in the opposite direction as usually thought. But this northerly movement—or the yearly dominating wind—as the resultant may be called, does not invariably follow the same direction; it has an easterly or westerly tendency or direction from the normal in different years. This difference in the direction of the yearly wind-force has a corresponding influence upon the coastal current; the latter flows normally along the coast in a southerly direction, and is pushed *on* to the land or *away* from it according to circumstances. The current carries the bulk of our floating fish eggs, and these, therefore, are some years kept close inshore and at other times carried out to sea, in which case they are lost to us. Year after year there are good hatching seasons and bad ones, and in a number of years afterwards there ought to be correspondingly plenty of fish or scarcity. This is the case: most of our market supplies consist of four years old fish—the average of maturity—and by comparing the periodic deviations of the winds on to the coast and away from it with the richness of the catch of fish per man four years afterwards, a very striking correspondence is found. This comparison has been made over a period of ten years, and in no case is there any important discord, so it would seem that a very interesting and also important answer has been found to the otherwise inexplicable fluctuation in abundance of fish. It follows that as this year's winds control the abundance of fish four years hence, it may be possible some day to make a fairly accurate forecast as to what the next succeeding years will bring.

July 3.—Prof. Liversidge, F.R.S., in the chair.—Note on action of nitric acid in neutralising alkaline soil: R. S. **Symmonds.** Culture-pots were filled with alkaline soil and treated with various proportions of nitric acid. Seeds of wheat were sown in these and in pots containing untreated soil. Photographs of the plants were taken, and show an enormously increased growth, due to the neutralisation of the sodium carbonate and its conversion into sodium nitrate. A further series of experiments is being carried out on a large scale, which will form the subject of a future communication. The author discusses the possibility of the manufacture of the required nitric acid on the spot from the atmosphere by utilising the power derivable from the pressure given in the outflow from the artesian bores.

CONTENTS.

THURSDAY, SEPTEMBER 19, 1907.

IRRIGATION ENGINEERING.

Irrigation: its Principles and Practice as a Branch of Engineering. By Sir Hanbury Brown, K.C.M.G. Pp. xv+301. (London: Archibald Constable and Co., Ltd., 1907.) Price 16s. net.

IRRIGATION is of such paramount importance to extensive tracts in India, and to the whole of Egypt, that it is in these countries that irrigation works have been carried out on the largest scale, and therefore the author, who has gained his experience in this branch of engineering in both these countries, is particularly well qualified for dealing with this subject; and by drawing his examples of works in illustration from both sources, and especially from Egypt, he has been able to present the principles and practice of irrigation in their grandest and most modern aspects. The whole object of irrigation is to supply water for agriculture to lands which are either devoid of adequate rainfall or on which the rain does not fall at a suitable period for the crops; and owing to the very unequal and irregular distribution of the rainfall in certain warm, and especially tropical, countries, large and extensive engineering works are often required to store and convey the abundant rainfall to arid regions at a distance. The simplest sources of water for irrigation are rivers which overflow their banks in the flood season, and inundate the adjacent low-lying lands, such as the Nile in Egypt, the Tigris and Euphrates in Mesopotamia, and the Indus in Sind. As, however, the land near the river bank is higher than the plains at the back, owing to the chief deposit of silt from the muddy flood-waters occurring when the overflow from the river loses its velocity on overtopping the banks, inundations would only occur with high floods, and would spread irregularly over the land according to variations in level.

To provide against these natural defects, and to obtain a uniform distribution of the fertilising silt as well as of the water, the basin system of irrigation was introduced, in which the land is divided by banks into a series of basins, and the water is admitted into the large low-lying basins at the back through sluices at the side of an embanked canal drawing its supply from the river above the highest up-stream basin of the set; whilst the smaller basins at a higher level adjoining the river are fed from a high-level canal deriving its water from the river further up-stream. By these arrangements the filling of the several basins in each set can be regulated with uniformity, and advantage is taken of a high flood to secure a large deposit of mud serving as manure. The mud is gradually deposited from the still water in the basins, and when the river falls the clear water is discharged, and the seed is laid in the damp mud. The basin system has been very extensively developed in Egypt; whereas in India canals draw the water from the rivers in flood-time, and irrigate the land by means of branch canals leading the water into field channels. Irrigation by inundation, however, only provides for winter crops; whilst the more valuable summer crops, such as sugar-cane, cotton, and rice, need water at definite intervals when the rivers are low, and protection from inundation during the flood season. This perennial irrigation enables two crops to be raised in the year, and more than doubles the value of the land; and the water stored by the Assuan dam has provided for the conversion of 450,000 acres from basin irrigation into perennially irrigated land. Besides rivers, wells, lakes, and artificial reservoirs afford sources for the supply of water for irrigation.

In India, wells irrigating 13 million acres are second only in importance to canals from rivers, which irrigate 17 million acres; whilst tanks enclosed by embankments, serving as primitive storage reservoirs collecting the rainfall and local drainage, irrigate 8 million acres; and the high concrete reservoir dam across the River Periyar, in the very rainy district of Travancore, stores up water which is discharged by a tunnel through the Ghats for irrigating the arid district of Madura, on the eastern side of the mountain range. Wells are used for irrigation in Egypt, but do not occupy at all the same important position as in India; though in olden times Lake Mœris provided a natural reservoir filled with water in flood-time, and supplementing the discharge of the Nile at its low stage, for which also the equatorial lakes act as regulators at the present time; whilst the reservoir formed by the Assuan dam supplies water for summer irrigation when the flow of the Nile is deficient. In the chapter on sources of supply it is stated that the storage required to secure the volume of water needed for the irrigation of summer crops for the whole of Egypt, during the hundred days in the year during which the flow of the Nile is at its minimum, is six thousand million cubic metres, of which one-sixth has been provided by the existing Assuan reservoir. The author enumerates five methods of increasing the storage, the first of which, namely, the raising of the Assuan dam, has been decided upon, since the book was written, for doubling the present supply; whilst the second proposal of building a second dam higher up the Nile has been rejected as impracticable. Little attention has been bestowed on the third project of forming a reservoir in the Wadi Rayan depression near the site of Lake Mœris; and a reservoir of this kind at the side of the river, when periodically filled up with muddy Nile water, would appear destined to be filled up before long with deposit.

The two last schemes for increasing the supply, advocated by Sir William Garstin, consist in effecting a great reduction in the loss from evaporation of the flow of the White Nile in passing through the swamps of the Sudd region, by diverting the discharge from the swamps into a straight cut, not less than 210 miles long, from Bor to the confluence of the River Sobat at Taufikia below the Sudd region, and combining this increased discharge with the utilisation of the Albert Nyanza for storage, during the four months of flood discharge, by regulating its outflow, so as to make up the deficiency during the remaining eight months. The new cut would have the great value of permanently increasing the flow of the Nile throughout the year below the confluence of the Sobat, but its construction would involve a very great expenditure, and occupy a long time; and it is very unfortunate that the fact of Lake Tsana, near the headwaters of the Blue Nile, being in Abyssinia is considered as precluding its utilisation as a storage reservoir for the irrigation of the Sudan and Egypt, with its great natural advantages of extensive area and commanding position. Several sections of reservoir dams are given in a chapter on dams and reservoirs, which, being drawn to various scales, are not readily compared, though forming an interesting series; but the foundations of the new Croton dam have had to be carried down more than forty feet deeper than shown on the section; and the Salt River dam, constructed for the irrigation of an arid district in Arizona, only about seventeen feet less in maximum height than the Croton dam, has the crest of its waste weirs raised the unprecedented height of 225 feet above the deepest part of the river-bed at the dam.

Interesting descriptions are given of the diversion weirs across rivers in India to raise their water-level for supplying inundation canals, and of the Zifta, Delta, and Assiout barrages for regulating the supply of irrigation water from the Nile, worked by Stoney's sluice-gates sliding on free rollers. The important function, however, performed by the Assiout barrage in raising the water-level of the river in August, 1902, during so low a flood of the Nile that the water could not flow into the great canals, until, by the prompt action of Mr. Webb in closing the gates, a sufficient head was obtained, for which the barrage had not been designed, should not be overlooked, as it preserved a large tract from a loss in non-irrigated crops of more than 600,000*l*. Moreover, the Esna barrage, in course of construction across the Nile between Assuan and Assiout, has been designed of sufficient strength to perform a similar duty when needed in perfect safety. Standard books, indeed, have been previously issued dealing with irrigation works on their grandest scale, in "The Irrigation Works of India," by Mr. Buckley, and "Egyptian Irrigation," by Sir William Willcocks; but the book under review will be very valuable for all persons interested in irrigation, by dealing in a single volume with and contrasting the principal works and systems of irrigation in these two great countries, and thus presenting a very comprehensive view of that most important subject of irrigation for the development of arid regions.

GEOLOGICAL EXPLORATIONS IN SINAI.

The Topography and Geology of the Peninsula of Sinai (South-eastern Portion). By W. F. Hume. Pp. 280+plates. (Cairo: National Printing Department, 1906.)

THE interesting region described in this memoir by the superintendent of the Geological Survey of Egypt extends from near Dahab along the western borders of the Gulf of Akaba to the promontory of Ras Mohammed. It lies east of Mount Sinai proper, or Gebel Musa, which is not, however, the highest of the Sinai mountains.

Attractive as the region is from an historical point of view, and interesting as it is to the naturalist, it offers few temptations for the ordinary tourist; and this not merely because it is an arid country. The Arab inhabitants are honest and obliging, but their dwellings consist simply of cloth stretched on a few poles, and placed under the protection of a rocky ridge. Keen as sportsmen, they use flint-lock guns, often of great length, serviceable for small game, as well as for the leopard, hyæna and ibex, which are the more abundant of the larger mammals. The country itself has been spoken of as "one of the most mountainous and intricate regions on the face of the earth," and Dr. Hume admits that much of it is a veritable wilderness with a bewildering complex of topographical structure. To the mountaineer it will hardly appeal, as there are no inaccessible peaks, but to the botanist and zoologist, who will find chapters specially devoted to them, and to the geologist, there are many attractions, not the least of which may be the absence of any extensive literature on their subjects.

The main portions of the area are composed of igneous and metamorphic rocks of ancient date—pre-Carboniferous at any rate. They rise in a mountain system trending north-east and south-west with a transverse chain that parts the region into two districts. The rocks include gneiss and sundry schists, granites, andesites, felsites, &c. The earliest sedimentary and volcanic rocks were penetrated by masses of granite, and some of the later intrusions have been arranged in strikingly symmetrical lines. The northern portion of this region is largely plateau, an old plain of marine denudation that appears only recently to have lost its capping of Nubian Sandstone. It has an average level of 1220 metres, except where cut by narrow gorges. In the southern portion, which comprises a multitude of ranges and peaks, the valleys are more deeply excavated, and in consequence the mountains, though lower, appear relatively higher than those in the north.

Still further north there is an area composed of barren Nubian Sandstone with overlying fossiliferous limestones of Cenomanian age, where the succession is greatly disturbed by trough-faults that have led to the production of rift valleys.

The structure, in a broad sense, is comparatively simple, as Dr. Hume observes, the main features having been produced by upheaval and dislocation rather than by erosion. Thus the principal mountain chain is due to a fault with a westerly downthrow of more than 5000 metres. Nevertheless, the influence of the rocks on the configuration of the land is well marked. The summits of many peaks are formed by felsite dykes; elsewhere parallel dykes of felsite and dolerite form the remarkable "dyke country," while the granite, which wears away in shells, presents curious rounded knobs and pillars. The coastal plain exhibits many features of interest in the presence of Miocene strata, and also of raised coral-reefs of Pleistocene age. Moreover, there are terraces of roughly stratified gravel in the principal valleys, as well as countless loose boulders. These were probably of torrential origin, distributed during the Glacial period, when, as Dr. Hume remarks, a small amount of *névé* might have accumulated on the Sinai mountains. Of still later date are some curious calcareous sandstones that contain oolitic grains, and are perhaps of marine origin. No economic products of great importance are known, though ores of copper, iron, and manganese have been found, and it is suggested that gold should be sought for.

It only remains to add that the work is well printed and illustrated. If the geological maps are exceptionally ruddy in tint, this arises from the extent of igneous rocks. For the topographical details the author expresses his indebtedness to Mr. H. G. Skill, who contributes also an appendix on meteorology. The photographic views enable the reader to gain a good idea of the scenery and rock-features, as well as of a hyæna-den, of certain stone-circles, and of the Sinai convent. H. B. W.

ELECTROCHEMISTRY.

A Text-book of Electro-chemistry. By M. Le Blanc; translated by W. R. Whitney and J. W. Brown. Pp. xiv+338. (London: Macmillan and Co., Ltd., 1907.) Price 10*s.* 6*d.* net.

THE new English edition of Le Blanc's "Electrochemistry" has followed very closely upon the publication of the fourth German edition. One is at once struck by the great increase in size of the book and by the large increase in the number of diagrams. From the translators' preface we notice that twenty-five of the diagrams have been added by themselves, and the book has certainly been improved by the additions.

Although the scheme of the book is much the same as it originally was, the additions are so numerous that it is almost a new work. By studying this edition and the first edition, which appeared in 1895, one is struck by the large amount of work which has been done in the domain of electrochemistry, albeit the fundamental laws have undergone very little change, the chief being one of degree rather than of principle. The ionic theory has been assailed from all sides, but although certain modifications have been made, such, for example, as the conception of the hydration of the ions, it must be conceded that it has rather gained strength than lost by the attacks. If those who assail the theory would give an alternative hypothesis which would as satisfactorily explain the phenomena of solution as does the ionic hypothesis, then the arguments would assume a more tangible form, and the ionic theory might be consigned to the limbo of history.

Prof. Le Blanc deals almost entirely with the theoretical aspects of electrochemistry, but at certain points he indicates the bearing of theory on practice. For example, on p. 18, when referring to the conversion of heat into electrical energy and of electrical energy into heat, a digression upon the "Electrical Furnace and its Industrial Importance" is made, the application of Ohm's law being given. Brief reference is here made to calcium carbide, cyanamide, carborundum, phosphorus, and the preparation of nitrates from atmospheric nitrogen, but the book, as already mentioned, does not deal with technical processes.

Chapter ii. deals with the development of electrochemistry up to the present time, and treats in the main with the development of the ionic theory.

More notice might have been taken of the difficult subject of the electrolysis of fused salts, the author having contented himself with a footnote on p. 316 referring the reader to Lorenz's "Die Elektrolyse geschmolzener Salze," and a remark that the phenomena are entirely analogous to those of aqueous solutions. The interesting phenomenon of electrolysis without electrodes is referred to on p. 317, and it is pointed out that in this case, as in electrolysis where both electrodes dip into the solution, Faraday's law is obeyed.

The translators, Drs. Whitney and Brown, have paid particular attention to nomenclature, and have endeavoured to be consistent throughout. The method adopted is set out in full in an appendix. The adoption of F instead of E for electromotive force is hardly happy; according to this rendering we get Ohm's law

$$C = \frac{F}{R}.$$

F is more generally used to denote a Faraday, or 96,540 coulombs of electricity. The translators employ the symbol Q for quantity of electricity. These are, of course, minor points, but they are inclined to muddle the student. It would perhaps be a good thing to convene an international committee so that electrical and electrochemical nomenclature might be standardised; at present it must be admitted that it is more or less chaotic.

From a theoretical standpoint we do not think it possible to meet with a better book than the one before us, and there is little doubt that it will be highly appreciated and widely studied. F. M. P.

AUSTRALIAN INSECTS.

Australian Insects. By Walter W. Froggatt, Government Entomologist, New South Wales. Pp. xiv+449; with 37 plates, containing 270 figures, also 180 text-blocks. (Sydney: William Brooks and Co., Ltd., 1907.) Price 12*s.* 6*d.*

THIS is the first general introductory work published on the insects of Australia, and it will be very useful to residents commencing the study of entomology, as well as to any European or American entomologists who wish for a general view of the Australian insect fauna, which contains a large number of highly interesting forms not met with in other parts of the world, though some species found in the extreme north appear to be only an offshoot from the rich tropical fauna of New Guinea.

The classification adopted is mainly that employed by Dr. D. Sharp in the "Cambridge Natural History." Mr. Froggatt commences his work with an introduction, tables of contents, and chapters on classification, distribution, structure, and fossil insects; after a detailed account of the principal groups of insects represented in Australia, including much interesting information about habits, &c., he concludes the book with chapters on the collection and preservation of insects, museum collections and types, publications dealing with Australian entomology, and an alphabetical index of Latin and English names.

We have, fortunately, no representative of the termites, or white ants, in Britain, though one species is found as far north as Bordeaux; but the author figures the huge nests of several Australian species, one of which, *Termes meridionalis*, Froggatt, builds what is called a "magnetic nest," like a brick wall, about 10 feet high and long (judging from the figure of the man standing in front), always pointing north and south, with the wall facing east and west. Another species, *Eutermes pyriformis*, builds a towering pillar-shaped nest, often 18 feet high.

Among the more remarkable specially Australian insects of various orders figured in this book, we may mention the curious apterous desert cockroaches (genus Polyzosteria, p. 19); the great Phasmidæ (of which *Podacanthus wilkinsoni*, Macleay, is figured as an example on plate v.); various strange grasshoppers, &c. (on plates vi. and vii.), and neuropterous insects (pp. 60, 61, plate ix.); the curious sawflies belonging to the genus Perga, &c. (pp. 71–73, plates x. and xi.); various handsome Buprestidæ (plate xviii.); the gaudy day-flying moths of the family Agaristidæ (p. 233) and the "whistling (stridulating) moths" of the genus Hecatesia, which emit sounds like the call of a Cicada (pp. 234, 235), of which latter group there are also many large and remarkable Australian species. We may also note that while the butterflies of Australia are not specially numerous or remarkable, the moths are extremely numerous and interesting, many being very remarkable either for their size, their structure, or their beauty. Of course, we do not meet with many British species, but among them we may mention forms of the painted lady butterfly and the convolvulus hawkmoth, hardly distinct from the ordinary European insects, and the well-known meal moth or flour moth (*Asopia farinalis*, L.) figured on p. 269.

Occasionally we note a trifling error; thus, on p. 41, the names *Locusta danica* and *Œdaleus senegalensis* appear to have been transposed by some accident.

We congratulate Mr. Froggatt on the publication of this useful and interesting book. W. F. K.

OUR BOOK SHELF.

Nature's Craftsmen: Popular Studies of Ants and other Insects. By Henry Christopher McCook. Illustrated from Nature. Pp. xi+317. (London and New York: Harper and Brothers, 1907.) Price 7*s*. 6*d*. net.

DR. McCOOK has long been known as one of the most painstaking and successful of the investigators of insect life in America, and the publication of a selection of his researches in a more popular form will, we hope, bring them under the notice of a far wider public than his former works have appealed to. There is no want of variety in the volume before us, and, in addition to ants and spiders, which are perhaps the author's favourites, he discusses bees, wasps, ant-lions, cicadas, caddises, &c. Still, nearly one-third of the book is taken up with the most interesting subject of the whole insect world, ants; probably the most highly organised of all known animals, born, not only in complete armour, like some of the ancient gods and heroes, but provided with all the tools and requisites necessary for their busy and industrious lives, even to brushes and combs, &c. Their wonderfully organised communities, where each works for all, and all for each, make our most advanced civilisations appear almost as barbarism in comparison, and our grandest architectural and engineering triumphs little better than mud-pies.

Among the most curious developments of ant-life are the so-called "honey-ants," where the nests contain a certain class of ants in which the abdomen becomes enormously distended with a sweet substance derived from a kind of oak-gall. When they have attained this condition, they pass their lives in the nests, hanging to the uneven roofs of the vaulted chambers, and they dispense food to the workers, by whom they are tended like the other dependent classes of the community, such as the queens and larvæ. An excellent illustration of one of these internal chambers is given on p. 99. This was taken from a nest eight feet long, three feet high, and a foot and a half wide, formed of galleries and chambers honeycombed in the solid rock.

The book is written in a very pleasing style throughout, with the exception of the last few pages, which bear signs of haste. The illustrations are also numerous and spirited, and many readers will be pleased to see the frontispiece, which gives us a portrait of the amiable author sitting on a lawn in a garden chair.

In conclusion, we may perhaps venture to express a regret that the word "instinct" is still used, as it appears to us to be an obsolete expression which is philosophically untenable at the present day, and which it would be just as well to avoid.

Concrete Steel Buildings. By W. Noble Twelvetrees. Pp. xii+408. (London: Whittaker and Co., 1907.) Price 10*s*. net.

THIS is a companion volume to the author's work on concrete steel, in which the distinctive characteristics of reinforced concrete were dealt with, and the theory underlying the design of structures in this material was discussed fully and in detail. In the present volume the author gives particulars of a number of typical pieces of constructional work in ferro-concrete which have been carried out in this country and abroad during the past few years. Mr. Twelvetrees has selected with great care the various examples of this method of building construction which he describes, and architects and engineers who consult this book will have little trouble in finding full descriptions of buildings similar to any they may be called upon to design. Examples of transit sheds for docks, railway goods stations, warehouses, factory buildings, business premises, villas, flour mills, hotels, theatres, &c., are all in turn fully described, and excellent illustrations are given of all important details, with copious notes as to the methods of making the concrete, the nature and disposition of the reinforcing steel, and of the results of proof tests of the structures. In the illustrations, which form a very important feature of a book of this nature, the author has wisely contented himself with giving the chief overall dimensions. When a radical departure from ordinary practice, such as the use of ferro-concrete, is made in constructional works, much can be learnt from the inevitable failures; and the last chapter of the book is devoted to a brief account of a few noteworthy collapses and of the probable causes of these failures, whether due to faulty design, or to bad workmanship, or to both causes. In the appendix a list is given of concrete-steel buildings and other structures in the United Kingdom, which will be found useful by those who are anxious to have the chance of inspecting such works before deciding to adopt this type of construction in any given case. An excellent index adds much to the value of this book for reference purposes, which will prove a welcome addition to the library of every architect and civil engineer. T. H. B.

Waterworks Management and Maintenance. By W. D. Hubbard and Wynkoop Kiersted. Pp. vi+429. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 17s. net.

THIS book is divided into three parts, the first dealing with the methods and principles of developing, improving, and storing water supplies; the second with the maintenance and operation of waterworks; and the third with water rates, and depreciation and valuation of waterworks property.

Although this book treats of American practice, and cannot be regarded as a text-book for experts, yet it contains a great deal of information useful to those having the designing and management of waterworks for urban districts.

The authors point out that in selecting a source from which a supply can be obtained a knowledge of the physical characteristics of the territory from which the water is to be obtained is the first consideration; a chemical analysis is necessary to detect impurities; and as drinking water is a medium through which the bacilli of certain diseases may be imbibed, and infection thus widely disseminated, a rigid bacterial examination has now become a recognised necessity.

Chapter i. treats of ground water supply and wells, the percolating capacity of soils, rate of filtration through sand, and purification works. The second chapter deals with water supply from rivers, and the means of fitting it for domestic use. The third chapter describes the class of engines in use for pumping, the other chapters treating of plans and records, service connections, meters and fittings, fire protection, financial management and accounts, water rates, and depreciation.

Attention is directed to the subject of electrolysis, or the effect that the introduction of street railways worked by electricity has had on the water mains; and illustrations are given showing the effect of electrolysis on the cast-iron mains. As a result of electrolytic action the metal of the pipes becomes in some cases so softened that it can be cut with a knife. Cast-iron is affected the least, wrought-iron next, mild steel the next, then high carbon steel, and lead the most. The salts in the ground also have a varying effect, the order of activity being chlorides, nitrates, and sulphates. The drier the soil the more resistance it offers to the passage of the current. Wasting of the lead in the joints also leads to leakage and eventual failure of the pipe by the blowing out of the lead.

Pictures from Nature's Garden; Stories from Life in Wood and Field. By H. W. Shepheard Walwyn. Pp. 311; illustrated. (London: John Long.) Price 6s.

To the naturalist the chief point of interest in this little volume is undoubtedly centred on the illustrations, which are reproductions from photographs by the author. Among these we may specially refer to one of a dormouse asleep (p. 34), which, so far as we know, is unique, and certainly of great interest. The photograph of a sleeping bat, apparently a pipistrelle (p. 27), is likewise excellent, as is also one of a Japanese or Manchurian sika-deer, with the white "chrysanthemums" on the buttocks fully expanded (p. 306). In both these instances it is a pity that the names of the species depicted are not given. As to the text, we venture to think even the author himself would admit that it is scarcely of a nature demanding detailed notice in the columns of this journal.

R. L.

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 intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

On Correlation and the Methods of Modern Statistics.

IN NATURE of August 29 (p. 461) appeared some account of a discussion at the British Association on modern methods of treating statistics. The following paragraph occurs:—

"Mr. A. R. Hinks, who was somewhat sceptical as to the general applicability of the new methods, inquired what meaning could be attached to the value 0·3 of the correlation coefficient in such cases as $y = \log x$. He also gave an example in which questionable conclusions had been arrived at by the method, the reason being that certain groups of stars had been studied for special purposes, while others had been neglected."

The obvious answer to the first part of Mr. Hinks's inquiry is that no meaning could be attached to the particular value 0·3 unless we were told what part of the relation $y = \log x$ it referred to, and then it would have a quite definite but limited meaning. Every statistician trained in modern methods in the case of statistics belonging to new material plots his regression lines and tests the approach to linearity in his material. When he finds any orderly system, but no approach to linearity, he naturally tests the dependence of his characters by the correlation ratio. That test applied to Mr. Hinks's case of two absolutely correlated variables $y = \log x$ gives unity or perfect correlation, as we might anticipate.

Writing to Mr. Hinks for further information as to the bearing of the second part of his criticism, he tells me that the report is too brief to be intelligible, and owing to his courtesy I have been provided with a fuller report of his speech, in proof, for the Journal of the Royal Statistical Society. The "questionable conclusions" reached by the method of correlation to which he refers occur in "a recent paper published under the auspices of Prof. Karl Pearson" (Winifred Gibson, Monthly Notices R.A.S., vol. lxvi., p. 445), and the special point to which Mr. Hinks refers is the result reached by Miss Gibson for the relationship between parallax and photometric magnitude. The point is an extremely interesting one, and that must be my excuse for ventilating the matter in the pages of NATURE. Mr. Hinks makes two criticisms, the first as to method and the second as to matter.

First, as to Method.—Mr. Hinks says that if the stars were uniform in size and brilliancy, the parallax and magnitude relation would be logarithmic, and consequently the coefficient of correlation would not be unity. "He understood that in such a case it was proper to use correlation ratios, but not correlation coefficients. If this was so, he would ask the exponents of modern methods to erect a very large and conspicuous danger signal to keep astronomical statisticians from falling into such a trap."

Now Miss Gibson's paper was, I believe, the first to place modern statistical methods before astronomers, and the statistician may well make slips in a new field. But as to *method*; what does she actually do? She calculates (1) the correlation coefficient between magnitude and parallax, (2) the correlation coefficient between parallax and amount of light, and finding both small, she plots (3) the regression line, and calculates the correlation ratio, and as this takes a value of 0·4, she points out that the correlation coefficient is not the suitable measure in this case. In other words, she puts up the very danger signal which Mr. Hinks requires! I fail entirely to see how Mr. Hinks's remarks as to the logarithmic relation apply to Miss Gibson's work. She has treated the matter correctly from the statistical standpoint, and her paper shows that she was fully aware of the possibilities attached to a logarithmic relationship, which she more than once cites.

Secondly, as to Matter.—Here Mr. Hinks is on safer ground, but one in which I fancy astronomers have been guilty of a considerable amount of circular reasoning.

They start from the hypothesis that magnitude is very closely related to parallax, and when the statistician shows that the best determined parallaxes show no continuous relationship between parallax and magnitude, they turn round and say: "Yes, but our stars were selected because they had big proper motions." They thereby screen entirely the fact that the fundamental hypothesis that the brighter stars are much the nearer as yet awaits statistical demonstration. Miss Gibson worked on the seventy-two stars given by Newcomb, as of fairly well-ascertained parallax. Mr. Hinks says that the peaks in Miss Gibson's parallax-magnitude curve are in two out of three cases due to selection of certain stars because of their exceptional proper motion. Now this naturally leads us to inquire why the stars with magnitudes about 2 and again about 6 were not selected by their proper motions, but those about 4 and 5 and again those about 7 to 9 were. Further, there is a fundamental point which Mr. Hinks has to meet. Statistically to produce large effect on the correlation of two quantities by selection, the character used for selection must have high correlation with both. In other words, if the selection of stars by proper motion is to pull down the assumed high relationship between magnitude and parallax to a low value, not only must magnitude and proper motion be highly correlated, but proper motion and parallax. Now these correlations have been carefully investigated, and we know what they are—they are such as to influence, but not very much influence, any relation between parallax and magnitude. Now I think the circular process of the reasoning I have referred to will be visible. It runs as follows:—

There is a high relationship between parallax and magnitude; it is not statistically evident, because the parallax stars have been chosen on account of proper motion; this involves a very high correlation between proper motion and magnitude; a very moderate correlation, but not a high correlation, does exist. Shall we say that these stars have been selected by reason of something else?

Surely the hypotheses of high relationships between magnitude and parallax and proper motion are of sufficient importance to deserve *proof*, rather than to be taken as axiomatic? If the reader will examine Table III. of vol. ii. of the Yale Observatory Memoirs (p. 202), which has reached me since Miss Gibson's memoir appeared, he will find the parallaxes of 163 stars, differing widely from Newcomb's series, dealt with, but the correlation ratio (0·28) is even less than that (0·40) found for Newcomb's material. The specious appearance of descending magnitude with the parallax groups is almost wholly due to the first group of large negative parallaxes, which seems merely to signify that large errors of parallax are more common with faint stars. I take it that 0·35 is an excessive value for the relationship between proper motion and magnitude.[1] Against these merely moderate relationships I would place those connecting spectral class and magnitude, which can be as high as 0·69, and, again, the fact that colour and magnitude are related at least as closely as parallax or proper motion and magnitude; and I would venture to ask whether it may not be that the mass, the chemical constitution, and the life-history of a star, as evidenced in its spectroscopic character, have sensibly more to do with the magnitude than its mere distance? After all, almost any theory of distribution of stellar mass, position, and motion would lead us to expect a relatively small correlation between proper motion and distance, sensible, indeed, on the average of great numbers, but as ineffectual for the purpose of selecting an individual as choosing an able assistant by a preliminary measurement of his head.

KARL PEARSON.

Biometric Laboratory, University College, London.

Plague Prevention in India.

HIS MAJESTY'S recent letter on this subject to the Government of India was well designed to stimulate the Government to more active efforts against the disease, but has been followed by pronouncements from it which do not suggest any strong hope that that object will be attained. In these pronouncements the Government of India issues advice to the heads of local administrations regarding the methods of dealing with plague—a familiar matter; but, as the *Pioneer Mail* of August 23 remarks:—"Nothing is said about finding the money for the proper carrying out of these recommendations." There is, moreover, another defect which suggests further doubts. The whole of the edict is filled with injunctions to avoid "any action which excites the opposition of the people." Now as almost every sanitary action, from cleansing the backyard upwards, does excite the opposition of a large percentage of the people, this policy means, I fear, not the advancement, but the abandonment of any large-scale operations against plague in India.

Obviously, in epidemics as in war, the superstitions, fancies, and trifling objections of the individual must give way to the public interest. The only alternative is widespread death. To use compulsion may be unpleasant to a Government, but it is a duty to use it. If a Government does not use compulsion it must be held responsible for the fatal results. In my experience, popular opposition to sanitary measures is not really a serious matter. The strength of it is in inverse proportion to the capacity and resolution of the authorities. What opposition has occurred in this case has, I think, been created largely by the original weakness which gave in to it. It is useful to compare the despotic and successful sanitary methods of the Americans with the feeble and futile system adopted in India.

It is difficult to see the object of this pronouncement of the Government of India, which will apparently tend only to hamper executive officers in the performance of their duties. We must infer that the recommendations were made chiefly with a view to please the numerous pseudo-philanthropists who exert so much evil influence in the councils of the great empire of Letspretendia.

Those who wish to ascertain what is really being done against plague in India, compared with statements in Parliament, should consult Prof. Simpson's recent lecture in the *Lancet*, especially that of July 27. According to him, the Government has spent only about 1,500,000*l.* on plague prevention, against 17,000,000*l.* on famine relief, and this in spite of the fact that 20,000,000*l.* surplus revenue has been collected during the same period (since 1896).

I have not seen any complete discussion of the actual measures which should now be taken against plague in India, but think that the following will be approved of by most hygienists who have considered the matter:—

(1) The whole of the plague administration should be centralised, removed from the hands of the civilians who have hitherto obtained such poor results, and put in those of experts, on the American system. This administration should allot the expenditure, indicate the researches, direct the practical measures, publish monthly reports showing exactly what it is doing, and be held responsible for the results of its work.

(2) The expenditure on plague research should be increased ten-fold. The present commission is doing excellent work, but the investigations can be obviously enlarged so as to include many new fields, such, for instance, as the search for a specific therapeutic agent, on the lines of work now being done in connection with sleeping sickness.

In the message of the Government of India there is no sufficient statement on either of these important points. We may rest assured that if they are not included the plague measures will remain as ineffective as before.

RONALD ROSS.

The University, Liverpool, September 16.

Root-action and Bacteria.

IN NATURE of July 18 (p. 270) I mentioned that I had proved the excretion from plant roots of a toxic substance. This substance proves to be alkaloidal in nature, and is precipitated, in addition to the usual alkaloidal reagents, by most of the substances in use as artificial manure. Potassium sulphate and chloride appear to be the most complete precipitants of all the reagents so far tried. They appear to precipitate the substance in the form of a base—a white amorphous powder. The amount excreted is by no means negligible, and *Sesamum indicum*, indeed, in its early stages at least, appears to excrete more solid matter than it builds up in its own substance.

Details are given in a Memoir of the Agricultural Department of India.

F. FLETCHER.

Ghizeh, Egypt, August 22.

[1] Dr. A. Lee has worked out for me the correlation ratio for more than 300 northern and 300 southern stars in Boss's catalogue. For the southern stars the correlation of magnitude and proper motion is insignificant, for the northern stars it is much less than in the above cases, and would be insignificant but for a group of four stars with magnitude less than 1·5. These points will he brought out in a forthcoming memoir.

SOME SCIENTIFIC CENTRES.

X.—The Liverpool School of Tropical Medicine.

On July 9, 1898, Major Ronald Ross completed the proof that the malaria of birds was transferred by the bite of mosquitoes from infected to healthy birds. In December, 1898, a commission was dispatched by the Colonial Office to British Central Africa to study blackwater fever, to inquire into the truth of Ross's discoveries, and to study the whole question further.

About this time, Sir Patrick Manson had been urging the formation of schools of tropical medicine, and the subject had received energetic support from Mr. Chamberlain. In Liverpool, also, the subject was warmly taken up, and with such practical result that the first tropical school was founded by Sir Alfred Jones, K.C.M.G., in November, 1898. Major Ross was appointed the first lecturer of the Liverpool School of Tropical Medicine, and the school was formally opened by Lord Lister on April 21, 1899, and on July 1 Major Ross delivered his inaugural lecture, directing attention to his scheme for extirpating malaria by attacking the pool-breeding mosquitoes. The further result of this was that at the end of July, 1899, the first (malarial) expedition of the school was dispatched to Sierra Leone, West Africa. This was the first of those expeditions to the tropics which have made the school famous. Since 1899 there has not been a year in which some expedition has not been carrying out research in the tropics, and at the present moment there are at work one in Brazil at yellow fever, another in Africa on trypanosomiasis; and a third is on the point of starting to study blackwater fever in Central Africa.

The educative effect of these expeditions has been immense, and we hardly think it can be doubted that every person interested, not only in West Africa, but in the tropics generally, owes a deep debt to the school. Not only has the direct practical outcome in the saving of life been great, but indirectly also a powerful effect is exercised on the young generation, so that now those going to the tropics do so with a knowledge of what risks they run in respect of malaria, and how to avoid them.

But, further, the influence of these expeditions and of the reports furnished by them has given an immense impetus to anti-mosquito measures all over the world. The most successful instance and the best known of these measures has been the extinction of malaria at Ismailia, and perhaps it is not too much to claim that the influence of the Liverpool School of Tropical Medicine has determined the magnificent success of anti-mosquito measures under Col. Gorgas against yellow fever at Havana.

In this connection it is of interest to point out that Major Ross will read a paper at Berlin this autumn summing up the progress of anti-malarial measures in British Possessions all over the world. The gain to the public is, then, we believe, a great one. That the scientific results have been not inconsiderable is evident from the publications of the well-known memoirs of the school. Since 1899, when the first memoir was published, twenty-one memoirs had been published up to 1906, together with a text-book, "The Practical Study of Malaria and Other Blood Parasites."

Perhaps the two most striking discoveries recorded in these memoirs were, firstly, that of Dutton, of a human trypanosome in man, *T. gambiense*, the finding of which was the forerunner of that of the same trypanosome as the causative agent of sleeping sickness; and, secondly, Dutton and Todd discovered, independently of Milne and Ross, the spirochæte, *S. duttoni*, of African tick fever, and they showed that it was transmitted by the tick *Ornithodorus moubata*.

Thus the school can claim a worthy, if not exclusive, share in the elucidation of three of the great diseases of Africa, viz. malaria, sleeping sickness (trypanosomiasis, and African tick fever. Thomas's successful experiment in Manaos in infecting chimpanzees with yellow fever by means of mosquitoes is also worthy of mention.

These expeditions have cost the school large sums of money, and have also involved the loss of two valuable lives, viz. those of Dr. Walter Myers and Dr. J. E. Dutton. Myers, who gave promise at Cambridge of a distinguished career, died of yellow fever at Para shortly after the commencement of his work. Dutton's brilliant career was cut short by death while working in the Congo. Two recent developments show that the school is still in vigorous youth, and is not content with its past achievements. We have above alluded to the publication of the memoirs. These memoirs were exclusively devoted to the publications of the results of the various expeditions of the school, and from this cause and from their somewhat expensive price it was thought advisable to change their form and to enlarge their scope. A journal of high standard devoted to tropical medicine and parasitology has long been needed, and it was resolved to admit publications from others than those who were connected with the school. The result has been to establish the "Annals of Tropical Medicine and Parasitology," which promises to have a successful and useful career before it.

Prof. Ronald Ross, F.R.S.

The expeditions, as we have already stated, have become a marked feature of the school's activity. They have necessitated the establishment of special research laboratories. For although underlying these expeditions is the idea that research into tropical disease is best carried out in the area where the disease is endemic, yet much material is accumulated during these expeditions which can only be worked out subsequently. As the laboratory accommodation is insufficient to accommodate all this material, a research department under a special director has been established at Runcorn, where ample room for animals and laboratory experiments exists. These laboratories also supply parasites in a living condition for the purposes of study in the teaching laboratories. Here numerous experiments have been and are being carried out in the treatment of sleeping sickness (trypanosomiasis). It was Thomas who first suggested atoxyl in the treatment of trypanosomiasis. This, followed by mercury, is probably the most hopeful treatment now in existence.

We may finally briefly refer to the laboratories, where the public, no less than by the expeditions, benefits by the training of medical men, already stationed in or about to proceed to the tropics. In fact, it is stated in its prospectus that the first of the objects of the school is to give a practical training to medical men proceeding to the tropics. In connection with this training, which is as thorough as the too-brief period of three months will allow, about thirty medical men pass through the school in the year, a number which is not too great for the staff successfully to cope with.

THE YEAR'S PHOTOGRAPHY.

THE annual exhibition of the Royal Photographic Society is now open at the New Gallery in Regent Street, and will remain open until September 26. Artistic, professional, and commercial photography are well represented, but we are concerned chiefly with the scientific and technical sections. The exhibition aims at showing the year's progress, and as the item that has aroused the most interest since last October is the commercial introduction of the Lumière "autochrome" plate, which serves for the copying of coloured objects in colour on a single plate, photographs by this method form the most conspicuous group in the exhibition. The results are transparencies on glass, and are conveniently arranged for viewing them in a darkened portion of the balcony. The character of the new plates has already been described in these columns, therefore it is sufficient to say here that they depend upon the usual principles of three-colour work, and that their novelty consists in having each plate complete in itself, and needing no instrument, taking or viewing screen, or other special accessory for their use or examination. Messrs. Lumière are to be congratulated on their success, and well deserve the medal that has been awarded them. As to the results, some appear to be excellent, while others must be faulty from the predominance of one of the three colours; but, as we have so often said before in connection with colour work, it is impossible to judge of the results as one would like to be able to unless the original is side by side with the copy. No exhibitor seems to have cared to submit any of his pictures to this test. This remark also applies to the other colour photographs, which demonstrate that the multiple-plate methods still hold their own, and that the standard of perfection has, perhaps, a tendency to rise. Photomicrographs of the grain of the "autochrome" plates and spectra taken on them are on view, and serve to show the limitations of three-colour processes when dealing with the comparatively unmixed colours of the spectrum.

Some of the photographs of Mars, taken two months ago at the Lowell Observatory, are shown by Profs. Lowell and Lampland. Several canals are visible, and one has been photographed double. Drawings of the planet made under high magnification are added for the sake of comparison. The Greenwich Observatory send four frames of work done during the year, which include the recent comet, Saturn and its satellite Phœbe, and Jupiter and its satellites VI. and VII. These astronomical exhibits will prove of great interest, not only to those who are students of the subject, but also to those whose chief source of information is their daily paper.

Of the considerable collection of photographs of living creatures it is possible to refer to only a few. Mr. Douglas English contributes a series of photographs illustrating the life and history of the British mud-wasp, but his most striking exhibits are those in which he has obtained a very close imitation of the colour of the original by locally modifying the image with reagents, and in one case backing it with "metallic powders." He is bold enough to send the actual skin in one case to show how very nearly he has reproduced the colour. Notwithstanding Mr. English's success, we are inclined to discourage work of this kind, because by such manipulation the examples lose much of their value as photographs, and it is very doubtful as to how long the colours produced in this way will remain without change; but it must be admitted that at present they convey an excellent idea of the originals. Among the other exhibits of special interest may perhaps be mentioned Mrs. Veley's "Lemur Studies," Mr. W. Bickerton's three photographs of the common tern alighting at its nest after flight, and Mr. Alfred Taylor's ten photographs of the "Long-eared Owl from the Egg to Maturity." Mr. Daniel Finlayson's three frames are of a kind that must be exceedingly useful for teaching purposes. He shows the leaves of four common plants "awake and asleep," five photographs illustrating "Red Clover strangled by Dodder," and ten distinct examples of "Seed Dispersal by Hooks, Parachutes, and Wings."

Pathological work is not much in evidence, but the majority of visitors will doubtless find a personal interest in Dr. G. H. Rodman's radiograph of the two hands of a young lady, one of which was severely affected by rheumatism. The small bones of the diseased wrist are apparently matted together. Mr. Martin Duncan's photomicrographs of living bacteria are noteworthy, though for practical purposes of identification microscopists will probably continue to prefer to deal with dead "preparations." Mr. Duncan gives no hint of his method which he "has now perfected."

There are numerous other exhibits of many various subjects, for the collection of this year surpasses that of any previous year that we recollect in interest, variety, and general technical excellence; but we must refer to Mr. Frederick E. Ives's diffraction gratings, though they are not strictly photographic. These replicas are made with fish-glue instead of gelatin, and, by the means described in the catalogue, he has obtained, in addition to normal results, "freak gratings" of many different kinds. Not only can most of the light be thrown into the first-order spectrum on one side, but vigorous copies can be made from weak originals. A considerable variation of colour effects is shown in the "freaks," and may serve to indicate some of the possibilities of variations that may occur to a greater or less extent in gratings intended to give normal results. These gratings can be seen on application to the attendant by anyone interested in the subject.

Those who wish to see the results of the practical application of photographic methods to pictorial purposes will find a collection of excellent examples in the west room which is devoted to this section, and a choice selection at the Gallery of the Royal Society of Painters in Water Colours, 5a Pall Mall East, this latter being the fifteenth annual exhibition of the Photographic Salon. In neither case is the method of production stated, so that it is not possible to know how much is pure photography nor whether any given example is likely to be reasonably permanent. It is, however, a noteworthy fact that, besides the platinum and carbon processes in their numerous variations, this year there are many "oil prints," that is, prints in which the image is produced in pigments prepared in oil, by the process introduced by Mr. G. C. H. Rawlins a year or two ago. It is satisfactory to note that as these processes that yield results of undoubted trustworthiness increase in number, there is a tendency for them to oust those that are less desirable.

C. J.

INTERNATIONAL SEISMOLOGICAL CONGRESS.

THE second conference of the International Seismological Association will be held at the Hague on September 21–25. The first two days will be occupied by the permanent commission, which will discuss the financial reports from the secretary and the director, election of officers, and other matters relating to general administration. The meetings of the general assembly will take place on September 24 and 25. Amongst matters of immediate seismological interest to be discussed we notice the question of establishing a station at Kashgar, seismological bibliography, the annual publication of a catalogue of earthquakes for the entire world, and the geographical distribution of sound phenomena which have had hypogenic origin. Other scientific questions which will receive consideration relate to the rapid publication of data relating to large earthquakes, the reduction of seismic elements to absolute values, and the reproduction of seismograms. Discourses and conferences relate to a catalogue of microseisms for the year 1904, and the earthquakes in that year which have been recorded throughout the world, together with the analysis of seismograms, the publication of seismograms obtained on August 16 and 17, 1906, and the new work now in progress at Strassburg Observatory. To carry out the above programme evidently means a full four days' continuous work.

From what we read in daily papers and magazines, it is clear that much haziness exists in the public mind as to how earthquakes came to have an international importance. The first successful attempt to treat earthquake phenomena in a scientific manner was undoubtedly due to the late Robert Mallett. Strange as it may sound, his work practically remained in abeyance until Japan, desiring to acquire some of the material civilisation of the west, invited to her shores people from all quarters of the globe. Although none of these was asked to give instruction relating to earthquake phenomena, none of them could refrain from giving serious attention to movements which were frequently, and we may even say rudely, brought to their notice. In 1880 a seismological society was established. The first important work accomplished by this society was to devise instruments which would measure earthquakes, the result of which was that constructors for the first time learned that earthquake forces could be expressed in definite mechanical units. This led to new types of structures, and these experience has shown will stand severe shakings whilst ordinary European structures seriously suffer. This issue of seismological investigation, inasmuch as it bears upon the safety of life and property, indicates that the study of earthquake phenomena is of more practical importance than is generally supposed. Among other outcomes of the study we may mention the determination of suboceanic sites where it would be fatal to lay a cable, the indication where certain cables have failed, and the collection of materials which enable those who insure to adjust rates to risks.

Whether the information bearing upon what may be called the "by-products" of seismological investigation will attract the attention of the International Association remains to be seen. Should it do so, then the British Government and the British investor may be compelled to go abroad to supply their wants. At present the work of the association is chiefly directed to that which is purely scientific, teleseismic records and their interpretation receiving the most attention. Since 1755 it has been recognised that a very large earthquake occurring in one country might give evidence of its existence in very distant regions by causing water in lakes or ponds to oscillate. In 1877 the oscillations of a bubble in a level at Pulkova were traced to an earthquake which destroyed Iquique. In 1884 cryptoseismic movement was frequently recorded in Japan. The late Dr. E. von Rebeur-Paschwitz also recorded these unfelt movements, which he traced to definite seismic centres.

In connection with the history of international seismological cooperation, it may be here mentioned that one of the first attempts to obtain the same was made in 1883 through his Excellency the late Sir Harry Parks and the Foreign Office of Japan. In 1895 attempts to repeat the same came from Japan and from Germany; the first successful attempt was that undertaken by the British Association in 1897, which now enjoys the cooperation of about fifty similarly equipped stations fairly evenly distributed over the land surfaces of the globe. This is an asset of considerable importance which we hope may continue to exist, and at the same time be able to assist the congress now sitting at The Hague.

THE IMMIGRATION OF SUMMER BIRDS.[1]

THIS second report is very similar to that first issued, which was noticed in NATURE for September 6, 1906. It has been prepared on the same lines, and is open, to a large extent, to the same criticism, though we are glad to observe that the various immigratory movements are now associated with the weather conditions prevailing in countries south of the shores of the Channel.

In the best interests of the inquiry, and at the risk of again being considered "somewhat hostile," the writer would once more urge the committee to confine its labours for several years to come to the publication of the observations received, and to refrain from drawing conclusions of any kind from its present limited knowledge. It serves no useful purpose to mention that particular species arrived on certain sections of the coast only, for in all but a few cases their supposed absence merely indicates that they escaped the notice of the observers, and nothing more; they have long been known as immigrants on the sections of the coast from which the committee has not, as yet, received information concerning them. The publication of observations of this nature has already misled some who have but little knowledge on the subject; and so also has the statement that the few species which arrived on the south-east coast held a north-westerly course and so reached Wales! No proof is offered in support of this very remarkable speculation, nor is any worthy the name

[1] Report on the Immigrations of Summer Residents in the Spring of 1906. By a Committee appointed by the British Ornithologists' Club. (London: Witherby and Co., 1907.) Price 6s.

afforded by the published data. In fact, the report generally bears evidence of having been drawn up on the supposition that the data are practically complete, whereas such perfection, or anything like it, is an absolute impossibility. The committee, and others interested in bird migration, would do well to remember that not one bird in a thousand that arrives on our shores, or which proceeds inland or coastwise, comes under the notice of competent observers, numerous though they be. This important consideration makes it imperative that some years must be devoted to the amassing and testing of materials ere the foundations of a trustworthy report can be laid.

The records collected by the committee are numerous, and, as interim reports seem to be desired, may be considered of sufficient interest and value to render them worthy of publication. There are a number of unfortunate slips in the report, some of which are so palpable that it seems strange that Mr. Bonhote's—the preparer's—colleagues on the committee did not detect them. W. E. C.

PRESERVATION OF MEMORIALS IN AMERICA.

As an outcome of an article which appeared in these columns on June 6 (p. 130), entitled "Landscape Protection in Germany," the American Scenic and Historic Preservation Society has sent us some of its literature. This society was incorporated in 1895 by a special act of the Legislature of the State of New York, and holds, therefore, a semi-official position in that State. It has to report annually to the Legislature, and has a right to make recommendations regarding improvements to any of the municipalities.

The society's aims are summed up to a large extent in its name. It endeavours "to protect beautiful features of the natural landscape from disfigurement, either by physical alterations or by the erection of unsightly signs and structures, and to preserve from destruction remarkable geological formations or organic growths possessing an artistic or scientific value"; and it also endeavours "to save from obliteration names, places, and objects identified with local, State and national history; to erect suitable historical memorials where none exist."

In towns and villages it aims at procuring parks and open spaces, where necessary for the health and comfort of the inhabitants; it makes every effort to prevent the destruction of trees, and stimulates as much as possible a desire for local beautification in the minds of the public.

The funds depend on the members' subscriptions and voluntary contributions. The Government gives no financial support, but public money is occasionally placed at its disposal for acquiring or keeping in order properties for the public benefit. It is also empowered, according to its charter, "to receive real or personal property, in fee, or trust . . . and to administer it as a public trustee."

By means of meetings, free lectures, circulating historical pamphlets, and various educational means, the society endeavours to engrain in the people an appreciation of the beauties of nature, and also a patriotic interest in historical localities. Its efforts are becoming fully appreciated all over America, for its services are requisitioned in many different parts and in many different ways, the verifying of historical sites and putting up of tablets to commemorate noteworthy events being the most usual. America is much to be congratulated on having such a society, and especially one that is so active.

NOTES.

PROF. J. B. FARMER, F.R.S., has accepted the editorship of the *Gardeners' Chronicle* in succession to the late Dr. M. T. Masters, F.R.S.

THE inaugural address of the coming session of the Royal Scottish Geographical Society will be delivered by Lord Milner in the Synod Hall, Edinburgh, on Wednesday, November 13.

WE regret to see the announcement that Prof. L. F. Vernon Harcourt, emeritus professor of civil engineering at University College, London, died on Saturday, September 14, at sixty-eight years of age.

THE managers of the Metropolitan Asylums Board have approved of the erection at Belmont, Surrey, of new laboratories for the preparation of diphtheria anti-toxin and for bacteriological work. The total expenditure on the laboratories is not to exceed 6500*l*.

Symons's Monthly Magazine, the present issue of which is the five hundredth number of that interesting organ of meteorological opinion, announces that Dr. G. Hellmann has been appointed professor of meteorology in the University of Berlin and director of the Prussian Meteorological Service, in succession to the late Prof. von Bezold.

A TELEGRAM from Seattle states that a volcano in the Aleutian Islands became active on September 1 and 2, and that ash ejected from it fell upon twenty villages. A disturbance recorded by a seismograph at Washington on September 2 appears to have been due to this eruption.

THE Royal Geographical Society has received the following telegram referring to the Anglo-American Polar Expedition, signed by Captain Mikkelsen and Mr. Leffingwell:—"Sledge trip covering 500 miles crossed edge continental shelf twice soundings 50 miles off coast and beyond 630 metres no bottom ship lost next year continuation geology ethnography surveying and exploration Beaufort Sea."

THE Royal Commission on Mines has appointed Dr. A. E. Boycott to make an investigation with a view to determine whether there are any indications of the disease known as ankylostomiasis (miner's worm) in coal mines in Great Britain. Mr. John Cadman has also been appointed to make a series of observations and tests of mine air in connection with the question referred to the commission whether any steps should be taken to lay down a standard of ventilation in mines.

PROF. E. HECKEL, director of the Colonial Institute at Marseilles, has been awarded the gold medal founded by Dr. F. A. Flückiger, of Strassburg, in 1893, and awarded every five years, in recognition of steps taken to promote the advancement of scientific pharmacy, irrespective of nationality. Mr. E. M. Holmes, the curator of the museums of the Pharmaceutical Society of Great Britain, received the first medal, and the second was presented to Dr. C. Schmidt, of Marburg.

THE discovery of an interesting dene-hole on the south side of Windmill Hill, Gravesend, was described in the *Times* of September 14. It appears that a workman engaged in making excavations for building purposes discovered a shaft, rather less than 3 feet wide, which descended vertically to a depth of 55 feet from the surface, when it entered the chalk, and after piercing 3 feet of this rock opened out into a large artificial cavern. This cave was divided into two chambers by a roughly hewn wall of solid chalk, a western chamber measuring about 30 feet by 24 feet, and an eastern one about 24 feet by 20 feet. The excavation consequently presented the exceptional character of a twin chamber. The roof showed numerous holes, apparently made by picks of horn used in excavating the chalk, whilst the walls had been smoothed, perhaps by means of flints. A curious smoothness on part of the roof of the eastern chamber, clearly due to long-continued but gentle friction, led to the suggestion that some substance like corn in the ear had been pitched into the chambers from the top of the wall, which formed a platform under the shaft, thus apparently lending some support to the view that the dene-hole may have been used as a subterranean store-house for grain.

Owing to the development of wireless telegraphy in the Navy, the Admiralty has decided to establish a separate branch of the Service for this work, and this branch will be kept quite distinct from the ordinary signalling branch. In order to place the new section on a proper basis, about three hundred men will be turned over to it as volunteers, taken from the leading signalmen as well as able seamen and marines. Ultimately the telegraphists will be recruited from boys entered in the training ships in the usual way. The Admiralty has also decided to erect a wireless telegraph station for the use of the Royal Naval Service at Corkbeg, near the mouth of Cork Harbour. This station is to supersede Roche Point station, the situation of which is not considered safe.

The President of the Local Government Board has authorised the following researches under the grant voted by Parliament in aid of scientific investigation concerning the causes and processes of disease:—(1) Further study by Dr. Sidney Martin, F.R.S., of the chemical products of pathogenic bacteria. (2) Bacteriological investigation by Dr. F. W. Andrewes of the air of sewers and drains. (3) Observation by Dr. W. G. Savage of the bacteriology of "garget" and maladies of the udder or teats of milch cows, and of possible relation of sore throat in the human subject to pathological conditions of the udder and teats of these animals; also investigation by him of paratyphoid fever and its microbic cause. (4) Joint investigation by Drs. M. H. Gordon and T. J. Horder of the life-processes of the Meningococcus, with a view to means of combating cerebro-spinal fever.

The Permanent International Commission of Aëronauts and the International Federation of Aëronauts held conferences at Brussels last week, under the presidency of Prince Roland Bonaparte. An address on the advantages of the universal adoption of the metric system in aëronautics was read by Dr. Guillaume, and a resolution in favour of its adoption by all affiliated aëro clubs was carried unanimously. Papers were also read on air currents, dynamics of the atmosphere, wind velocity, temperatures at high altitudes, aëronautic observatories for practical meteorology, the history of dirigible balloons, progress of the problem of flying and aërial navigation, and the economical manufacture of hydrogen for balloons. On Sunday, thirty-four balloons started from the Parc Cinquantenaire in competition for the valuable cup to be presented to the aëro club of the country the balloon of which covers the greatest distance. The contest was won by a German balloon, which descended at Bayonne, having covered a distance of 1000 kilometres. The second place is shared by a Swiss balloon, which covered 900 kilometres, and a British balloon, which travelled 890 kilometres. The international conference will be held next year in London.

The *Frithjof*, with the Wellman expedition on board, arrived at Tromsö on September 13, the attempt to reach the North Pole by airship having been abandoned for this year. On September 2 Mr. Wellman's balloon, the *America*, was towed about two miles in a northerly direction to Vogel Bay Island. Off this island the airship was set free, but the wind, coupled with a driving snowstorm, finally beat it back over the mainland of Spitsbergen. The gas being allowed to escape, the airship descended and landed on a glacier about half a mile inland. No damage was sustained, except that a few tubes and wires were broken and bent. The scientific instruments on board were uninjured. The *America* was in the air three hours. In the one hour and a quarter during which she was travelling by her own power she made about fifteen miles, including some beats to windward, demonstrating the power of the motor and the dirigibility of the airship. In three days the entire ship, including even part of the gasoline, was conveyed back to camp in good order. The balloon-house and the entire plant were put into condition for the winter. Three men were left to guard it until next summer.

On September 13 the *Lusitania*, the world's greatest and fastest ship, reached New York, having covered the distance between Queenstown and Sandy Hook, 2782 miles, in five days fifty-four minutes, at an average speed of 23·01 knots. Although the *Lusitania* has not lowered the Atlantic record, she has crossed at a greater pace than any boat on a maiden voyage ever did before her. The slight difference existing between the *Lusitania's* average and the *Deutschland's* record of 23·15 knots in 1903 is attributed to fog. The progress marked in steamship construction since the advent of the *Umbria* twenty-three years ago is instructive. The length has been increased 50 per cent., and the displacement is more than three times what it was. The power of the machinery has been multiplied by five, but so great is the difficulty of increasing the speed that the *Lusitania*, notwithstanding its enormous advance in size and power, has not added more than 25 per cent. to the speed. The *Lusitania* has a length of 760 feet, a breadth of 88 feet, and a depth of 60 feet 4½ inches. Its draught is 33 feet 6 inches, its displacement 38,000 tons, and its gross tonnage 32,500. It requires about 5000 tons of coal to steam to New York, and carries a cargo of 1500 tons and 2198 passengers. The indicated horse-power of the steam turbines is 68,000, and the steam pressure 200 lb. The full complement of the ship is 827 persons, the navigating staff numbering sixty-nine, the engineering staff 369, and the personal 389.

Two papers read at a conference of the Catholic Truth Society on September 11 dealt with the question of the bearing of scientific progress upon religious belief. The Rev. J. Gerard, S.J., in a paper entitled "Science and her Counterfeit," pointed out that the true man of science, that is, the investigator actively engaged in scientific research, must be distinguished from purely popular writers and lecturers on scientific subjects. "It is the first principle of science," he remarked, "that nothing should be taken on faith, that we should prove all things, and take no step forward until we have made quite sure of our ground." Many writers, however, who undertake to supply the demand for popular scientific instruction, contradict in their practice the principles which men of science insist upon as necessary for the attainment of real knowledge, and encourage the habit of hasty conclusion instead of the spirit of scientific caution. Hypothesis is an essential part of scientific progress, but, as Dr. B. C. A. Windle explained in a subsequent paper on scientific facts and scientific hypotheses, it is necessary to distinguish clearly between hypothesis or theory and scientific observation. Let facts be accumulated in as great a measure as possible, and theories too, in reasonable number, but let us be quite clear as to what are facts and what are theories, and quite definite in our ideas as to the relative value of the two categories. Father Gerard and Dr. Windle are justified in their remarks as to the unscientific character of much that is put forward in the name of science, but without the authority of careful and accurate observation. One reason for this is the attempt made to instruct people in scientific progress who will not take the trouble to understand the alphabet of nature. To the general public a sensational assertion is much more interesting than a plain statement of fact, and a personal opinion is confused with the established truth to which it refers. It is, however, a sign of progress that the road to the present position of science is strewn with the wreck of hypotheses and theories. No true philosopher regards a hypothesis or theory as a Procrustean bed upon which all new knowledge must be placed, but only as a working or suggestive explanation of observed facts. In this respect the scientific type of mind differs from that which is content to accept mediæval scholastic philosophy as a final court of appeal for new learning.

Biologisches Centralblatt for August 15 and September 1 contains an article by Mr. A. Mordwilko, of St. Petersburg University, on the biology of the Aphididæ, being a summary of a larger work on the same subject. The reproduction of these insects is discussed in the first portion of the article.

IN *British Birds*, No. 4, Messrs. Witherby and Ticehurst continue their account of important additions to the list of species recorded from our islands since 1899. Attention may also be directed to a note by the first-named writer on the nesting of a pair of herons in a pool on Dungeness beach.

THE greater portion of the August issue of the *Museums Journal* is devoted to the conference held at Dundee in July last, where the presidential address was delivered by Mr. J. Maclauchlan. The majority of the papers read was devoted to subjects connected with art and manufactures rather than to natural science.

TWO papers in part iii. of vol. li. of the Memoirs and Proceedings of the Manchester Literary and Philosophical Society are devoted to zoological collections made by Mr. S. A. Neave in N.E. Rhodesia. In the first, which is illustrated by a coloured plate of two new species, the collector discusses the birds, while in the second Mr. G. A. Boulenger, who describes one new fish, records the cold-blooded vertebrates obtained.

THE habits of the North American short-tailed shrew-mouse (*Blarina brevicauda*) form the subject of an article by Mr. A. F. Shull in the August number of the *American Naturalist*. In winter, at any rate, the species feeds largely on snails of the genus Polygyra. These snails are hoarded by the shrews for future use, the emptied shells being either left on the surface of the ground or deposited in various parts of the nests or burrows. Short-tailed field-mice and vesper-mice are also attacked and killed for food, while numbers of insects and earthworms are likewise consumed. The shrews are therefore highly beneficial to the agriculturist.

To the August number of the *Zoologist* Mr. Graham Renshaw contributes some notes on the Californian condor (*Gymnogyps californianus*), a species in imminent danger of extermination. Although in former days ranging so far north as British Columbia, this condor—the largest bird-of-prey in the United States—is now represented only by a small remnant in south-west California. A flock of twenty-six was, however, seen so lately as 1894, and it is hoped that the species may still be holding its own in the more remote mountains. A specimen is now living in the Zoological Park, New York.

WHAT amounts to little less than a revolution in the taxonomy of invertebrates is proposed by Mr. R. T. Günther in the August issue (vol. li., part iii.) of the *Quarterly Journal of Microscopical Science*. Although their molluscan affinities were suggested by d'Orbigny in 1834, the arrow-worms (Sagitta, &c.) have been definitely classed by nearly all modern zoologists among the annelids, in which they constitute the group Chætognatha. Mr. Günther is, however, convinced that they are in reality primitive molluscs. "No organ of importance," he remarks, "has been described in chætognath anatomy which is not paralleled by similar and, we believe, homologous organs among the Mollusca. Indeed, we believe, we can go further and demonstrate that the divergences of structure between the Chætognatha and the Mollusca are slighter than those known to exist between different orders belonging to the latter phylum." The Mollusca, according to the author, typically pass through a free-swimming ("veliger") stage, and while in creeping and sessile forms the foot and shell attain high development, in pelagic types the shell tends to disappear, and the foot may either likewise atrophy or become modified into a swimming organ. On this view the class may be divided into Nectomalacia and Herpetomalacia, the former including the shell-less Chætognatha and the shelled Cephalopoda, and the latter all the rest.

IN *Nature Notes* for September, Mr. O. C. Silverlock records the results of experiments conducted by himself during the last two years with the view of testing the sensibility of ants to changes of temperature and to the ultra-violet rays of the spectrum. As regards the first point, the experiments indicate that very small changes of temperature are perceived by these insects, the sensations of heat in which must be much more delicate than in human beings. Many ants, for instance, perceive so small a rise of temperature as 0°·3 C., while a very large percentage take cognisance of a rise of 0°·5 C. In respect to the ultra-violet rays, it has been already shown by Lord Avebury that these affect ants like true light-rays, and this being so, the author is of opinion that these rays probably appear to them as a colour of which the human mind cannot form a conception. The ants do not appear to be chemically affected by these rays, but they change their positions when placed in the spectrum by reason of their dislike to the colour of these rays, and also on account of the smaller heating effect produced by this end of the spectrum.

IN the report for the year 1906–7 of the industrial section of the Indian Museum, Calcutta, Mr. I. H. Burkill enumerates the additions to the collections received during the year; among the art specimens is a sword and silver scabbard presented by the Tashi Lama. Of the products examined by Mr. D. Hooper in the laboratory, the oleo-resin of *Hardwickia binata*, the gum-resin of *Mangifera indica*, and the oil of *Cochlospermum gossypium* are interesting; also the sample of Kashmir hops.

IT was a happy inspiration to bring together in the Natural History Museum at South Kensington a collection of Linnean mementoes in commemoration of the bicentenary of the great Swedish naturalist. The collection, consisting of portraits, autographs, manuscripts, specimens and books, is arranged in one of the bays of the great hall, and a small pamphlet, prepared by Dr. A. B. Rendle, explaining the different exhibits has been issued as the third of the special guides of the museum.

AN ingenious but difficult hypothesis, tracing the origin and evolution of angiosperms to aposporous developments from a type allied to the thallose liverworts, is offered by Mr. O. F. Cook in vol. ix. of the Proceedings of the Washington Academy of Sciences. It is suggested that as aposporous prothalli arise from the sporophyte in certain varieties of *Nephrodium pseudo-mas*, so the gametophyte of the primitive angiosperm may have had its origin; the proposition requires the elimination of the macrospore, and leads to the comparison of the nucellus with an aposporous prothallus, thus running counter to accepted homologies. It cannot be said that the arguments advanced are sufficiently weighty to warrant a reversal of existing opinion.

THE third part of the botanical series of the *Philippine Journal of Science* (vol. ii.) contains determinations of new or little-known indigenous ferns, and a collation of species of Dryopteris, both prepared by Dr. H. Christ, and the diagnoses of new Philippine palms, by Dr. O. Beccari; also Mr. E. D. Merrill contributes a first list of Philippine botanical literature. Dr. Christ notes that there is a tendency to the production of insular reduced types among the ferns, instancing the irregularity and reduction of fronds in *Dryopteris canescens*, and the peculiar stunted forms grouped under *Leptochilus heteroclitus* and *Pteris heteromorpha*. A new species of Christensenia, more recognisable under the generic name Kaulfassia, is described. Dr. Beccari's communication includes three species of Areca, one as robust as *Areca catechu*, also species of Pinanga, Arenga, Livistona, and Calamus.

MR. R. N. HALL, in his "Notes on the Traditions of South African Races, especially of the Makalanga of Mashonaland," reprinted from the *African Monthly*, and published by the African Book Co., Ltd., Grahamstown, has revived his controversy with Mr. R. MacIver regarding the date of the Zimbabwe temple. In his reply to the theory that the ruins cannot be dated earlier than the fourteenth or fifteenth century A.D., he lays special stress on the statement of De Barros that, on the arrival of the Portuguese at Sofala, about 1505, the Moors informed them that the temple was then ancient, and that the Makalanga possessed no tradition of its erection. It is obvious that on such a question the oral traditions of savages are of little value. But Mr. Hall discusses at length various lines of evidence, which, he believes, establish the permanence of such traditions among the Bantu races—their veneration of ancestors, their genealogies of royal families, their belief that their forefathers migrated from the north, their tales of the early Portuguese occupation, of cannibalism, the slave trade, and so on. He further asserts that the Makalanga have been less migratory than their Bantu kinsfolk, and hence their belief in the extreme antiquity of the Zimbabwe is deserving of credit. On the other hand, he admits that these traditions were not recorded at the time when Europeans first came in contact with them. On the whole, the Makalanga traditions in the versions now accessible do not command perfect confidence, and they do not furnish conclusive evidence in disproof of the archæological facts on which the conclusions of Mr. MacIver were based.

THE third part (the second in order of issue) of the Eugenics Laboratory Memoirs has just been issued by Messrs. Dulau and Co. It is entitled "The Promise of Youth and the Performance of Manhood," and contains the results of an inquiry, by Mr. Edgar Schuster, into the question how far success in the examination for the B.A. degree at Oxford is followed by success in after-life. Apart from the Oxford class lists, the investigation is based on "Crockford" and Foster's "Men at the Bar." The results show a striking relation between the earlier and later success. Thus among those who took their degree in 1859 or previously, and subsequently entered the Church, 68 per cent. of the first-class honours men obtained some clerical distinction or first-class scholastic appointment, whilst the percentage falls to 37 per cent. for the second-class men, 32 per cent. for the third class, 29 per cent. for the fourth, 21 per cent. for those who took pass degrees, and 9 per cent. only for those who took no degrees. The results in the case of those subsequently called to the Bar are similar. Taking a rougher division, 32 per cent. of those who obtained first to fourth-class honours subsequently obtained some form of office or appointment that was reckoned as distinction, whilst only 16 per cent. of those who obtained pass degrees or no degrees did so. It would seem from these figures that the degree examinations are a better test of general ability, and not of a merely special type of ability, than is generally believed. It seems a pity that these memoirs cannot be issued at a lower price, or, preferably, published in some recognised journal.

DR. GUSTAV VON ZAHN contributes to Nos. 5 and 6 of the current volume of the *Zeitschrift der Gesellschaft für Erdkunde* a paper on the physical and economic geography of the isthmus of Tehuantepec. The author visited the isthmus in October, 1906, and devoted special attention to existing and possible routes across it as means of interoceanic communication. His conclusions are strongly in favour of a new Transpacific route from Salina Cruz.

A LECTURE delivered before the Versammlung deutscher Naturforscher und Ärzte at Stuttgart by Prof. Dr. E. Hammer in September last is reprinted in *Petermann's Mitteilungen* (vol. liii., p. 97). Prof. Hammer discusses the scales of maps most useful for geological and general economic purposes, favouring 1 : 25,000 for ordinary publication. He lays great stress on the need for such maps bearing some indication of the degree of accuracy of the contour lines shown, as well as of the actual determinations of height upon which the contours depend.

THE *Mitteilungen* of the Vienna Geographical Society contains (vol. l., p. 139) an interesting paper on the "zonal" distribution of rainfall, by Dr. Fritz von Kerner. The author has repeated and extended the measurements of Loomis's rainfall maps made by Sir John Murray, using the more recent maps of Supan, and gives the rainfall in belts of latitude, first for all longitudes and also for the eastern and western old world and the new world separately. Detailed comparisons are given with Murray's results, and also with the measurements of Bezdek published in 1904. Supan's maps for the four seasons are treated in a similar way, the accuracy of the work being tested by comparing the sums of the four seasonal values with those obtained independently from the map for the whole year.

THE most noteworthy feature in the report of the Mauritius Observatory for 1906 is the shortage of rainfall; the annual amount for the island (mean of fifty-seven stations) was 72·4 inches, as compared with the average, 79·5 inches. Notice is directed to an apparent connection between droughts in Natal and Mauritius, well-marked winter droughts at the coast stations of the former place being followed by summer droughts in Mauritius at intervals of from three to seven months.

WE have received from the Deutsche Seewarte its monthly meteorological chart for the North Atlantic Ocean for September, which, like the corresponding chart published in this country, is replete both on face and back with information of value to seamen, and includes notes on ice, fog, &c., brought down to the latest possible date. A comparison of the face of the English and German charts naturally exhibits slight differences in the results; this is unavoidable when compilation is made from data received from different sources. The back of the German publication contains, *inter alia*, charts showing the weather conditions between Ushant and Gibraltar, and sudden changes observed in the sea-surface temperature south of the Newfoundland Bank, each chart being accompanied with useful explanatory text.

THE Publications of the Japanese Earthquake Investigation Committee, Nos. 23 and 24, are devoted to an account and study of the seismograms of what is called the "Great Indian Earthquake of 1905." The preface states that these are issued as a systematised account of the instrumental observations of the earthquake, to be laid, for discussion, before the International Seismological Association at its next general conference. The data yielded by the seismograms are discussed with a wealth of elaboration and tabulation which tends to obscure the conclusions drawn; some of these are diametrically opposed to those generally held in this country, and the data on which they are based seem more consistent with the view that this earthquake was not so very "great," and that the distant records are imperfect. The value of the series of reproductions of forty-one seismograms taken at twenty-nine different stations would have been increased had the reproductions of Milne seismograms been less coarse in texture, but even with this drawback they form a collection which will be extremely useful to students of seismology, and we have only to regret that it should have been left to the Japanese Government to produce an adequate report of a British earthquake.

A NEW microphone for wireless telephony, the invention of Prof. Majorana, is described in the *Electrician* of August 30. The microphone consists of a jet of water falling on a collector made of two cylindrical pieces of platinum. The two pieces of platinum are connected to a battery, and a current passes depending on the thickness of the water film connecting the two surfaces; this thickness is varied by passing the stream of water before it falls on the collector through a receptacle, one side of which is formed by a membrane actuated in the ordinary manner of a telephone transmitter. It is stated that the vibrations produce corresponding fluctuations in the water jet, and the secondary current reproduces in consequence the sound waves. The collector circuit is connected to the spark-gap in the wireless transmitter, a Poulsen arc in nitrogen being the most suitable spark-gap to employ. No particulars are given of distances over which transmission has been accomplished.

THE *Halbmonatliches Literaturverzeichnis* of the *Fortschritte der Physik* continues to fulfil its function of bringing the titles of papers published in the various departments of physics promptly before its readers. It is interesting to notice that nearly 40 per cent. of the papers published fall within the section cosmical physics.

THE general characteristics of the treatment of elementary geometry adopted by Messrs. Barnard and Child in their "New Geometry for Schools" (Messrs. Macmillan and Co., Ltd.) and similar volumes have been described in these columns on more than one occasion (vol. lxix., pp. 97 and 391; vol. lxxi., p. 174). To meet the requirements of teachers and students who wish only to follow the subject up to particular standards, the course of work has been subdivided, and three new volumes containing various sections have recently been published. Part iii. of "A New Geometry" contains the equivalent Euclid, Books ii., iii. (35–7), and the harder parts of Book iv.; parts iii. and iv. (in one volume) include, in addition, Euclid, Book vi., and the algebraical treatment of ratio and proportion for commensurable quantities; and "A New Geometry for Middle Forms" contains the substance of Euclid, Books i.–iv., together with additional matter. The six volumes, which now form Messrs. Barnard and Child's series on practical and theoretical geometry for schools, provide students in any part of the Empire with courses of study which cover satisfactorily the revised syllabuses of examining bodies, and follow the reformed methods of geometrical teaching brought about by the reports of committees of the British Association and the Mathematical Association.

OUR ASTRONOMICAL COLUMN.

DANIEL'S COMET (1907*d*).—An excellent reproduction from a photograph, and a description of comet 1907*d*, are published in the September number (p. 385) of the *Bullétin de la Société astronomique de France* by M. F. Quénisset, of the Juvisy Observatory. With a clear sky, the comet appeared incomparably brighter than the Andromeda nebula, and gave the impression of being about the brightness of a second-magnitude star; the tail could be seen, by the naked eye, extending to a distance of 8° or 10°. Between July 12 and August 15 twenty-six photographs were obtained, three portrait lenses of 16·0, 13·5, and 3·8 cm. aperture, and 0·740, 0·565, and 0·130 metre focal length, respectively, being chiefly employed. On these photographs the structure of the tail is very sharply defined, and on one obtained with the last-named objective the tail can be traced for not less than 17°. From the photographs obtained with this instrument on August 7 and 8 there is evidence of a rotatory motion of the comet about a line joining the nucleus and the sun.

As seen in the 24-cm. (10-inch) equatorial and on the photographs taken with a Viennet objective, the structure of the tail near the head was fan-like, the colour being a fine green, and the brightest part was directed towards the sun. A visual examination of the comet with a spectroscope revealed the three strong hydrocarbon bands on a brilliant background of continuous spectrum. These bands were sharply defined on the red side, and faded away gently towards the violet, and, on replacing the spectroscope slit, they, with others, were seen resolved into lines; the order of their brightness was green, blue, orange.

From Mr. G. Gillman, of Aguilas (Spain), we have received a drawing showing the observed path of the comet from August 13 to 21. On the former date Mr. Gillman, as shown on his drawing, was able to trace the tail for a distance of 25° in a W.S.W. direction.

Owing to its decreasing brightness and to the fact that it does not rise until about 1½ hours before sunrise, the comet is becoming a difficult object, but we give below a further extract from the ephemeris published in No. 4196 (p. 337, August 23) of the *Astronomische Nachrichten*:—

Ephemeris 12h. (Berlin M.T.).

1907	α (true) h. m.	δ (true) ° ′	log r	log Δ	Brightness
Sept. 21	10 46·3	+7 5·1	9·8179	0·1879	6·4
23	10 55·7	+6 25·8			
25	11 4·8	+5 47·1	9·8550	0·2085	4·9

As mentioned last week (p. 503), Herr Kritzinger, of Berlin, recently pointed out (*Astronomische Nachrichten*, No. 4198) that the radiant point of this comet was in $346° + 1°$ on September 12. Mr. W. F. Denning informs us that he watched the sky on September 10, 12, and 14, the weather being very clear, but did not notice any meteoric shower from the point mentioned. There was an active radiant at $355° + 5°$, however, about ten degrees E.N.E. from the position given by Herr Kritzinger. This display is often seen in September, and there is another at $346° + 1°$ (exactly agreeing with the cometary radiant), often noticed both in August and September. The correspondence in the apparent places is probably accidental.

Mr. A. J. Hawkes writes from Bournemouth to suggest that the fine sunsets seen on Monday, and also at the end of last week, may be due to meteoritic dust in the track of the comet recently crossed by the earth.

THE LOWELL EXPEDITION TO THE ANDES.—In a recent communication to Dr. W. J. S. Lockyer, Prof. David Todd briefly describes the location and work of the Lowell expedition to the Andes for the purpose of observing Mars under the best conditions during the last opposition. Prof. Todd states that he selected Oficina Alianza, in northern Chili, for the location of the Amherst College 18-inch telescope, one of the instruments sent out by Prof. Lowell, and has found the atmospheric condition most favourable. Cloudless skies obtained day and night, and a windless and steady atmosphere produced an average "seeing" of 4 on a scale of 5. More than 5000 photographs, covering all regions of the planet, were obtained by Mr. E. C. Slipher, and many of them exhibit clearly the much discussed double canals. The telescope is the last one, of large size, erected by Messrs. Alvan Clark and Sons, and their chief mechanician, Mr. A. G. Ilse, is a member of the expedition. Photographs of the annular eclipse on July 10 were also secured, and the ringless phase of Saturn was much observed and photographed. Prof. Todd removed the station to a point in the higher Andes above Limas during the first week in August.

MARKINGS ON THE THIRD SATELLITE OF JUPITER.—In No. 4199 of the *Astronomische Nachrichten* (p. 381, September 6) Senor J. Comas Solá continues his description of the markings he has observed on Jupiter's third satellite, and gives position angles determining the positions of the same, at stated times, with regard to the direction of the axis of rotation of the planet. From the discussion of his results he concludes, provisionally, that (1) the visibility of the northern white cap is independent of the satellite's position in regard to the planet, and is incomparably greater than that of the other cap; its brightness is comparable to the snow-caps of Mars. (2) As on Mars, the northern cap of satellite III. is always bordered by a dark area, which appears darker nearer to the cap. (3) The northern cap appears to be turned towards us, and, if it is situated at the extremity of the axis of rotation of the satellite, the inclination of the equatorial plane to the orbit of the satellite must be considerable. (4) The dark spots and areas are difficult to observe, and appear to be variable in a very short time. (5) As yet nothing can be said of the rotation period of the satellite.

A plate of twelve drawings accompanies the paper, and shows very markedly the different features referred to, and their variations from time to time, as observed during the period November 24, 1906, to March 25, 1907.

ASTROPHYSICAL OBSERVATIONS AND ANOMALOUS DISPERSION.—In Nos. 4197–8 (p. 341, September 2) of the *Astronomische Nachrichten*, Prof. Hartmann discusses at length the possible explanation of several observed astrophysical phenomena by the theory of anomalous dispersion. He first discusses the general problem, and then its effect in the observed phenomena of the chromosphere, sun-spots, prominences, faculæ and flocculi, and the fixed stars. The results of the discussion are not universally conclusive, but Prof. Hartmann points out that, with stated conditions, the question may be decided by special observations. A bibliography of fifty-six papers on this subject is given at the end of the discussion.

FORTY YEARS OF CORNISH MINING.

MY connection with Cornish mining began in the year 1867, when I succeeded the late Sir Clement (then Dr.) Le Neve Foster as lecturer and assistant secretary to Mr. Robert Hunt's Miners' Association of Cornwall and Devon. It was a time of transition, for copper-mining after a brilliant career of a century or more was rapidly declining, and tin-mining, which though far more ancient had become second in importance, was once more in the ascendant. The man-engine, the employment of which had been greatly assisted a quarter of a century earlier by substantial prizes offered by the Royal Cornwall Polytechnic Society, was in use in a dozen of the principal mines, wire-rope and skip were gradually replacing chain and kibble, and rock-boring machines, thanks to the initiation of my predecessor, had already been practically tested in several parts of the county. These were real advances, but kibble-winding was still common even in the deepest mines; the cobbing hammer, the bucking iron, the hand-jigger, and the wooden shafted stamp were still at work to a large extent; while the stonebreaker, the California and pneumatic stamp, the various forms of pulveriser, the Frue and Luhrig vanners, the Wilfley and Buss tables, the self-acting and round slime frames, the air-compressor, and many other contrivances which are now looked upon as essentials in well-provided mines were only beginning to appear. When one compares the present condition of Cornish mining with its condition forty years ago, it is obvious that a sort of revolution has taken place.

In mining proper there has been no great advancement during the forty years. Somewhat greater depths have been attained in a few instances, and notably at Dolcoath, but Cornwall is still far behind several other mining regions in this respect. We are now more impressed than heretofore with the advantages afforded by good shafts, good underground roads, and good surface transport; the tramroad and tram-wagon have largely displaced the wheelbarrow; underground ore-bins, once so rare, are now becoming common; but in the main our system of underground mining was so good even a century ago that there was not very much room for improvement. Still, I will venture to predict that during the next forty years more vertical shafts will be sunk, that levels will be driven farther apart, that there will be a great deal more cross-cutting, and that our underground tramroads will be better constructed, so that "three men at a wagon" will be no more heard of.

As to the methods employed for breaking the ground, the chief changes have resulted from the use of boring machines and high explosives. In 1868 I first saw Doering's machine at work in Tincroft Mine. It was not a success, for, being operated by steam, the workings were rendered almost unbearable; in fact, while steam was the motive power, the use of the machine drill made very little progress either at home or abroad, and it is certain that if compressed air had not been introduced boring machines would to-day play a very small part in mining or tunnelling. Once introduced, however, the immense value of the system was at once recognised.

The difference between "to-day" and "yesterday" is seen in the fact that no rock-drill or air-compressor has ever been employed in the great mining parish of Gwennap, several of whose mines were still at work a generation ago, while at present all the great mines of the neighbouring parishes of Camborne and Illogan depend very largely upon these machines, not because they break the ground more cheaply, for it is well known that such is not the case (and, moreover, in narrow lodes they do not even break the ground more advantageously, for the "pay-streak" inevitably becomes much contaminated with barren "country"), but because they open the ground more speedily. One good effect of their employment has been the enlargement of the main drifts, and consequent improved ventilation, and this has been especially benefited by the large amount of cool exhaust air set free by the machines. The greater number of machine drills hitherto have been employed in sinking, rising, or drifting, but there is a constant and growing tendency to employ them in stoping also.

Forty years ago much gunpowder was still used in the mines; to-day, after many experiments with compressed powder, cotton-powder, and other such compounds, and after nitro-glycerin had been tried and given up because of its danger, only such "high explosives" as dynamite, gelignite, and the like are used. These high explosives only came into use after much experimenting, by the Royal Cornwall Polytechnic Society in particular, but they have proved themselves very serviceable, especially in hard ground, and they are also found to be much safer in use than the old black powder.

Great improvements have been effected in the machines used for compressing the air employed in working the machine-drills; compound engines, compressing the air in successive stages, are now generally employed in the larger mines.

Compound engines, mostly of the tandem type, were introduced into several Cornish mines by Mr. Sims more than half a century ago, but with the low-pressure steam then employed did not recommend themselves, and so went out of use. A compound engine using high-pressure steam has been employed for years past in pumping at the Basset Mines for working the ordinary force pumps; of late many attempts have been made to introduce centrifugal pumps operated by electricity for draining the mines. A certain measure of success has attended these efforts, particularly at the Tywarnhaile Mines, and more recently at Wheal Vor; but it must be admitted that up to the present the Cornish system of pumping, the rods being operated by a simple vertical engine, single acting in the case of large installations, holds the field.

The use of electricity is spreading in the Cornish mines apart from pumping. At East Pool it has long been employed for surface traction, the mill being a mile or more away from the mine. At South Crofty it is employed for operating the new stamp mill; in several mines it supplies power to work pulverisers, buddles, and other dressing machines, and in this direction—as also in electric lighting—there is a large field for extension.

There have been great improvements in the engines used for winding during the past few years. It no longer takes thirty to forty minutes to raise a kibble of stuff from the bottom of the deeper mines, as it did at one time; skips running between guides are now common, cages bringing the ore-wagons direct to surface are employed in several mines, while the men are mostly brought up from below in shaft-gigs or special skips, so that the man-engine, once so great a boon and used in no fewer than twelve mines, can now only be seen in operation in the Levant Mine. For modern winding wire-ropes are universally used, and are practically indispensable. Accidents from its use are, indeed, exceedingly rare. Mr. Morgan's traversing engine, erected some years since for hoisting from Williams's Shaft at Dolcoath, will soon be at work again, but so far no proposals seem to have been made for using this remarkable engine anywhere else.

For signalling in shafts the old "knocker line" is still in use, and has its advantages. Indicators for the guidance of the engine-man are, of course, placed in the engine house in every case where men are raised, and in most other cases; overwinding is an extremely rare occurrence, such is the carefulness of the engine-man. The telephone was introduced in Wheal Eliza by Dr. Le Neve Foster many years ago for signalling from below, but it did not "catch on." It is, of course, used for ordinary business purposes in several of the mines.

The steam-boilers used in Cornwall are mostly of the Cornish or Lancashire type, and work at comparatively low pressures. The number of these boilers working above 60lb. is not very great, and those working at 100 or more could almost be counted on the fingers. Multitubular boilers, portable or semi-portable, are used in some instances where good water is obtainable, and particularly for winding, while the electrical pumping plant at Tywarnhaile is worked by engines which consume "suction gas."

Many improvements have been introduced in the treatment of ores; the ores treated in Cornwall now are almost exclusively of tin, copper ore being rare, while the working of iron, lead, and zinc ores has practically ceased.

The first crushing is generally done by stonebreakers of the Blake type, followed by stamps of the Cornish, California, or pneumatic type, the "rows" being finally reduced by some form of pulveriser. Self-feeders have not yet been used for the Cornish stamps, but they are always employed in connection with the California and pneumatic stamps. At Dolcoath powerful batteries of all three types can be seen regularly at work.

For dressing the crushed ore, while buddles are still very generally used at some stages, Wilfley, Buss, or other tables of the percussion type, or Frue vanners are employed in most of the larger mines. Hydraulic separators are mostly used to remove the slimes before feeding the pulp to the Wilfley and Buss tables, but in the case of the Frue vanner the slimes are generally removed for separate treatment at a later stage.

For slime treatment there is still nothing better known than the dead-frame, the ordinary round slime table, or the Acme table. The old-fashioned swinging rack for cleaning slime has practically disappeared, though it had some notable merits.

Most tin-ores need calcination before they can be cleaned for the market. In some of the smaller mines the old reverberatory oven is still in use, but in the larger mines the Brunton revolving calciner is always employed.

The calcination of tin-ores yields in some mines large quantities of "arsenic-soot," which is collected in long flues of masonry; this soot, at one time valueless or worse, is now an important by-product. It is handled by the ton as freely as sand, and apparently with equal impunity for cases of arsenic poisoning are far rarer in Cornwall than in London. Another important by-product in some mines is wolfram, which at one time was merely a deleterious component of the dressed tin, but is now profitably extracted at many of the mines, and in particular at Clitters United, East Pool, and South Crofty by means of the Wetherill magnetic separator. In this machine the powdered and thoroughly dried concentrates are carried slowly over electro-magnets on traversing belts. The magnets remove the slightly magnetic particles of wolfram, while the non-magnetic particles of cassiterite pass on and fall into a separate receptacle. The wolfram so separated in most cases still contains a considerable percentage of tin-oxide. At the mines mentioned this tin-wolfram product is "pickled" with dilute acid (aided by jets of steam at East Pool) in order to remove certain highly magnetic iron oxide components, which seriously interfere with the operation of the magnetic separator. A similar "pickling" was recommended by Dr. Richard Pearce forty years ago, and has occasionally been used for the removal of copper from calcined tin ores.

At Tynwarnhaile, and also at Dolcoath, the Elmore oil processes have been, or are being, introduced for the concentration of low-grade copper ores. The wet ore-pulp is mixed with oil and subjected to a partial vacuum, by which means the ore-particles are floated up from the waste as a sort of mineral scum, which is readily separated from the waste, and with much less loss than is the case by the methods hitherto employed.

Enough has been said in this hasty summary to show that the Cornish miner to-day, as in the past, is very ready to avail himself of such new methods and appliances as have a reasonable prospect of success, although it must be admitted that he is rather fond of letting other people experiment for his benefit.

J. H. COLLINS.

THE IRISH PEAT INDUSTRIES.[1]

ACCORDING to reports published in 1814 by the Bog Commissioners, Ireland possesses 3,028,000 acres of "peat bog," of which 1,648,000 acres form "available" or so-called "red" bog, and about 1,380,000 acres form "mountain peat soil." The "red bog" is mainly confined to the great central plain of the island, and the "mountain bog" to the counties of Wicklow, Donegal, Mayo, Galway, and Kerry. As the accompanying outline bog map (Fig. 1) shows, there are few portions of the island destitute of bog.

The slow but continuous reclamation of Irish bogs which has been going on for the past three hundred years is referred to in a work written, in 1645, by Dr.

[1] Abridged from the Economic Proceedings of the Royal Dublin Society, vol. i., part x. (July)

Gerard Boate. The method of reclamation practised in Ireland at the beginning of the seventeenth century, consisting as it did of draining the bogs and manuring the dried surface, was probably, owing to radical differences in detail between it and the Dutch fen reclamation process, of independent origin from the latter, which was introduced about the same time on the Continent at Groningen, in Holland, and at Emden, in East Frisia. At a later period—in the reign of William III.—the Dutch offered to introduce their system into Ireland upon condition of being allowed to establish a self-governing colony in the Queen's County.

The drainage and reclamation of the bogs have always been subjects of interest; the existence of so much unreclaimed land being a source of loss to the State, and its humidity being detrimental to the health of the community.

We find, for instance, a writer in 1660 recommending that "An Act of Parliament should be made that they who did not at such a time make some progress in draining their bogs should part with them to others that would," and about sixty-five years later an Act was passed

FIG. 1.—Outline bog map of Ireland.

by the Irish Parliament for the encouragement of the drainage of bogs.

Schemes for the drainage and reclamation by burning and manuring the surface of the bog, on the one hand, or by covering it with a layer of sand and manure after a due interval for subsidence, on the other, were published in 1814 in the reports of the Bog Commissioners. These reports described also the numerous successful plantations of trees in Irish bogs made during the eighteenth century. The engineers engaged in the work were of opinion that the bogs could be drained and converted into arable land without much expenditure of time or money.

It would be scarcely economic to attempt the reclamation of bogs the average depth of which is 25 feet, such as those in the central plain of Ireland, without first making a serious effort to utilise the "available" peat of the bogs. Apart from the large sum of 41,565*l.* expended in the years of the Bog Survey, there have been since that time smaller sums contributed by the State to the development of the peat industry. The Department of Agriculture, for example, has within the last few years spent upwards of 6317*l.* in experiments on the preparation of peat-moss litter and fuel. It employed the services of an expert to report upon the various Continental processes, and to select the machinery necessary for the carrying out of the experiments which were subsequently performed at Inny Junction, County Cavan, and at Castleconnell, County Limerick.

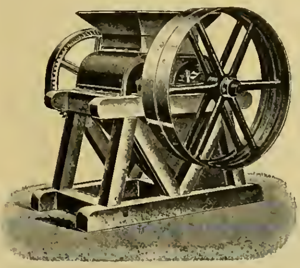

FIG. 2.—Dolberg's peat-moss litter dividing machine.

Within the past hundred years many attempts have been made in Ireland to utilise the peat supply. About the middle of the nineteenth century a turf-charcoal factory was established at Derrymullen by Rogers, but was, however, after a brief period of work, abandoned. A similar fate awaited the turf-distillation factory established in the year 1849 by Reece under the guidance of

FIG. 3.—Peat-moss litter baler, Umaras, co. Kildare.

Sir Robert Kane at Kilberry, near Athy. Although a bright future seemed to lie before this factory, which was the first of its kind in Europe, it was, after a few years' active work, closed by its directors. In 1863 a process for the manufacture of "sieve turf" was worked on a large scale for a short time in connection with the Creevelea Iron Works near Sligo. At Derrylea, near

Portarlington, in 1866, several thousand tons of press turf were made by a modification of the oldest known "dry-press" process—that of Gwynne, which was itself tried on a small scale in 1855 at Kilberry. Of historical interest also is the fact that, of "wet-press" processes, one of the oldest found in the literature of peat is that which was employed by Williams in 1844 at Cappoge, in the Bog of Allen.

In recent years there have been built in Ireland many peat-moss litter factories, such as those at Umaras, near Monasterevan, County Kildare; at Coolaney, County Sligo; at Maghery, County Tyrone; at Ferbane and Rahan, King's County; and at Inchicore and Ringsend, in Dublin. The peat paper factory at Celbridge, County Kildare, belonging to the Callendar Paper Company, has recently been closed. At Umaras and Maghery there are peat-fuel factories, and at Kilberry a fuel called "electro-peat" is manufactured. Quite recently experiments have been carried out at Carnlough, County Antrim, on the production of ammonia from peat, and the installation of a

FIG. 4.—Peat digester, peat paper factory, Celbridge, co. Kildare.

plant capable of producing 5000 tons of ammonium sulphate per annum is now being completed at a cost of 85,000*l*.

It is convenient to divide the peat industries into three classes, namely, the fibre, the fuel, and the distillation industries. In this paper the first, and probably the most important, class will be considered more fully. In the peat-moss litter districts of Ireland the peat is dug out of the bog in large sods, which are dried in the air and stored under cover to prevent the re-absorption of water. The air-dried peat is next disintegrated by the rotating circular saws contained in the body of a dividing machine (so-called wolf, Fig. 2), sifted free from mould, and compressed into bales by vertical knee-lever presses, such as that used at Umaras (Fig. 3). From the "wolf," which is placed on the ground floor of the factory, the divided peat is carried by elevators to the upper floor, where, after passage through a cylindrical sieve, it is delivered into the funnel-shaped mouth of the baler. The mould can at the same time be collected apart. It is exported in large quantities by the owner of one of the factories to southern countries for the preservation and packing of fruit and vegetables grown there.

Where a suitable canal system exists the peat-litter industry is successful, but where canals are not available the industry is crippled by the high rates of carriage charged by the railway companies.

The purified peat moss can be used for the preparation of peat molassine meal and for the manufacture of alcohol, but as the latter process can scarcely at the present time be carried on remuneratively it is not practised in Ireland.

The peat paper factory which was established in 1903 at Celbridge, and turned out large quantities of wrapping paper yearly, was unsuccessful. It was finally closed in December, 1905. The peat, brought on cars from a bog situated at a distance of several miles from Celbridge, was subjected to a preliminary treatment in a large spherical revolving digester (Fig. 4), from which it was conveyed by cars running on a small iron railway to the scarifying and beating machine, where it was converted into pulp. After passing through sand-traps, the unbleached pulp was delivered on to an endless band, by which it was brought between the revolving rollers of a paper-pressing machine. The band of paper thus formed was glazed and polished by vertical rollers.

The motive power of the factory was electricity, which was generated in a dynamo driven by a 200 horse-power turbine worked by water from the adjacent Liffey.

The brown wrapping paper sold by the company was of a strong texture, excellent quality, and contained about 66 per cent. of peat fibre. Considering, however, the large amount of material present in crude turf which is useless for the manufacture of paper, it will be readily seen that the preliminary treatment of the peat should be carried out in the immediate neighbourhood of the bog.

The accompanying illustrations from the author's "Reports upon the Irish Peat Industries," part i., are reproduced by the courtesy of the Royal Dublin Society.

HUGH RYAN.

ZOOLOGY AT THE BRITISH ASSOCIATION.

The Physical Basis of Inheritance.

ONE of the most interesting features of the programme of Section D was a discussion, jointly with Section K, on the physical basis of inheritance. In opening the debate, Prof. S. J. Hickson, F.R.S., dissented from Montgomery's view that the inherited characters are transmitted *solely* by the chromosomes. The principal piece of evidence which is quoted in support of this hypothesis is Boveri's experiment (1889) in which an enucleate echinoderm ovum of one species, fertilised by a spermatozoon of another species, produced a larva with purely paternal characters; but similar subsequent experiments have not always resulted in a larva with purely paternal characters. Confirmatory evidence of the theory is held to be afforded by (1) the constancy in the number of chromosomes in the somatic cells; (2) the reduction to half the normal number of chromosomes in the sexual cells; and (3) the presence of similar heterogeneous chromosomes in the sexual cells of certain Arthropods and their mutual conjugation during fertilisation. If the theory be true, it appears necessary to hold that the chromosomes maintain their individuality, but there is convincing evidence that in some animals this is not the case, *e.g.* in certain Rhizopoda (*e.g.* Pelomyxa), Suctoria (*e.g.* Ephelota, Dendrosoma), and Cœlenterates. Moreover, if it be true that the cytoplasm of conjugating cells is not concerned in the transmission of hereditary characters, it is difficult to account for the long duration of the period of conjugation in Infusoria and the cases of fertilised enucleate eggs which produced larvæ with maternal characters. Prof. Hickson suggested a possible explanation, viz. that where the characters are comparatively rigid, as in mammals, insects, and some other groups, they are aggregated in definite masses, and may be associated with the chromosomes, but where it is advantageous for the characters to remain more variable they are associated with the cytoplasm, as in the Protozoa and some Cœlenterates.

Prof. J. B. Farmer, F.R.S., said that although the chromosomes are probably not the actual bearers of the hereditary characters, they may produce their results by acting upon some specific substance in the protoplasm of the cell. He pointed out that the behaviour of the chromosomes in the heterotype division, preceding the formation of sexual cells, provides an arrangement for the sorting out of characters such as is shown to occur by breeding experiments. The chromosomes themselves consist of congeries of smaller entities—the chromomeres—which are probably very numerous; possibly it is these smaller entities which are associated with the hereditary characters. Such an assumption would answer the often raised objection that the characters exhibited by an organism are more numerous than the chromosomes. In any case, the heterotype division provides a mechanism for arranging these entities on a mathematical basis. The development of an organism on certain definite lines is the result of interaction of the nucleus and cytoplasm, and as there is no mechanism apparent in the cytoplasm for the sorting out of characters, while such is present in the nucleus, it seems reasonable to associate the latter with the carrying of the hereditary characters. Moreover, in many cases only the nucleus of the spermatozoon enters the egg during fertilisation, and yet the parental characters are conveyed.

Mr. R. C. Punnett pointed out that in the interpretation of the facts of heredity the student of genetics has been led to the conception of factors in the gametes upon which his unit characters are based. Between the postulated behaviour of these factors in segregation and the observed behaviour of the chromosomes in the divisions of the germ-cells there is a striking agreement. Nevertheless, certain cases of dihybridism offer phenomena pointing to the existence of gametic series in which the four types of gametes are produced, not in equal numbers, but in such ratios as 7 : 1 : 1 : 7 or 15 : 1 : 1 : 15. If the cytologist desires to regard the chromosomal elements as the physical basis of heredity, he must provide some scheme which will include these phenomena.

Prof. V. H. Blackman stated his belief in the chromatin as an active agent in the process of heredity. Boveri's work on the multiple fertilisation of echinoderm eggs seems to indicate that not only do the chromosomes carry the hereditary properties, but also that they are physiologically differentiated. The speaker suggested that in the protozoan nucleus there is a duplication or even a multiplication of the parts, and that it is not necessary for the whole nucleus to divide or for chromosomes to be evident; a portion of the nuclear substance pinched off may contain representatives of each of the characters.

Mr. R. P. Gregory pointed out that in all the somatic cells the division of the nucleus shows a certain form of symmetry, whereas just previous to the formation of gametes this symmetry is replaced by another—the heterotype division. From experiments in regeneration and vegetative propagation, it appears that all the characters are distributed throughout all the cells of the organism, whereas breeding experiments show that segregation takes place on the formation of gametes, one form of symmetry being replaced by another in precisely similar manner to that indicated by the study of the nucleus. It is impossible to believe that this is a mere coincidence.

Mr. A. D. Darbishire said he would only attempt to answer one question, viz., Are there any characters which depend for their manifestation on factors which exist in the cytoplasm? His observations on the starch grains in peas afford an affirmative answer. The difference between round and wrinkled peas depends largely on the nature of the starch grains. In round peas the grains are potato-shaped, in wrinkled peas they are round in contour and compound. In the hybrid the grain is intermediate between those of the parents in three respects:—(1) in contour; (2) in compoundness, about half the grains being simple and half compound; (3) in the number of pieces in the compound grains, which is usually three, rarely two (in non-hybrids it is six). As is well known, the formation of starch grains depends upon certain plastids produced, not by the nucleus, but from others previously existing in the cytoplasm.

Mr. L. Doncaster held that the maternal characters in the hybrid larvæ referred to by Prof. Hickson were only found in the very early stages, and could not properly be called hereditary characters. He suggested that the abnormal behaviour of the nucleus in the Protozoa might be associated with their great simplicity of organisation, no differentiation of chromosomes bearing hereditary characters having yet taken place.

Prof. M. M. Hartog said that the essential part of the chromosome in heredity appeared to be, not the chromatic elements, but the achromatic basis, a view advocated also by Boveri. He thought it was futile to attempt to exclude the cytoplasm from the genuine basis of heredity. With reference to the suggestion, made earlier in the discussion by Mr. C. C. Hurst, that cytologists should investigate the relations between the nucleus and the external characters of crosses, Prof. Hartog was inclined rather to request breeders to investigate certain forms exhibiting exceptional cell divisions. In at least two species of Tradescantia single chromosomes are often left out in the heterotype division of the pollen, and appear finally to be digested. In several species of Hemerocallis at the same stage the chromosomes are distributed into either three or four cells, and the pollen grains are consequently irregular in size, in number, and in the chromosomes they contain.

Prof. Hickson, in replying to the criticisms, regretted that there was not time to traverse them in detail. Referring to Wilson's work on the heterogeneous chromosome in the nucleus of the testis cells of *Anasa tristis*, he pointed out that Foote and Strobell deny the presence of such a chromosome. If, as was asserted during the discussion, specimens of this animal from some localities possess this chromosome while others from a different locality do not, that is a strong argument against the all-powerful influence of the chromosomes in regard to the hereditary characters.

The Experimental Study of Heredity.

Mr. R. C. Punnett illustrated his lecture on this subject by a series of actual examples, drawn chiefly from fowls and sweet-peas. He pointed out that the laws of heredity associated with the name of Mendel apply equally to plants and animals; the comb of the fowl, the stature of the sweet-pea, the colour of the stock, the hair of the rabbit, rust immunity in wheat, and some diseases in man, all conform to the same laws of heredity. Experimental work with animals may well lead to a solution of many problems in human disease; but, important as are the practical results, this study has a still greater importance in relation to our scientific conceptions, for it must radically affect our views of the process of evolution, the nature of mutation, and the physical basis of heredity.

Protozoa.

Mr. F. B. Rowley exhibited a series of models of Protozoa—Amœba, Vorticella, Paramœcium, Actinosphærium, and the parasite of human malaria in blood corpuscles—constructed chiefly of gelatin, which give an excellent idea of the appearance of these organisms in life.

Mr. H. B. Fantham discussed the classification of the Haplosporidia. He and Dr. Ridewood suggest the division of the group into two sections:—

(1) Polysporulea, in which the pansporoblast gives rise to nine or more spores, *e.g.* Rhinosporidium, Neurosporidium.

(2) Oligosporulea, in which the pansporoblast gives rise to a few (four) spores or to a single spore, *e.g.* Haplosporidium, Bertramia, Cœlosporidium.

The Movements of Spirochaetes.

Mr. Fantham pointed out that the nature of the movements of Spirochætes would serve as an aid in separating this genus from Spirillum. Knowledge of these movements would therefore be of value in connection with the vexed question of the nature of the organism of relapsing fever. Spirochætes, especially *S. anodontae*, with its pointed ends, usually move very rapidly, but in slowly moving specimens the organism can be seen to move forward while turning on its long axis. The motion can be resolved into two components:—(1) a vibratory motion of flexion of the body mainly for progression; (2) a spiral motion of the body as a whole due to the undulating membrane—a spirally wound lateral extension of the ectoplastic periplast bearing striations (the contractile myonemes). The body of a Spirillum bears flagella, and is more rigid than that of a Spirochæte in motion. The so-called flagellate (ciliate) stages of Spirochætes are merely due to the splitting off of myoneme fibrils from the undulating membrane during its rupture, resulting from violent contortions or approaching death.

Some Points in the Structure of the Larva of Lanice conchilega.

The Rev. G. A. Elrington described, in the pelagic larva of *Lanice conchilega*, a gland situated on the dorsal side of the œsophagus, and composed of a cluster of large pear-shaped cells, the thin ends of which converge to the orifice of the gland, which lies in the mid-dorsal line of the "neck" region. From its staining reactions it is evident that the gland is concerned in secreting the mucin of the gelatinous tube in which the larva is found enclosed. The gland, which is not present in the adult or in a young worm which was just beginning to form its sandy tube, is evidently a transitory structure, which persists only so long as the larva retains its transparent tube. In the pelagic larva there are three separate nephridia, there being no trace of the fusion characteristic of the nephridial apparatus of the adult.

Mr. Arnold T. Watson expressed the opinion that the gelatinous tube, in which the larva floats, not only serves as a protection, but is also the means of collecting food particles, which on being brought into contact with the outside of the tube adhere to it. In order to secure this food the larva from time to time partially emerges from one end of the tube and applies to its surface the ciliated groove which runs from end to end of its growing tentacles. Development of the organism is thus carried on to a stage further than would have been possible in the absence of solid food. By the time the animal settles down on the sea-bottom and begins to construct the membranous sand-covered tube inhabited by the adult, the mucus-secreting gland, being no longer required, disappears, and owing to its dorsal position does so without disturbing the formation of the permanent ventral glandular structures which produce the membranous basis of the tube of the adult.

The Development of Ophiothrix fragilis.

Prof. E. W. MacBride, F.R.S., described the early stages of development of this common British Ophiurid. Two sets of cultures were studied, the first obtained by fertilising the eggs artificially, the second by allowing the ripe male and female naturally to shed their reproductive products. In the first series, segmentation resulted in the formation of a morula, an invagination followed, and it then transpired that the interior cells were precociously formed mesenchyme. The cœlom appeared as a single vesicle at the apex of the gut. In the second series segmentation resulted in the formation of a thick-walled blastula, followed by a regular invagination. At the pole of the larva opposite the blastopore a great crest of vacuolated cells—serving as a float—was formed. (This crest was not seen in the larvæ of the first series.) The larva then assumed a triangular form, the cœlom appeared at the apex of the archenteron as a bilobed vesicle, and the crest slowly diminished in size. The cœlomic vesicle divided into right and left halves; of these, first the left, then the right, divided into anterior and posterior parts. Somewhat later, from the anterior portion of the vesicle of both sides a sac was budded off; that of the left side became five-lobed, and gave rise to the water-vascular system; that of the right side generally remained small, but sometimes also assumed the five-lobed form, showing that it is a rudimentary fellow of the water-vascular system. The larva of *Ophiothrix fragilis* affords final and convincing proof that the echinoderm larva possesses three somites, the middle one of which becomes, on the left side, the water-vascular system.

The differences in the early phases of development of the two series above described are probably attributable to the fact that the eggs withdrawn from the female and artificially fertilised were not quite ripe, and therefore not quite of the same chemical composition as those naturally shed. In certain features the development of the artificially fertilised eggs resembles that of *Ophiothrix brevis*, a species with shortened development, a fact which leads the author to ask if mutations may not be due to slight chemical differences in ova at the moment of fertilisation.

Sex in Crustacea, and the Nature of Hermaphroditism.

Mr. Geoffrey Smith's studies upon parasitic castration show that animals belonging to widely different phyla, but especially Crustacea, when attacked by various parasites, undergo an alteration in their sexual nature. At first the gonad in both sexes degenerates to a greater or less extent; the males assume in varying degrees the secondary sexual characters proper to the female, while those of the male practically disappear; the females, without assuming any male characters, suffer a certain amount of degeneration of the secondary characters, *e.g.* the ovigerous appendages. Finally, either on recovery from the parasite or during the degenerative process, the male may develop ova of large size in the testis, alongside mature spermatozoa. The females never produce spermatozoa in their ovaries. These results, which apply especially to the effects of the parasitic Rhizocephala upon the crabs they infect, show that hermaphroditism can be called forth by an external cause acting upon a sexually differentiated animal, and that it can only be called forth in the male, not in the female. A partial temporary hermaphroditism is assumed by other Crustacea (*e.g.* the crayfish, spider-crab, and Orchestia) at particular seasons when a period of growth, as opposed to one of reproduction, is being initiated. The conclusion that hermaphroditism is a property of the male sex, developed in response to altered conditions of metabolism, can be applied to this state as found normally in Cirripedes and parasitic Isopods, both of which lead a sessile, inactive existence when adult, and have their vegetative functions developed to a high degree. In the parasitic Isopods all the individuals are at first free-swimming males, which, on settling down to their parasitic life, develop the hitherto latent female part of their organisation. The presence in some Cirripedes of males which may degenerate completely, even in the larval stage, and other facts, suggest that all the individuals are primarily males and subsequently females.

Mr. F. A. Potts confirmed Mr. Smith's results from his study of the effects of Peltogaster on the hermit-crab, in which also the assumption of the character of the opposite sex is confined to the male. Especially interesting is the appearance, in parasitised males, of the tufts of hair modified for egg-bearing, and the testes in many cases contain ova.

Experiments on Seasonally Dimorphic Forms of African Lepidoptera.

Dr. F. A. Dixey stated that it is often found that the successive broods of Lepidoptera produced in the course of a year differ widely in appearance according to the meteorological conditions prevailing during their immature stages, the contrast being especially marked where there is a sharp distinction between the periods of rain and dry weather. Mr. Guy Marshall, working at Salisbury, in Mashonaland, has succeeded in showing that, by artificially varying the conditions to which the butterflies are exposed during their immature stages, it is possible to bring about in the midst of one season the emergence of a form which under natural conditions would only have been produced in the other. The period during which the animal is susceptible to climatic influences varies in different species, the critical stage being in some cases confined to the larval, in others to the pupal, condition. In one instance (*Belenois severina*) the effect of moisture combined with heat differs entirely from the effect of the former alone.

The Function of the Spiracles in Sharks and Rays.

Mr. A. D. Darbishire concludes that in the dog-fish water is drawn into the pharynx by way of the spiracles, and to some extent by the mouth, and is expelled through the gill clefts. In the skate the spiracles play a more important part, for when the animal is at rest all the water which enters the pharynx does so by way of the spiracles; none enters by the mouth. In *Rhina squatina* (the angel-fish) no movement of the spiracles is visible; there is a uniform current of water into the mouth and spiracles, and the water is driven out again through the gill slits by the undulations of the "gill covers."

The Systematic Position of Polypterus.

Mr. E. S. Goodrich pointed out that Polypterus and Calamoichthys, both from the rivers of tropical Africa, forming the order Polypterini, have no near relations among living fish. The presence of rhomboid ganoid scales, paired gular plates, a persistent spiracular gill cleft, true clavicles, a bilobed air-bladder, and a straight tail, form a combination unknown in any other order. Owing to their lobate pectoral fins, paired gulars, rhomboidal scales, outwardly diphycercal tail, and to a considerable resemblance in the disposition of the roofing cranial bones, Huxley (1861) placed the order Polypterini in the group Crossopterygii, in which it has been left by subsequent writers, associated with such extinct forms as Osteolepis and Holoptychius; but on comparing Polypterus with these fossils the resemblance is by no means close. The similarity in arrangement of the surface bones of the skull is only general, and such as may be found in most primitive Teleostomes. The scales of Polypterus and Osteolepis are of very different structure, those of the former being of the true ganoid type. The tail is not truly diphycercal, but of a modified heterocercal type, the notochord, in the young at any rate, being turned upwards (as shown by Budgett). In Actinopterygii there may occur a median ventral gular plate as well as two lateral series; two of the anterior plates of the lateral series may be more or less enlarged, as in Palæniscidæ; the paired plates of Polypterus may be the homologues of these plates of the Actinopterygii, and not of the more median plates of the Crossopterygii. The skeleton of the pelvic fin and girdle of Polypterus is much more actinopterygian than crossopterygian in structure. The resemblance of the fins of Polypterus to the lobate fins of the Crossopterygii was shown by Budgett to be superficial only. The relationship of Polypterus to the Actinopterygii is supported by a comparison of the structure of the scales and of the fins, by the presence of large solid otoliths in the ear, and the double nostrils on each side of the snout, while the brain, the alimentary canal with its pyloric cæcum, the kidneys and testes, the separate anus and urinogenital apertures, are also consistent with this view.

Colour Variations in the Skin of the Hamster.

Prof. Simroth (Leipzig) exhibited a series of skins of the hamster (*Cricetus frumentarius*), which is common in the cornfields of some parts of Germany, and especially in Thuringia. The usual coloration of the skin is grey along the back and black ventrally, these two being separated by a lateral reddish area, and there are three white or pale yellow patches at the sides of the head and breast. The skins, however, show great variations in coloration. In one series the red areas and then the white patches disappear, the upper side becomes grey, greyish-brown, and finally black, so that the whole skin is now black. In another series the under side becomes lighter, followed by a similar change on the upper side, leading finally to an albino, the rarest variation. The black specimens were first noticed during the hot summers some years ago. It is not yet clear whether these colour variations are to be attributed to climatic conditions or are atavistic.

Photographs of a Young Living Okapi.

Sir E. Ray Lankester, K.C.B., F.R.S., exhibited photographs of a living okapi taken by Signor Ribotti at Bambili, on the Welle River, in the Congo Free State. The animal is a young colt showing the striping of the upper part of the fore and hind legs and hind quarters, and the dark body colour, apparently as in the adult. It is worthy of note that this is the first time that a European has seen a living specimen of the okapi. Some doubt having been recently expressed as to whether okapi is the native name of the animal, Sir E. Ray Lankester remarked that he had shown the photographs and a portion of a skin to some of the African pygmies, now in London, who recognised them, and at once spoke of them under the name okapi.

Plankton Investigations off the Isle of Man.

Prof. Herdman gave an account of his plankton investigations off Port Erin during April. These were undertaken with the object of testing different kinds of open and closing tow-nets, and of gaining information regarding the detailed distribution of the organisms according to locality, depth, and date. Examples were given of very different results, quantitative and qualitative, obtained from quite similar nets hauled not far apart as regards both distance and time. Sudden variations in the vertical and horizontal distribution of the plankton were discussed, and the seasonal changes were also considered; obviously great care and much observation of the gatherings of organisms are required before these can be considered as adequate samples. Prof. Herdman concluded that our methods must be investigated before the attempt to investigate nature on a large scale can be made, and also that an intensive study of small, well-chosen areas is necessary before conclusions can be drawn with regard to relatively large regions such as the North Sea or the Atlantic Ocean.

Mr. W. E. Collinge traced the rise, and pleaded for the due recognition, of economic biology; Prof. Simroth gave an account of his pendulation theory in relation to geographical distribution; Mr. J. W. Jenkinson described his further experiments on the development of the frog; Mr. T. V. Hodgson pointed out the principal features of interest in the collections of Pycnogonids from several Antarctic expeditions; and Prof. R. J. Anderson detailed his observations on the thickness of the skull in Mammalia; but these papers cannot be well summarised in the space here available. J. H. ASHWORTH.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE physiological section has for several years devoted one morning to some subject of general interest. This policy was inaugurated at Cape Town by the discussion on the effect of climate upon health; it was followed up at York by one on the physiological minimum of rest for children, opened by Dr. T. D. Acland; and this year at Leicester by one on the physiological and therapeutical value of alcohol. The interest which this subject has aroused of late made it a particularly appropriate one, more especially as the matter has not been recently discussed in at all a dispassionate way. From this point of view the meeting at Leicester was all that could be desired, and perhaps the most remarkable feature in connection with it was the very narrow margin which separated those who took different views as to the value of alcohol.

The discussion was opened by Prof. Cushny, F.R.S., who reviewed the effect of alcohol on the various systems of the body, alluding especially to its very doubtful effect as a stimulant to the alimentary system, its effects upon the circulation, especially the heart, as recently worked out by Prof. Dixon, and its action upon the muscular nervous system and on the power of the body to resist toxic agents. In doing so he introduced some of the subsequent speakers. Dr. Rivers gave an extremely interesting account of the use of the ergograph in obtaining records of the effect of alcohol. It was very remarkable to see how great was the psychical element in ergograph tracings; this, indeed, was so marked that much the same effect could be obtained by giving a dose of alcohol and one which the patient thought was alcohol, or even one which merely excited his curiosity. Dr. Rivers has been able, in conjunction with Prof. Dixon, to administer considerable doses of alcohol in forms which were not recognisable, and in doing so he has found no certain beneficial effect on the power of performing muscular work. Some curves shown by Dr. Waller, F.R.S., were quite in harmony with this view. These results admittedly supported the contention put forward by Sir Victor Horsley, F.R.S., and Miss Sturge, that the ergograph gave results which were as yet too uncertain to yield a verdict which could be considered as final.

On one point there was unanimity, namely, that alcohol even in the smallest quantities was deleterious to the quality of mental work. This was insisted upon, not only by Sir Victor Horsley, but by Prof. Dixon, who took a much more optimistic view of the value of alcohol. Prof. Dixon especially considered it valuable in cases of cardiac collapse, on account of the readiness with which it appears to be absorbed and assimilated.

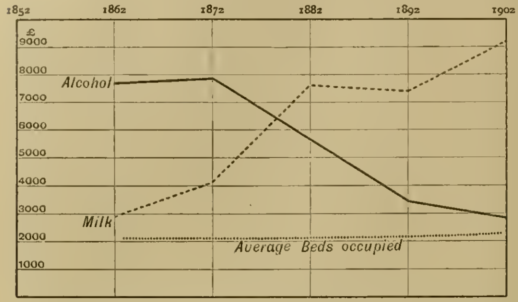

FIG. 1.—Diagram showing the gradual diminution during the past forty years in the administration of alcohol and the increase in the use of milk during the same period. The figures are summarised from the statistics of seven large London hospitals.

From the point of view of the use of alcohol in the treatment of disease, Sir Victor Horsley showed curves (Figs. 1 and 2) illustrating the departure from alcohol which has taken place in the last decade, not only in hospitals generally, but in hospitals for the treatment of fevers—a class of complaints in which alcohol was previously supposed to be especially beneficial.

Still dealing with the relation of alcohol to disease, Dr. Reid Hunt gave an account of the interesting experiments that he has been conducting which point conclusively to the fact that alcohol lowers the power of resistance of the body to a certain specific toxic body, acetonitryl.

Two points remain, the dose of alcohol which may be regarded as harmless, and the much-debated question of whether alcohol is a food. These points are closely connected. The impression left on the mind at the end of the discussion was that whether alcohol is or is not a food is largely a matter of definition. It seems certain, on the one hand, that it is oxidised in the body, yielding a corresponding amount of energy—in this sense it is a food. Such a definition includes many substances—morphia, for instance—which are clearly injurious. If alcohol is not only a "food" but "a useful food," it must be shown that it can be taken without injury to the organism in sufficient quantities to supply an appreciable proportion of the energy of the body. This has not yet been done.

Tuesday, August 6, was devoted to a discussion upon a much more technical subject, the value of perfusions. This was introduced by Prof. Schäfer, F.R.S., who gave an exact account of the best methods for perfusing the heart and the kidney. Others who took part in the discussion were Prof. Cushny, Dr. Alcock, Prof. Zuntz, and Mr. Barcroft. Perfusion has become so important a method in physiological and pharmacological research that some authoritative statement of its limitations would be useful. At present this may be approached in two ways: (1) by a discussion of the best fluids for the purpose, and here we may mention the work recently done at Oxford by Dr. Vernon, who advocated the addition of albumin to Ringer's solution; and (2) by an inquiry into the organs which seem to react most readily, when perfused, to the stimuli which normally produce functional activity. Along this line Mr. Barcroft tentatively put forward the thesis that those organs the coefficient of oxidation of which is lowest stand perfusion much better than others. Thus the heart and muscle react well when perfused, whilst the glandular structures appear incapable of full functional activity when irrigated with an artificial blood supply. Such a tissue as unstriated muscle, which probably has a lower coefficient of oxidation than any of the organs mentioned, will retain a considerable degree of functional activity if it be merely suspended in warm saline solution.

A very interesting discussion followed upon the presidential address. We need not further allude to the address itself, as it has already appeared in the columns of NATURE, than to say that the president's main thesis was that every practitioner should be trained in the quantitative administration of chloroform in surgical cases with an apparatus which delivered air containing a known percentage of the anæsthetic to the patient.

This view was very warmly supported by Sir Victor Horsley and Dr. Vernon Harcourt. Dr. Frederick Hewitt pointed out the difficulties which attended the administration of chloroform in this way, which consisted partly in the impracticability of having apparatus at hand in a great number of cases, and the difficulty in using them in cases where there was great personal idiosyncrasy in the patients. Prof. Waller made it clear, however, in a few words at the end that a person who had been instructed in quantitative ideas as to the administration of chloroform was in a better, not a worse, position to administer it without apparatus if need be, than the man who had only a rule-of-thumb knowledge. This view

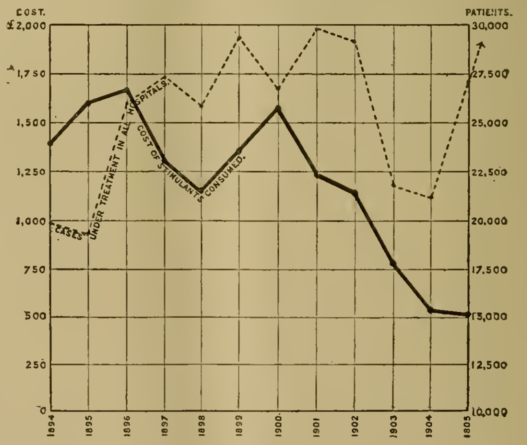

FIG. 2.—Metropolitan Asylum's Board Statistics. Diagram showing the fall in the administration of alcohol to fever patients during the years 1894 to 1905. The dotted line shows the number of patients beginning in 1894 with 20,000. The continuous black line shows the amount of money expended on alcohol beginning in 1894 with 1388*l.*, and falling to 515*l.* in 1905, although the number of patients in the hospitals that year was 27,162.

fairly represented that of the meeting, and it was supported by Prof. Schäfer, F.R.S., Prof. Gotch, F.R.S., and others.

The individual papers were perhaps fewer than is usually the case. Prof. Sherrington, F.R.S., added another to the series of communications on the coordination of reflex muscular movements in the spinal animal which has added so much to the interest of the British Association meetings in the last few years. Very beautiful examples were shown of graded reflex movements which took place in response to graded stimuli. His experiments throw a good deal of light upon the action of strychnine. This drug appears to cause an exaggeration of the rebound which takes place normally after reflex inhibition. The inhibition may be re-established by giving chloroform. Two practical points were brought out:—(1) that in many cases the physiological units of musculature do not correspond to the anatomical ones; and (2) that there is a portion of the gluteus maximus muscle which does not respond either to ordinary reflex stimulation or to strychnine.

Papers on the physiology of nerve were read by Dr. Alcock and Prof. Macdonald. Interesting in themselves, these communications were rendered doubly so by the fact that their writers take a diametrically opposite view of the nature of the nervous impulse.

Three reports were presented by committees; they dealt, respectively, with the metabolic balance sheet of the individual tissues, the ductless glands, and the effect of climate upon health. Their work evoked more interest than usual. The afternoon was spent in discussing the report of the committee of which Sir Lauder Brunton is chairman, and which is a very strong one. It has worked very hard in its efforts to produce a schedule for the collection of the necessary data for the comparison of the climatic conditions of various localities with the diseases which are prevalent in them. Along another line the committee has been greatly strengthened by the active interest of Prof. Zuntz, who came over to Leicester and gave an account of the work which is now being inaugurated in Berlin.

Prof. Zuntz is continuing the work which he and his collaborators carried on in the high Alps, and at the present time two travellers, Drs. Schilling and Jaffé, are making a corresponding set of observations upon themselves in Togo. It will be of great interest to compare the effects of hot climate with the positive results which were obtained upon the high Alps.

J. BARCROFT.

THE KINGSTON EARTHQUAKE.

THE official report on the Kingston earthquake, of January 14 last, by Mr. Maxwell Hall, contains, in addition to the customary compilation of accounts of time, duration and violence of the shock, some interesting records of the peculiar behaviour of the sea on the north coast of the island. At Annotto Bay and Port Maria the sea receded, about three or four minutes before the shock at Port Maria, at about the same time after it according to the account from Annotto Bay, the amount of the recession being equivalent to a vertical fall of from 12 feet to 20 feet; after the shock the sea returned in a wave which swept up the shore to 6 feet or 8 feet above its normal level. This phenomenon was only recorded at the two localities mentioned, a fact which points to its being probably due to movement of the land rather than to a sea wave. At the Kempshot Observatory, St. James, the masonry pier of the transit instrument, resting on solid rock, was found to have been disturbed, so that the west end of the axis was 32″ higher than the east end. In Kingston Harbour subsidence of the land was noticed along the shore-line, of more than 24 feet in places, but this appears to have been due to the shaking down of loose accumulations of recent deposits, as there is no indication of a permanent change of level in the centre of the harbour or on land except near the shore-line.

Beside the official report, we have received from Prof. Carmody, of Trinidad, a series of photographs taken in Kingston on the second and third day after the earthquake. Two of these are reproduced, which show the character of the damage done; this was greatest in the case of walls facing east, those facing north or south being generally uninjured. A noteworthy peculiarity was the fact that arched openings seem to have withstood the shock while

FIG. 1.—Railway station wall facing south.

the rest of the wall was destroyed; as there is no form of construction less suited than the arch to withstand the strains set up by an earthquake shock, this can only be

FIG. 2.—Typical north and south narrow street.

ascribed to the badness of material used for building, the arches having stood owing to the necessity for using better material and more skilled workmanship in their construction.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BY the will of the late Mr. A. H. Blount, lord of the manor of Orleton, Hereford, who died in London on June 17, Yale University will receive a bequest the value of which, after payment of duties, &c., will amount to about 80,000*l*.

THE new session of Birkbeck College, London, will be opened on Monday, September 30, when an address will be given by Mr. G. G. Chisholm. The laboratories will afterwards be open to inspection, and demonstrations will be given. There will be an annual exhibition of students' works on Friday, Saturday, and Monday, September 27, 28, and 30.

THE Department of Agriculture and Technical Instruction for Ireland will, next month, award not more than three commercial scholarships to young men having a sound general education and some commercial experience. The object of the scholarships is to afford facilities for the holders obtaining training in some higher institution, approved by the department, with a view to their employment as teachers of commercial subjects in Ireland. The scholarships are of the value of 100*l.* each, and are tenable for two years. Candidates must have been at least twenty-one years of age on September 1, and must fill in and return a certain form to the secretary of the department not later than September 25. The department also proposes to award three industrial scholarships to persons engaged in industries, such as the woollen, linen, leather, and tanning industries. The scholarships will be of the value of 80*l.* each, and may be renewed for a second or a third year at the discretion of the department.

The new buildings in Queen's College, Belfast, which are to be formally opened by Lord Kelvin on September 20, are for the purpose of affording increased accommodation in the departments of chemistry, physics, engineering, natural history and geology, physiology, pathology, medicine, and surgery. The chemical buildings are now completed by the erection of a large lecture room, a lecture preparation room, and a museum for chemical specimens. In physics there are new elementary and advanced laboratories, and in engineering a laboratory, a lecture room, and a drawing office. The additions to the natural history and geological departments include a laboratory for elementary classes in biology, a laboratory for geology and mineralogy, and rooms for advanced classes and private research in zoology and botany. The physiological department has been provided with three new laboratories, viz. for histology, chemical physiology, and experimental work, and the pathological department with private research rooms for the professor and his assistant, and a laboratory for advanced classes in bacteriology. The medical buildings have been extended by the addition of a class room, &c., specially designed for operative surgery. The cost of these extensions has been defrayed by private donations, with the assistance of a Government grant.

A medical department of the Board of Education has been established to advise and assist in the discharge of the new duties imposed on the Board by the Education (Administrative Provisions) Act in regard to the medical inspection of school children which local education authorities are required by that Act to carry out in England and Wales. The chief duties of the Board in this direction will consist in advising and supervising local education authorities as to the manner and degree in which those authorities carry out this medical inspection; in giving such directions as may be necessary regarding the frequency and method of such inspection in particular areas; and in considering and sanctioning such arrangements as may be proposed under the Act by individual authorities for attending to the health and physical condition of the children. The organisation and *personnel* of the Board's medical department are not yet fully determined; as a first step Dr. George Newman has been appointed chief medical officer of the Board. Dr. Alfred Eichholz, who has for nine years been on the Board's staff as medical inspector of schools, will also be appointed to the medical department, and further appointments will be made in due course. The Board intends in the autumn to issue a circular to local education authorities regarding their new duties in the matter of medical inspection of school children.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 9.—M. Henri Becquerel in the chair.—The contact phenomena of phonolitic trachyte from Griounot, Cantal: A. **Lacroix.**—Bi-secondary butylene chlorohydrin: Louis **Henry.** The secondary butyl alcohol, CH_3—CH_2—CH(OH)—CH_3, was prepared synthetically from ethylmagnesium bromide and aldehyde; this was converted into the secondary iodide, and from this, by the action of alcoholic potash, symmetrical dimethylethylene was prepared. The chlorohydrin results from the interaction of this hydrocarbon and hypochlorous acid. Its physical properties are given.—The resistance of the air: M. **Jouguet.**—Contribution to the study of the alloys of cobalt and tin: F. **Ducelliez.** The present note deals with alloys containing between 57 per cent. and 66 per cent. of tin. The alloys are probably formed of a mixture of CoSn and Co_3Sn_2.—Celestite from Mokattam: M. **Couyat.**—Parasitic phanerogamic plants and nitrates: Marcel **Mirande.** Parasitic phanerogams without chlorophyll cannot absorb nitrates from their hosts. The green hemiparasites vary, some being capable of absorbing nitrates from the host, others not.—Variation in the ramification of umbels: H. **Ricôme.**—The causes of the death of the young hippopotamus of the museum menagerie: E. L. **Trouessart.** The animal died from injuries to the head caused by the mother in repelling the young hippopotamus from the breast.—The culture of the turbot: R. **Anthony.**—The subterranean waters of the Basque country: E. A. **Martel.**

New South Wales.

Linnean Society, July 31.—Mr. A. H. Lucas, president, in the chair.—The geology of Newbridge, near Bathurst, N.S.W.: W. Noel **Benson.**—Revision of the Australian species of the genus Anthobosca (Hymenoptera: fam. Scoliidæ), with descriptions of new species: R. E. **Turner.** By careful comparison with exotic species in the British Museum collection, the author has convinced himself that the insects classed in the genus Anthobosca are the male sex of the insects usually known in Australia as Dimorphoptera (Sm.).—The Mollusca of the Mast Head Reef, Capricorn Group, Queensland, part ii.: C. **Hedley.** This part enumerates the Gastropoda collected on and around Mast Head. Thirty-seven new species are described and figured. The geographical range of shells previously only noted on the one part from Torres Strait, on the other from the neighbourhood of Sydney, is greatly enlarged. Altogether, two hundred and two mollusca are added to the known fauna of Queensland.

CONTENTS.

THURSDAY, SEPTEMBER 26, 1907.

THE GEOLOGICAL SOCIETY OF LONDON.

The History of the Geological Society of London. By H. B. Woodward. Pp. xx+336; illustrated. (London: The Geological Society, 1907.) Price 7*s.* 6*d.* (to Fellows, 6*s.*).

The history of the Geological Society of London is rich in interest and instruction, as the society is unique in the extent of its influence on the science it was founded to promote. Geology had no chance of a satisfactory beginning, because of its immediate discovery of evidence inconsistent with the Mosaic account of Creation and the universality of Noah's deluge. Thus geology was driven at once into cosmogony, and started where it should have ended, and its immediate encroachment on the domain of dogma involved religious controversies that were not only tiresome, but demoralising. Classical and mediæval literature both contain some true descriptions of geological phenomena, but such observations were too occasional to influence the general trend of thought. The men who wrote the first general geological treatises, from Burnet's "Sacred Theory of the Earth" to Townsend, were essentially theologians, who failed owing to their application of spiritual laws to the natural world. The pioneers of geology were not free to choose their own ground and work on it at leisure; it was their misfortune rather than their fault that their views were often the illogical offspring of observations distorted by a cosmogonic squint. "A well-educated geognost" (a term then used as synonymous with geologist), according to Bakewell in 1813, "has lost the use of his own eyes."

This method did not suit the British mind, which, in the domain of natural science, preferred facts that could be verified by observation to the uncertain products of speculation. Mephistopheles, in Goethe's *Faust*, speaking as the evil genius of Continental science, sneers at the British respect for first-hand facts:—

> "Are Britons here? They travel far to trace
> Renowned battlefields and waterfalls."

The founders of British geology believed, above all things, in such field work, and most of them were interested in economic geology and were quite indifferent to cosmogony. Their studies were devoted to the distribution of soils, as by Lister in 1684, and the agricultural surveys begun by the Board of Agriculture in 1794; or to mining geology, such as the papers of Strachey of 1719 and 1725; while William Smith, engineer and surveyor, deplored "that the theory of geology was in possession of one class of men, the practice in another." Applied geology was, however, then of no general interest, and the science was judged by its contributions to cosmogony. It was prejudiced, according to Lyell, by "the imputation of being a dangerous, or at best but a visionary pursuit"; and it was the mission of the Geological Society to reform the methods of geological work so as to remove any justification for this reputation. Its founders were full of contempt for the vain wranglings between Neptunists and Plutonists, between naturalists and theologians, and it was their ambition to direct geological inquiry into useful channels and secure a foundation of positive knowledge, on which at some future date a geological system could be firmly based. This policy was proclaimed in 1811, when the society adopted as its motto a passage from Bacon, which recommended toil instead of talk. Its loyalty to this principle was remarked by Fitton in 1817, who, in an account of the society's transactions in the *Edinburgh Review*, said that they were limited to the record of "strict experiment or observation, at the expense of all hypothesis, or even of moderate theoretical speculation." According to Lyell, in 1832, the ideal of the founders was "to multiply and record observations, and patiently await the result at some future period . . .; and it was their favourite maxim that the time was not yet come for a general system of geology, but that all must be content for many years to be exclusively engaged in furnishing materials for future generalisations"; and he claimed for the society the credit of brilliant success as the reward of its consistency to that principle.

The Geological Society had two English predecessors, the Askesian Society and the British Mineralogical Society, founded respectively in 1796 and 1799, and amalgamated in 1806. The Geological Society dates from November 13, 1807, when a party of eleven men dining at the Freemasons' Tavern, according to one version (the diary of Wm. Allen), "instituted a Geological Society"; but according to another (a letter by Sir H. Davy) they established "a little talking Geological Dining Club." This misunderstanding led to conflict between those who held that the society should be a mere social dining club and should not encroach on the domain of the Royal Society by publication of important scientific work, and those who intended that the society should raise the status and advance the knowledge of geology by a strenuous, progressive policy. Scientific London had to face this problem, Is it better for each science to have its own society, or for all of them to unite into one great institution? Some of the leaders of the Royal Society thought that the inevitable competition and overlap between independent societies would be injurious; they proposed that the Geological Society should become a branch of the Royal Society, which was to have the right to publish in the Philosophical Transactions any papers it cared to select from those read before the Geological Society. The geologists, however, considered that scientific progress could be best be secured by independent societies working in friendly alliance. Their rejection of the federal policy was probably the wisest course, but it cost them the fellowship of Sir Joseph Banks and Sir Humphry Davy, who resigned as a protest against the alleged trespass on the sphere of the Royal Society.

The dinner, though part of the original plan, appears to have been always of secondary importance, and was soon abandoned to an independent geological dining club. The early meetings, however, consisted of dinner at 5 p.m., the reading of papers from seven to nine, after which often followed an informal assembly, wherein, soothed by smoke and stimulated by wine, discussion was prolonged until after midnight.

The Geological Society quickly justified its independence by raising the standard of scientific publication. It issued its Transactions on a scale of magnificence which the society makes no attempt to maintain. They were one of the finest scientific serials of their day, and the style in which the Government now issues the memoirs of our national Geological Survey is beggarly in comparison. The extravagance in illustration was possible owing to the lavish generosity of the members. Many of them were wealthy men, and they freely spent their money in promoting the objects of the society. Thus Warburton advanced 1000*l.* towards the preparation of Greenough's "Geological Map of England," and some of the members contributed an equal sum towards its publication. Most of the founders and early leaders of the society were men of distinction and influence; they were peers, members of Parliament, city merchants, and men of that professional class of which London is preeminently the home. According to Leonard Horner, the council of the society elected in 1816 "was a Council fit to govern the world."

The young society was at first exclusive, and did not represent the whole of British geology. It elected forty-two honorary members, but the list did not include William Smith. This strange omission is not clearly explained by the author, who hints that it may have been due to social prejudice. Possibly it was partly due to the fact that William Smith, in spite of the immense theoretical value of his work, was essentially an economic geologist, and he, like the two other prominent workers at applied geology, Farey and Bakewell, did not join the society. They may have regarded it as too academic, and the society may have regarded them as too commercial. On the other hand, Robert Jameson kept aloof because the society despised his high soaring flights. He was elected an honorary member in December, 1807, but that was before the publication of his "Elements of Geognosy," of which the preface is dated "The College, Edinburgh, January, 1808"; if this work, a statement of Wernerian geology, had been published a few months before, it should have cost him his honorary membership. His election did not apparently affect him, for he promptly founded the Wernerian Natural History Society at Edinburgh in 1808, perhaps in order to combat the grovelling geologists of London, and he does not appear ever to have joined the London society or taken any part in its proceedings. Was it ignorance or irony that led to the selection of the society as trustee of the Jameson fund, established to commemorate its greatest British protagonist?

The early exclusiveness of the society was due to its enthusiasm as well as to its defined policy. The election of new members had to be unanimous; absence from meetings was to be punished by fines; and no one could attend more than twice as a visitor. Although the society was also a dining club, its first ordinances were animated by the severe zeal of a star-chamber. The members were delightfully confident of their mission; according to the first constitution "all questions on which difference of opinion may arise shall be determined by ballot at the next ordinary meeting," and according to the author (p. 23) this rule appears to have been intended for the summary settlement of geological problems, and not of the society's business. But the society was too successful for such regulations, which were burst by the rapid growth in its roll of membership and the immense influence of its scientific achievements.

All this early history of the society and a summary of its work is now accessible in Mr. H. B. Woodward's monograph, which has been prepared for the centenary meeting to be held on September 26 to 28. The council is to be congratulated on having entrusted the work to an author who has an unrivalled knowledge of the literature of British stratigraphical geology, and is possessor of a rich store of traditional personal information. Mr. H. B. Woodward has been aided by many helpers. Amongst others, Sir Archibald Geikie and Prof. Bonney have read the proofs, Mr. Monckton has contributed an account of the medals, Mr. Herries has edited the reprint of the charter, and Prof. Garwood has arranged the excellent series of photographs. The author has compressed into 336 pages of fairly open print a condensed account of the work of the society, a guide to the available materials as to its history, summaries of the lives of the founders and chief early members, and instructive reprints or summaries of important discussions, one of which shows the reception accorded to Buckland's announcement of the former glaciation of the British Isles. Numerous appendices give lists of early fellows, of the presidents and the subjects of their annual addresses, of the council, the officers and officials, the awards of medals and funds, and reprint of the charter. The information is condensed, but apart from the appendices it is never dull; it is enlivened by racy stories and witty epigrams; the materials have been wisely selected, and presented with Mr. Woodward's usual literary skill.

The author's personality comes out in selection rather than in comment. He is perhaps too discreet, for he hints at explanations where a definite statement of his opinion would have been valuable. The course of the society has not always run smooth, and it is interesting to find that some of the modern criticisms are similar to those made at intervals through its life. A society with a strong policy and a definite ideal cannot expect unanimous approval, and its traditions have always been radical. It secured on incorporation an unusually liberal charter, and it has repeatedly been the pioneer in important reforms. Amongst other innovations was the admission of women to the meetings in 1860, an experiment abandoned, however, in 1863.

Mr. H. B. Woodward's history is worthy of its subject. He naturally devotes most attention to British stratigraphy, but one chapter might perhaps have been devoted to the society's contributions to foreign geology, so many of which are of first-class importance.

The author is gently sarcastic regarding the nomenclature of some modern palæontology published by the society. The artificial Linnean system was adequate for the biology of the eighteenth century, which was innocent of such principles as "heterogenetic homogeneity." The plastic terminology that is in process of development in correspondence with the variability of life has lost in simplicity, while it has gained in truth. Scientific names, like other words, must be allowed to change in meaning, even though the change may puzzle geologists as much as a lawyer is puzzled to define such common terms as mine or mineral. The author notes with apparent regret that a fossil should be called a "konincko-phyllid cyathophyllum"; but the Geological Society would be untrue to its inspiring traditions if it closed its journal to those whose living faith in evolution is much more than a mere verbal creed, and must be expected to influence all their practice. J. W. G.

ANCIENT BABYLONIAN LETTERS.

Late Babylonian Letters. By R. Campbell Thompson. Pp. xxxvi+226. (London: Luzac and Co., 1906.) Price 15*s.* net.

OF all the ancient written matter that has been discovered by modern archæological research and deciphered by the professors of languages long dead, perhaps the documents most interesting to the general reader are those which reveal to us the daily life of the people who wrote them thousands of years ago. These "human documents" are always interesting reading. Royal instructions, reports of generals or of astrologers, ministers or caravan-leaders, diplomatic correspondence, and last, but not least, the ordinary letters from one man to another, whether anent business or pleasure, have been during the last half-century recovered from the past, and are now supplementing in a most remarkable way the formal annals of the historians. From Egypt we have the famous "Tell el-Amarna Letters" of 1400 B.C., the correspondence of the time of the priest-kings (1000 B.C.) published by Spiegelberg, and the interesting series of Greek letters recovered from the sands of Oxyrrhynchus by Drs. Grenfell and Hunt, not to speak of the Coptic epistles of the monks of Deir el-Bahari in the seventh century A.D., translated by Crum and by Hall. From far Turkestan we have the wooden tablets inscribed in Kharoshthi characters, discovered by Dr. M. A. Stein, which tell us of the daily life of the Indian kingdom of Khotan in the flourishing days of Buddhism; and now Mr. R. C. Thompson (late of the British Museum), of the University of Chicago, has published an edition of a series of late Babylonian letters, being "transliterations and translations of a series of letters written in Babylonian cuneiform, chiefly during the reigns of Nabonidus, Cyrus, Cambyses, and Darius," *i.e.* from about 550 to 480 B.C. These letters are preserved in the British Museum, and the original cuneiform texts have been published by the Trustees.

The book is published by Messrs. Luzac and Co. in their admirably got-up "Semitic Text and Translation Series." Print, paper, and binding are good and appropriate. As a frontispiece Mr. Thompson gives an adaptation (with English text instead of Babylonian) of a remarkable Babylonian map of the world, which we recommend to the attention of Mr. Beazley for comparison with other ancient maps. We do not believe, by the way, that this map, with its restricted knowledge, really represents the world as known to the Babylonians of the sixth century B.C. It is obviously a copy of a far more ancient map, dating from the days when the Babylonian knew of but little beyond the limits of his own fens, which he conceived as an island surrounded by the waters of the Persian Gulf.

The perusal of these letters will be useful to the modern historian who is not content merely to recapitulate the annals of his ancient *confrères*, but wishes to give a picture of the civilisation of an ancient people. With the exception of an occasional royal epistle, such as the very interesting one of Ashurbanipal (No. 1, a century older than the rest) ordering the collection of tablets for the royal library at Nineveh, now in its entirety preserved on the shelves of the British Museum, these letters were written by the ordinary Babylonian "man in the street," the ordinary middle-class inhabitant of Babylon, and his wife. For the ladies of Babylon were as busy with the stilus as those of London are with the pen, and many of Mr. Thompson's collection were written by women. They relate to the usual round of life of a civilised people as led in an Oriental country. The letters of the modern inhabitants of Cairo, Baghdad, Lahore or Delhi must be very like them. Perhaps at Benares, rather, we might get their very counterparts. For in Babylonia, as in modern India, the temples of the gods and the business of the priests were a great factor in the city life, and a large proportion of these letters "is connected with the business of the great temple of the Sun-god at Sippar," with the landed property belonging to the temple, from which the priests drew their revenues, and with the arrangements for the temple-dues, which were often paid in kind. This is an ancient touch, which we should only find paralleled now in India and the Far East. An Oriental trait is the correspondence with regard to the transport of food, goods, materials for building, &c., by beasts. The back of a beast of burden was then, as now in the same country, the only means of transport. Babylonia has not progressed a step in the direction of the improvement of transport since the days when these letters were written; and the completion of the Baghdad Railway seems still far off!

Of the ordinary letters between man and man on matters of interest only to themselves Mr. Thompson gives many specimens. Travellers in a far country write to their friends asking for news, and upbraiding their faithless correspondents, for then, as now, "one had not time to write." Husbands indite model epistles to their wives, like one, highly commended by the editor, which reads :—

"By the grace of the gods I am well, as also is Bêl-iddin. See, I am sending a letter to Iddina-

Marduk, the son of Ikiša-apli, that he may give thee the *gur* of wheat. Be not remiss in the housework, but be careful; pray the gods on my behalf, and speedily let me have news of thee by the hand of some traveller."

And so forth. In conclusion, we may congratulate Mr. Thompson on his interesting book, and, for the necessary *amari aliquid*, warn him against indulging in rather too breezy translations, such as "Why, an't please thee, have I and my daughters to pass the time in thirst for a letter from thee? Rack thy brains (for an excuse and then) by Šamas, see why Bêl-uballit, an't please thee, hath taken away all my dates" (p. 175). Elsewhere (p. xxxii) Mr. Thompson presents an even more alarming version of the same epistle:—"Why, pray, am I and my daughters to pass the time thirsting for a letter from thee? Now, gather thy wits together, and then, by Šamaš, observe! Why, pray, hath Bêl-uballit taken away all my dates?" This style of translation is hardly sufficiently dignified, and is to be avoided. The lady Gagâ, who writes the letter to her father, was no doubt a very energetic female, but Mr. Thompson's version of her filial exhortation seems to us to be rather too energetic. The index and vocabulary at the end are very complete and useful.

PSYCHOLOGICAL SCIENCE.

Psychology—General Introduction. By Dr. C. H. Judd. Pp. xii+389. (New York: Charles Scrib-Price 7s. 6d. net.

The Major Symptoms of Hysteria. By Dr. Pierre Janet. Pp. x+345. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1907.) Price 7s. 6d. net.

THESE two books furnish yet one more proof—if further proof were needed at the present day—of the right of psychology to a place among the primary sciences. In Prof. Judd's book we have a concise and well-synthesised statement of the methods and principles of the science, in the form of a general introductory text-book; Dr. Pierre Janet shows the exclusive importance of those principles in the diagnosis and cure of a widespread disease.

Prof. Judd leaves his readers in no doubt as to his general standpoint or the guiding idea of his book. He develops his subject along the lines of "function" in contradistinction to "structure," and "objectivity" as opposed to the "subjectivity" of mere introspection, laying great stress throughout on "organisation" as the general explanation of mental products. In a well-worded preface he attempts to anticipate criticism by summarising the general principles of treatment which he has followed. Briefly they are: (1) "A functional view of mental life"; (2) the genetic method; (3) a coordination of physiological and psychological data; (4) an endeavour to make clear "the significance of ideation as a unique and final stage of evolution." These principles he follows faithfully in his book, the marked "objectivity" of treatment almost amounting to materialism in the earlier pages. Analysis of material conditions takes precedence of, and to a great extent supplants, introspective description of mental states; moreover, the absence of any definite discussion of the general relation of mind and matter tends to intensify this impression of materialism. But if such an illusion should arise in the reader's mind it is quickly dispelled by later chapters, more particularly by the chapter on "The Concept of the Self." The nature of this concept as ultimate and supreme for psychology, though admitting of a developmental history, is very well brought out. The chapter following this, on "Voluntary Choice," is rather disappointing.

Parts of the book are of outstanding excellence. The discussion of space-perception seems to the writer an ideal of what a treatment of this difficult subject should be The chapter headed "Experience and Expression" is also very good. It brings out well the importance of motor factors to the general structure of experience, not in the form of muscular *sensations*, as the first imperfect statements of the theory would have had one believe, but as forms of "motor organisation" in the central nervous system. In this chapter we have developed in greater fulness that central idea of organisation which dominates the whole book.

Two small points call for criticism. First on p. 97, to explain contrast effects as merely after-effects in the retina is surely a case of over-simplification. Undoubtedly the two classes of phenomena are closely connected, but the relation is more complicated than the text would have the reader believe. Secondly, what is called the Principle of Fusion (Association) on p. 223 should not be dismissed as self-evident and requiring no explanation.

On the whole, the book is an excellent treatment of the general principles of psychology, and may be confidently recommended to all earnest students of the science. It is a book that should be read more than once. On the title-page it is described as the first volume of "a series of text-books designed to introduce the student to the methods and principles of scientific psychology." We can only say that our experience of this volume encourages us to look forward with eagerness to the publication of the later volumes of the series.

Dr. Pierre Janet's book is a collection of fifteen lectures given in the medical school of Harvard University towards the end of last year. Much of the material, cases and explanations alike, is taken from previous publications of the author, as, *e.g.*, "Névroses et Idées fixes," "L'état mental des Hystériques," &c., but the form of exposition makes of it an independent scientific and literary achievement for which all who are interested in mental diseases will be thankful to its author. Prof. Janet is admittedly supreme in the domain of pathological psychology, and the present book will do still more to confirm that estimate of his position. His statement of the major symptoms of hysteria is no mere external classification. Taking somnambulism as the typical form of hysterical accidents, he shows with copious illustration and acute argument how such symptoms shade off into fugues, double personalities, convulsive attacks, contractures, paralysis, anæsthesias, &c., while exhibiting the same essential relations in all these various forms. By the time lecture xiii. is reached, the evidence is overwhelming as to the extent of hysterical symptoms and the ground of their relationship to one another. "Dissociation" and "suggestibility" are the words employed to describe the underlying mental state, and their exact meanings are very carefully and thoroughly worked out. The final outcome is a definition of hysteria, an enumeration of its direct and indirect stigmata, and incidentally a theory as to the nature of personal synthesis, with which this disease is so closely connected.

To medical practitioners and psychologists alike the work should be of supreme value. W. B.

THEORY AND PRACTICE OF LUBRICATION.

Lubrication and Lubricants. A Treatise on the Theory and Practice of Lubrication, and on the Nature, Properties, and Testing of Lubricants. By Leonard Archbutt and R. Mountford Deeley. Second edition, thoroughly revised and enlarged. Pp. xxxii+528. (London: C. Griffin and Co., Ltd., 1907.) Price 21s. net.

THIS work may be divided into two parts, which, in fact, have little connection with one another. The first is that which deals with the chemical and physical properties of lubricants generally, and will appeal more particularly to analytical chemists, to whom samples of lubricants are submitted for the purpose of estimating their commercial value. So far as one can judge, this part of the work is particularly clear; full directions are given for carrying out any of the tests, in order to obtain such things as the free acids. This will, however, hardly appeal to the average user of lubricants, as what he requires is some simple mechanical test which will, more or less, indicate the value of the oil. The second portion of the work deals with the mechanical testing of oil, and also the design and construction of bearings generally, together with the general theory of friction, as given in chapter iv. This is particularly well written, and gives the full theory of lubrication as developed by Osborne Reynolds, Goodman, and Towers, and will repay a careful study. An account is given of the various oil-testing machines as designed by Thurstan, Smith, and Goodman. Judging from our own experience, while these machines when extremely carefully handled give trustworthy results, one is never quite certain as to what is really being obtained; whether it is a test of the lubrication itself, of the materials forming the bearing, or of the condition of the bearing. We should be inclined to say that it would probably be a small part of each, and, moreover, it does not give much idea as to the value of the lubricant for continuous use, which is now the rule for engine work generally. Doubtless, owing to the great length of the book, some 500 pages, the authors have been unable to devote a large space to the design and lubrication of bearings, although they give much useful information as to the composition of bearing metals generally, and also the admissible loads. They do not, however, give the attention to forced lubrication which we consider it deserves. The whole tendency of modern engine practice, either with enclosed or open engines, is to substitute pressure lubrication for gravity, and this has entailed wholly different construction of bearings from those with the ordinary drip lubrication.

The large subject of ball and roller bearings is dismissed in some three pages, and, considering the importance and growing use of the ball bearing in large sizes, we think this type of bearing deserved fuller attention. The mechanical lubrication by means of sight-feed lubricators, which allows the attendant to regulate exactly the quantity of his oil, is well illustrated, and rightly so, because this method is found in practice very considerably to economise the oil supply. Splash lubrication, as used by Willans and by many motor-car engineers, is alluded to, but its defects as regards the oil working up into the motor cylinders are not pointed out, nor is it shown that this method of lubrication is fast being driven out in favour of a pressure system. The authors, in the chapter on gas-engine cylinder lubrication, give some interesting analyses of the deposit found in the cylinders, and point out that the deposit is not wholly of a carbonaceous nature, but contains quite a considerable portion of sulphur obtained from the gas. They also recommend the use of pure mineral oils, as against the mixture of a small quantity of a neutral fixed oil. This wholly agrees with our own experience, namely, that a pure mineral oil is the only one possible to use when the compression of the engine is in the neighbourhood of 200 lb. per square inch. It would almost appear as if the whole difficulty of running at very high compressions is to prevent deposits of carbon. The only way to overcome this is to use an oil which will entirely burn, and in very small quantities. All those who are interested in lubrication generally will welcome Messrs. Archbutt and Deeley's work, more especially those in a consultative position, but we fear that, owing to its length and the predominance of the chemical and physical side, it will not be of the service to engineers generally that a smaller and less scientific work would be, as it must be borne in mind that the great majority of those who have to use lubricants have neither the time nor inclination to make accurate chemical tests.

F. W. BURSTALL.

OUR BOOK SHELF.

The Savage South Seas. Painted by Norman H. Hardy. Described by E. Way Elkington. Pp. xii+211. (London: A. and C. Black, 1907.) Price 20s. net.

To those who know the parts of Melanesia which Mr. Norman Hardy pictures, or who, like the writer, have seen much of his work, this book will come as something of a disappointment; and this from no fault of the artist, who is generally successful in reproducing, not only the physiognomy, but the musculature and the tricks of movement of the folk whom he portrays. The truth is that the tone of the reproductions (apparently made by the three-colour process or one of its modifications) of Mr. Hardy's water-colour sketches leaves much to be desired; in many of the reproductions there is a darkening of the colour scheme, giving crepuscular and storm effects—where none are intended—to many of the landscapes, as plates 2 and 4. In the case of illustrations showing figures, the tone of the whole group may be so lowered that people, houses and utensils show up in scarcely differentiated tints of brown against a sky for the colour of which the writer knows no warrant (illustration 19).

But there are also many charming and realistic pictures, such as plates 3 and 33, though in the last the excellence of the drawing and colouring of the canoe and the figures seated therein is perhaps somewhat discounted by the excess of grey and brown in the landscape.

Plate 16 may be picked out for special praise. It gives a very real impression of the Rigo dubu, seen at midday, when the glare of the sun lightens the grey of its weather-beaten posts and renders the yellowish soil on which it stands almost white.

In spite, then, of defects of the kind mentioned, the illustrations of this book give a better idea of Melanesia than can be obtained by photographs or black and white drawings, and so the work must be pronounced a success. Mr. Hardy is also to be congratulated on the accuracy of his observation, for in so few instances are there ethnographical inaccuracies in the plates or their accompanying short descriptions that it may be useful to point out the chief of these in as far as they affect New Guinea. Probably no girl ever danced her way to "the dubu dance" flirting her petticoats the while, as is shown in the frontispiece. Kaivakuku masks do not exist among the Roro tribe, though they occur among the Waima and Kevori, both Roro-speaking tribes. The feather head-dresses of the girls (illustrations 14 and 15) are distinctly yellowish, not red as shown in the plates; indeed, red feathers are carefully excluded from this dancing head-dress, the parrots providing the feathers being subjected to special treatment in order that their feathers may be of the desired colour.

In this book the illustrations so far exceed the text in importance and quality that little need be said concerning the latter, which contains many inaccuracies and misprints, is written in poor English, and generally falls far below the level of other volumes contained in this series. C. G. S.

A Text-book on Hydraulics, including an Outline of the Theory of Turbines. By Prof. L. M. Hoskins. Pp. v+271. (London: Archibald Constable and Co., Ltd., 1907.) Price 10*s.* 6*d.* net.

THIS book is intended for the instruction of engineering students during their university or college course, who have already acquired a good practical knowledge of pure mathematics, and possess a fair elementary acquaintance with the principles of mechanics. After a short introductory chapter dealing with definitions and principles, followed by a chapter on hydrostatics, the flow of water through orifices under different conditions is considered, and Torricelli's theorem is stated, and instances of its application explained. Bernoulli's theorem, which the author calls the general equation of energy, and upon which he bases his explanations of the problems of the steady flow of liquids, and its applications, form the subject of the next four chapters. Various formulas for the flow of water in pipes under definite conditions are then deduced from the general equation of energy; whilst a separate chapter is devoted to a discussion of the methods of estimating the frictional loss of head in pipes.

In treating of uniform flow in open channels, the author, after referring to Chézy's formula, $v=c\sqrt{rs}$, as the basis for calculating the mean velocity, and alluding to Bazin's experiments for determining the influence of the nature of the surface and the shape of the channel in modifying c, deals fully with the well-known, general, empirical formula for c deduced by Ganguillet and Kutter from the measurements of flow in a wide range of channels, which is a function of the slope, the hydraulic radius, and a coefficient of roughness depending on the nature of the surface of the channel. To facilitate the adoption of this complex formula, a table is given of the values of c computed for a certain range of conditions, and also a graphic diagram from which they can be obtained by measurement. The more complicated question of non-uniform flow in open channels is next discussed, deduced in the first instance from the general equation of energy for streams of variable cross-section; and the portion relating to hydraulics is concluded by a consideration of the different methods, direct and indirect, by which the discharge of streams differing greatly in volume can be measured.

The theory of turbines forms the subject of the last seven chapters of the book, under the respective headings dynamic action of streams, theory of steady flow through rotating wheel, types of turbines and water wheels, theory of the impulse turbine, and of the reaction turbine, the tangential water wheel, and turbine pumps. The book terminates with three appendices, in which the general equation of energy is applied to the steady flow of gases, relative motion is explained, and tables of conversion factors are given. The subjects dealt with are elucidated by one hundred and thirty-seven simple diagrams in the text, and examples are added in almost every chapter relating to its contents, for the student to work out, to which the answers are appended. This book will be valuable in training engineering students possessing a fair knowledge of mathematics to solve any problems in hydraulics they are likely to meet with in practice, and it will also furnish them with an insight into the principles on which the working and efficiency of turbines are based.

Flora of Sussex, or a List of Flowering Plants and Ferns found in the County of Sussex. By Rev. F. H. Arnold. Pp. xxii+154. (London: Simpkin, Marshall and Co., Ltd.; Arundel and Horsham: Mitchell and Co, 1907.) Price 5*s.* net.

THIS is a new and revised edition of the flora, including phanerogams, pteridophytes, and Characeæ, brought out by the author in 1887. The principal changes will be found in the additions to the species and many new localities. The introduction is not altered except for the increase in the list of contributors, to which are added the names of Mr. C. E. Salmon, Mr. W. Whitwell, Rev. E. Ellman, and Rev. E. S. Marshall. The last-named has been a most energetic worker, especially in West Sussex, and several of the new species were first discovered by him. A complete revision will be noted for the species of Rubus, for which the localities are provided chiefly on the authority of Messrs. Salmon, Marshall, and Rogers, and also a revision of the genus Salicornia. Among the species added to the county list are *Epilobium Lamyi*, *Wolffia arrhiza*, *Utricularia neglecta*, *Chenopodium botryoides*, *Spartina Townsendi*, and *Spartina alterniflora*, first found by the author. Most of these species were previously known from adjacent counties, as noted in the appendix, where the list has escaped revision. The author was not fated to see the publication of this book, which will be welcomed by all systematic botanists sojourning in Sussex; a note saying that he dictated the preface on the very day that he was taken ill is added by his daughter, who has also prepared the three illustrations which are included.

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 intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Reconstruction of Diprotodon from the Callabonna Deposits, South Australia.

SOME years ago, under dates June 21 and June 28, 1894, NATURE contained a notice of an extensive deposit, at Lake Callabonna, South Australia, of fossil bones of Diprotodon, Phascolonus, various species of extinct kangaroos, and of a large struthious bird, since named *Genyornis newtoni*, in honour of the late lamented Prof. Newton, of Cambridge, and in recognition of much personal kindness received from him by the writer. Since that date various and more detailed references to some of the forms represented in this deposit have appeared in the Transactions and Memoirs of the Royal Society of South Australia; and now, at last, after a lapse of years, which may have seemed unnecessarily long to those unacquainted with all the circumstances of the case, we have lately completed at this museum a complete cast in plaster of the skeleton of *Diprotodon australis*. Some of your readers may be interested in the photograph of this cast which I now send you (Fig. 1), as well as in one which gives our idea of the reconstruction in the flesh of this marsupial (Fig. 2).

As has been previously mentioned in your columns and in the other publication referred to, the state in which the Callabonna fossils were originally found, and the injury which they suffered as the result of a long journey on camel back to the railway line, were such as to require the expenditure upon them of much detailed preparatory labour before they could be restored to a sound and enduring condition; but while the ultimate result has been quite satisfactory as regards the appendicular skeleton, there have been much greater difficulties, and not so completely a satisfactory result, in respect to the skull and vertebral column. In both these categories the bones were to a degree above all the others soft, friable, broken, and infiltrated with saline matter that was difficult to remove. In the skulls particularly, the constituent bones were both broken and greatly distorted. Those that had been found lying on their sides were laterally compressed to an extent that the whole cranial mass formed a flattened slab which in some instances did not exceed a few inches in thickness. In other cases the compression had occurred in a dorso-ventral direction with a like result of producing many fractures and much distortion of the proper relation of parts. Fortunately, the distortion has not affected every skull in the same way, so that in the construction of the cast it has been possible to utilise undisturbed parts of different skulls.

Nevertheless, even with the considerable mass of material available, both from Callabonna and from other localities, there were some parts of the skull which were never found in an intact condition, and it is in these respects that the cast is not to our satisfaction.

For the information of those who will, it is hoped, eventually possess a copy of this cast, it may be well now to mention those parts the correctness of which we cannot, unfortunately, for the above reasons guarantee. Coming under this category are the occipital region, with the exception of the condyles and the immediate boundaries of the neural foramen. In not a single skull from Callabonna or from elsewhere was this extensive region without such serious breakage and distortion as to render a faithful reproduction of its details impossible. Consequently, in our restoration we have followed as best we could the details of Owen's figure (Owen's "Fossil Mammals of Australia," Plate xix., Fig. 3). Then another part that was always greatly damaged was the anterior or malar pier of the zygomatic arch, the broken parts being generally telescoped; thus we are not quite satisfied that we have got this region as it should be, though in other respects the zygoma is correct. Also, as might be expected, the thin laminar edges of the lateral boundaries of the mesopterygoid fossa were always broken, so that we have been consequently devoid of objective guidance in their reconstruction.

For the vertebræ, many of which were also in a particularly fragmentary and friable condition, a set belonging to one animal which was numerically nearly complete was used as models. Where parts of these were deficient, as often occurred, they could generally be supplied by the corresponding segment from another animal, but not always so. We had no model for the neural spines of the sixth and seventh cervical vertebræ, which are thus parts added in conformity with what we conceive to be the serial plan of arrangement. Fourteen vertebræ bear ribs, and there are five of the lumbar series; four are fused to form the sacral mass, and there are nineteen separate segments in the tail. The ribs, with one exception, are those belonging to the vertebræ, but as most of them were considerably twisted or otherwise distorted, it was sometimes necessary that they should undergo the operation known to wheelwrights as "cutting and shutting" before they could be set properly both to their respective vertebræ and to one another.

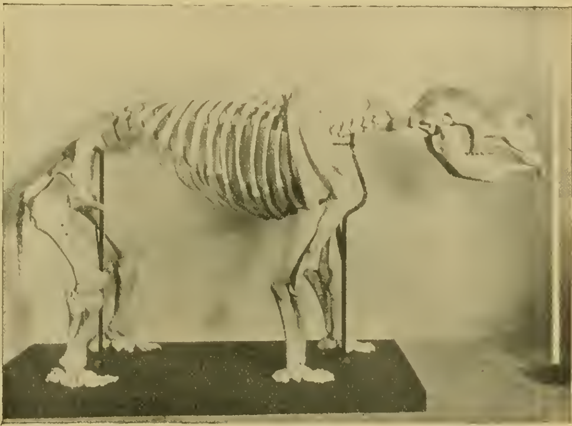

FIG. 1.—Plaster cast of the skeleton of *Diprotodon australis*.

As previously stated, the limb bones, from their fewer fractures and better texture, gave much less trouble in their restoration than those of the axial skeleton. Most of them belong to the same individual as the vertebræ, but some, in a damaged condition, have been replaced by other bones of suitable size. The peculiar feet, the structure of which was revealed by the Callabonna discovery, have been described (Memoirs Royal Society of South Australia, vol. i., part i.).

It is clear by reference to the bones of other skeletons in the Callabonna collection that the animal now represented was of medium size only, the height of the cast at the shoulder being 5 feet 6 inches, but unfortunately the skeletons of the very large individuals were much more incomplete than that which served as our model. I think it would be safe to place the height of the largest animals in life at 6 feet, or perhaps even a few inches more.

With regard to the restoration in the flesh, the photograph which I send you was made by my friend Mr. C. H. Angas, a skilful delineator of animals, with such help as we could give him from the anatomist's point of view. There can, I think, be little doubt that in its general build the Diprotodon had considerable resemblance to a gigantic wombat, and as such we have drawn him. Opinions may, however, differ as to our treatment of the muzzle. The huge overarching nasals, which greatly exaggerate the somewhat similar formation in the tapir, and the very massive bony internarial septum, must indicate some special, and probably some protuberant, development of the soft parts in this region. Bearing in mind the many cranial, as well as other skeletal, resemblances between Diprotodon and Macropus, we have consequently assigned to the former in our restoration a snout of the same type as that of the latter animal, but of greatly exaggerated size and prominence. In the case of the ears, we have compromised between the extremes of length of those organs as they occur in the kangaroos and wombats, with, however, a nearer approach to the former proportions. The result, on the whole, has been to make the head appear much more like that of a very massive and bulky kangaroo than of a wombat. In the original sketch we have presumed the animal to be covered with a very dark short fur of wombat type. For a setting we have delineated the Diprotodon amidst surroundings that represent some *present* characteristics of Central Australia. Thus in the background, to the left, is part of the white expanse of one of those large salt-encrusted clay pans of which Lake Callabonna, where the bones were found, is an example. In the distance beyond the lake is shown one of the flat-topped hills that are very characteristic of the "desert sandstone" region of the interior. The vegetation in the foreground is chiefly "saltbush" (Atriplex spp.), some species of which, together with allied plants, having apparently formed the principal food of the Diprotodon, just as these now supply the chief sustenance of the introduced Herbivora, while here and there is a trailing plant of "parakylia" (Claytonia spp.), so well known to travellers in the dry central regions for its moisture-holding properties.

I might add, though the information has already appeared in your columns, that a copy of this cast is in the possession of the Zoological Museum at Cambridge University, and that portions of it, together with some original bones, have been sent to the Natural History Department of the British Museum. Replicas of it have also been sent to the museums of Melbourne, Victoria, and of Perth, Western Australia.

E. C. STIRLING.

The Museum, Adelaide, South Australia, August 6.

FIG. 2.—Restoration of *Diprotodon australis*.

The Origin of Radium.

IN a communication published in NATURE of November 15, 1906, I described some experiments which had given results indicating the growth of radium in a preparation of thorium which had been previously precipitated in a solution of a uranium mineral. I had found from other experiments that the thorium after this treatment contained a radio-active body which did not decay appreciably in the course of several years. It was a simple matter to demonstrate that this active substance was not radium, uranium, or polonium, and I therefore assumed that it was actinium, since Debierne has stated (*C.R.*, cxxx., 906) that the chemical properties of actinium are similar to those of thorium, and since, moreover, an emanation which completely lost its activity in less than half a minute was evolved in small amounts from the oxides of the thorium treated in this manner. I therefore suggested that actinium was the parent of radium and the intermediate product between uranium and radium.

Rutherford has recently given an account (NATURE, June 6) of some experiments in the course of which a solution of actinium was successively precipitated with ammonium sulphide in order to remove the radium present. From the results obtained he concludes that the parent of radium is distinct from actinium, and is separated from the latter by precipitation with ammonium sulphide.

For the past ten months I have been continuing my experiments with the object of determining more definitely the properties and chemical behaviour of this elusive parent. The general manner of proceeding has been to obtain as complete a solution as possible of known weights of different uranium minerals. These solutions have been treated in the manner described in my earlier communication, with special precautions and modifications. The growth of radium in the solutions of the rare earths finally obtained was determined by measurements of the amount of radium emanation present at frequent intervals, and the rate of growth was calculated by an expression which took into account the rate of production of the emanation by the radium. The minerals used included carnotite, Joachimsthal pitchblende, gummite, uranophane, and a specimen of very pure uraninite from North Carolina containing only 0·03 per cent. of material insoluble in dilute nitric acid.

The space available in these columns will permit of only a brief mention of some of the more interesting results. In confirmation of Rutherford's statement it was found that the rate of production of radium was not influenced appreciably by the presence of radio-actinium and its products, which were completely absent from most of the solutions at the start. Continued observations of the growth of radium in the first solution prepared indicate that the rate of production of radium has been constant, within the limits of experimental error, for a period of more than 500 days.

I have attempted with one of my preparations to repeat the separation of the radium parent from actinium by the ammonium sulphide treatment which Rutherford has described. No separation could be detected when freshly prepared, pure ammonium sulphide was used. It was found that the radium parent can be quite completely separated from actinium by repeated precipitation with sodium thiosulphate under the conditions usual for the precipitation of thorium. In the case of a solution of the parent substance with thorium and other rare earths treated in this manner, less than 1 per cent. of the parent present remained in the filtrate, as was shown by the growth of radium in the two fractions obtained in this process. Since ammonium sulphide is always open to suspicion unless freshly prepared, and since on standing in loosely stoppered bottles it ultimately changes wholly into ammonium thiosulphate, it appears probable that the separation noticed by Rutherford was due to the latter reagent.

An interesting relation has been noticed between the growth of radium and the activity of the substances other than thorium in my solutions containing the radium parent. This proportionality is quite striking in those solutions containing the more completely purified salts. The activity of the substance present in these salts is comparatively high, and is about equal to the activity of the radium (itself) with which it is associated in the mineral. More significant still is the fact that this radioactive substance does not appear to possess any of the characteristic properties of the recognised radio-active elements. It is impossible that it is uranium, thorium, radium, or polonium. It has none of the properties that have been given as characteristic of actinium. About four-tenths of a gram of thorium oxide, containing an amount of this new body sufficient to give a leak of 500 divisions per minute in an α-ray electroscope, did not produce sufficient actinium emanation to permit its detection in another electroscope of greater sensitiveness. The thorium oxide had been prepared some weeks before by the gentle ignition of the oxalate, and was very porous. A strong current of air, about four litres per minute, was drawn over the preparation. There was no difficulty in measuring the thorium emanation evolved by this material under these conditions.

That the active substance is not actinium is also indicated by the fact that from a solution more than five months old no active substances other than thorium products could be separated by treatment with ammonia, by the formation of finely divided sulphur from sodium thiosulphate, or by the precipitation of considerable quantities of barium sulphate in the solution. The first process should have separated actinium X, and the two last should have separated radio-actinium had these products been present. The solution contained about 3 grams of thorium and a quantity of the new substance having an activity equal to that of about 35 grams of pure uranium.

Another important matter is the behaviour of the oxides obtained by strongly igniting the hydroxides precipitated by ammonia from a solution similar to the above. The activity of these oxides remains nearly constant for long periods, showing only a slight initial rise corresponding to the formation of thorium X in the thorium present. No rise corresponding to the formation of actinium X can be observed, but if actinium were present a separation of this product would be expected.

For these and certain other reasons I think that there is good cause for believing that uranium minerals contain an element emitting α rays, which is different from the other elements that have been identified, which produces no emanation, and which resembles thorium in its chemical properties. The activity of this element appears to be about the same as that of the radium (itself) with which it is associated in minerals. It is without doubt a product of uranium, and is probably the immediate parent of radium. It is very likely that this body is contained in Debierne's actinium preparations and in Giesel's "emanium" compounds, especially in the former, and its presence may perhaps explain the confusion which has resulted from Debierne's earlier assertions that actinium accompanied thorium as opposed to Giesel's positive statements to the contrary (*Chem. Berichte*, xl., 3011). The proportion of the total activity of a mineral due to the actinium present is very small, for the activity which can be attributed to actinium is less than 9 per cent. of the total.

The rate of disintegration of radium as determined from its growth in preparations similar to those described above, separated with great care from very pure North Carolina uraninite, indicates that the half-value period of this element is about 1900 years. It is hoped that certain experiments now in progress will make it possible to determine this factor with a satisfactory degree of certainty.

BERTRAM B. BOLTWOOD.

Sloane Laboratory, Yale University, New Haven, Conn., September 9.

The Body of Queen Tii.

IN NATURE of September 12, p. 494, a summary description was given of the remarkable discovery made by Mr. Theodore M. Davis, of Newport, R.I., of the tomb of the famous Egyptian Queen Tii, Thyi, or Teie, mother of the heretic-king Akhenaten, at Thebes. A remarkable point with regard to this discovery has been raised by an "Occasional Correspondent" of the *Times*, who informs us that the supposed remains of the queen, after having been examined by Dr. Elliot Smith, turn out to be those of a young man, at most twenty-five years of age! It is concluded therefrom that the discoverers were mistaken in their attribution of these remains, and that the coffin is not that of the queen at all, but of Akhenaten, whose name appears on it; but this cannot be the case. On the catafalque the inscription definitely states that it was given by Akhenaten to his mother Tii, and the mention of Akhenaten's name only on the coffin need mean also no more than this. The coffin is that of a queen; the diadem and necklace and other objects found are also the parure of a queen, not of a king, and the heads of the canopic jars are portraits of Tii.

The fact that the body found with these things is that of a man would mean simply that, as Prof. Sayce says in a letter on the subject published in the *Times* of September 17, "the mummy of the Queen had been torn to pieces like that of the King; and that, subsequently, when an attempt was made to put the tomb in order, the first mummy that came to hand was thrust into the Queen's jewelry wrappings, and coffin. It was not the first time that the Egyptians resorted to similar measures, and it would explain the otherwise puzzling absence of funeral furniture in the tomb."

In an article published in the *Graphic* of September 14 describing the tomb, I assumed that the weight of Dr. Elliot Smith's medical authority was decisive, and that therefore the body must be regarded as that of a man, at the same time suggesting reasons for this fact more or less similar to those advanced by Prof. Sayce; but the discoverer is by no means convinced that Dr. Smith is right at all. Since penning my article in the *Graphic* I have received a letter from Mr. Davis, giving his reasons for his sturdy belief, in the same terms as one received by Prof. Sayce, who communicates its gist to the *Times* as follows:—"Immediately after the opening of the tomb he had the mummy examined by Dr. Pollock, of Luxor, 'and a prominent American obstetrician. . . . In the presence of the doctor and surgeon, Mr. Ayrton, and one or two other persons, the mummy was opened and the bones exposed. In fact, the mummy had absorbed so much moisture that it could not be unwrapped, but it yielded to the touch and disintegrated to such an extent that there was no difficulty in exposing the bones from end to end. The pelvis was admitted to be the criterion of the sex. Both doctor and surgeon instantly agreed that it was the pelvis of a woman. The surgeon made a most thorough examination, and explained to us why it was a woman's pelvis, and what the difference is between the pelvis of a man and a woman. He practically stated that the 'greater breadth of the pelvic arch gives one of the most easily appreciable points of contrast between the male and female pelvis; the pelvic arch in the female forms an angle of from 90° to 100°, while in the male it averages from 70° to 75°.'" To me Mr. Davis writes:—"In any event, I shall exhaust the question of the sex of the pelvis before conceding Dr. Smith's opinion."

If, however, Dr. Elliot Smith is really right, and the body is that of a man, the fact does not in any way affect the discovery. The tomb, catafalque, coffin, canopic jars, diadem, &c., are those of Tii, and the bones found were in some way substituted for hers. They cannot be those of Akhenaten, as he must have been a middle-aged man when he died. H. R. HALL.

Use of the Word "Telephotography."

NATURE of August 29 contained an article by Dr. Shelford Bidwell entitled "Practical Telephotography." May I enter a protest against the use of the word "telephotography" to describe the method of transmitting pictures to a distance? Without wishing to go into the merit of the term, I would point out that it has been applied for years to photography by means of a lens consisting of a negative as well as a positive element, as in the well-known "telephoto" lens of Dallmeyer. There is already an extensive literature in which the term "telephotography" is used with this meaning, and to employ it now to describe something totally different can only ultimately result in confusion. Would it not be better to employ the term customarily employed, viz. "phototelegraphy"? R. CHILD BAYLEY.

20 Tudor Street, London, September 7.

I BELIEVE that the word "telephotography" was coined by myself, and first appeared at the head of an article published in NATURE on February 10, 1881, in which an account was given of the earliest attempt to transmit photographic pictures by electrical means. The term was at the time generally adopted by the Press, and has found its way into several books of reference. In the "Century Dictionary" (1900) telephotography is defined as "the art (not yet attained) of producing a photograph, distant and invisible from the camera, by means of electrical connections with a suitable apparatus near the object." No other meaning is given.

The word was not employed in the sense in which it appears to be now current among photographers until at least ten years later, the date of Mr. Dallmeyer's invention being 1891; but I have no great affection for my neologism, and propose in future to write "telegraphic photography," thus avoiding the possibility of confusion. "Phototelegraphy" I take to mean signalling by flashes of light, as in heliography. SHELFORD BIDWELL.

Beechmead, Oatlands Chase, Weybridge, September 13.

DOUBLE STARS.[1]

PROF. BURNHAM tells us in the preface to the first mentioned of these works that when he was attracted to the subject of double stars he had to draw the main part of his information from an early edition of Webb's "Celestial Objects." A useful book, no doubt, and one which has given many an amateur his first insight into a fascinating study, but its modest dimensions compared with those of the ponderous tomes the titles of which appear at the foot of this column may serve to remind us of the progress that has been made since that book occupied a prominent place as a recognised authority. It is in no small measure due to the difficulties arising from this scantiness of information that Prof. Burnham experienced in his early days that we owe this magnificent compilation. In those far-away times it was necessary to collect the history of double stars, to make manuscript copies of all the catalogues that could be obtained, to note carefully all that was published; and though this necessity may no longer exist, these manuscript catalogues have been kept posted up to date, and it is the final and complete outcome of this long-continued work that has now found its way into the printers' hands. We therefore get the results of accumulated experience in the form that the author has found most useful.

The catalogue gives the approximate coordinates of 13,665 stars, the position angle and distance at a given epoch, the magnitude of the components, and such other information as can be pressed into a single line. The value of such a work consists in its completeness. It may be confidently assumed that some information concerning every star recognised as double within the area under review previous to 1906, will be found here. All who have worked with incomplete or disconnected catalogues will know how to appreciate the usefulness of this compilation. In no department of astronomical research is the literature more scattered. Amateurs have contributed much to double-star measurement, and their observations are necessarily distributed through many channels. To collect and make available these many sources of information is a task of no common difficulty, and is perhaps only possible to one who has narrowly watched the growth of the material and sifted the details as the observations appeared. Alertness, industry and a keen interest in the subject were as necessary as access to publications or orderly method of arrangement. No one was better equipped for the task than Prof. Burnham, and we may be grateful that he has accomplished it.

The notes to the catalogue will be of greater interest to those who are concerned in the attainment of astronomical results than is the catalogue itself. Here are recorded a sufficient number of measures to show the motion where there has been any relative change, and so far as possible its character and amount, or to exhibit the unchanged relation of the components where no motion has been detected. References to the original places of publication, which would be used in subsequent calculations, are given for each star. The author gratefully acknowledges that he has been given a free hand in the selection of observations and comments, and he adds that he "has omitted nothing that in his judgment would be worth giving." Here the author assumes the position of a critic, a position for which he is admirably fitted by his long training and close study. Many will be prepared to surrender their judgment

[1] "A General Catalogue of Double Stars within 121° of the North Pole." By S. W. Burnham. Pp. lv+256 (Washington, D.C.: Published by the Carnegie Institution, 1906.)

"A General Catalogue of Double Stars." Part ii. Notes to the Catalogue. Pp. viii+257-1086. (Published by the Carnegie Institution, 1906.)

and accept his ruling. All will be cautious how they dissent from his expressed opinions. But it seems to us that to recommend the wholesale rejection of a large number of published measures of double stars is a drastic proposal, from which a less stern critic than the author might well recoil. It may be admitted that the possessors of small telescopes have always struggled to measure objects for which their instruments were unfitted. Indeed, a double-star observer never seems happy unless he is trying to measure something he can see very imperfectly. But simple dissatisfaction with the manner in which an observation has been made does not offer any adequate criterion for the rejection of doubtful observations, and we can hardly accept the assertion "that there need be no difficulty or hesitation in deciding as to the proper material to be used." This, as it stands, is a hard saying, and we may very well doubt if we have correctly understood the author.

He is on safer ground when he declines to deduce any inferences which might be based on the grouping of statistics. He is at present content to collect facts and to regard as premature any attempt to establish, or even suggest, theories on the limited information at command. The remark is made that very little has been done in the way of finding close pairs below the ninth magnitude, and that the effect of recent discovery in this direction may controvert the conclusions drawn from the older measures. This may doubtless be true, but the lack of sufficient data has seldom prevented the adoption of a working hypothesis. Certainly when Prof. Burnham sums up what has been accomplished in a century of double-star observing the results seem somewhat meagre for theory building, and emphasise the necessity for that careful and systematic measurement upon which he insists. There are only eighty-eight systems for which orbits have been found, and of this number only thirty-four can be regarded as of any value. As to the remaining fifty-four systems, the periods and "all the elements of the orbits are wholly uncertain and worthless. They cannot be regarded even as approximations . . . and in some instances it is not certain that they are physical systems at all." This severe criticism can be justified. Perhaps some of these indecisive results and the eagerness to build upon unsuitable observations may be traced to the influence of Herschel, and the apparent success that attended his ingenious device for deriving an approximate orbit. More rigorous methods have, however, given results of scarcely greater trustworthiness, and the tendency now is to leave double-star orbits severely alone.

It may be of greater practical utility to note that our knowledge of double stars has suffered from the want of organisation among observers. As the author puts it, "Since the observations of Struve the work of micrometrical measurement of double stars has not been wisely distributed. A vast amount of time has been practically wasted in the duplication of measures of the prominent and familiar pairs and in observing objects which need no attention except at long intervals." But Prof. Burnham may here be reminded that it is not enough to suggest that the working lists of double stars should be more carefully selected. What is wanted is authoritative leadership and sympathetic guidance. Such an influential position the writer of these books might worthily occupy. His competency no one would question. The necessity for cooperation among astronomers and the judicious husbanding of resources is becoming more and more recognised. The beneficial effect of organisation in coping with large masses of work is acknowledged. Isolated and unmethodical labour is accompanied by many evils, but none more noticeable than that of overlapping and needless duplication. These evils cannot be entirely avoided, but they can be reduced to a minimum.

Overlapping may to some extent be beneficial. An example is supplied by the very admirable work which Mr. Lewis has lately published through the Royal Astronomical Society. But it is not often that two experts work on so nearly parallel lines. Mr. Lewis has done in a very thorough and masterly manner for the Struve stars what Prof. Burnham has accomplished for a larger number. Mr. Lewis's work may be the more efficient, in the sense that it enables us to dispense with a larger number of original authorities, but there would have been no great difficulty and some advantage in combining the merits of both compilations. It is not necessary to give illustrations of the way in which observations are duplicated. It is difficult to quote instances in which independent lines of investigation are being pursued. The Lick Observatory has made the search for close double stars of feeble magnitude peculiarly its own. In this department is doubtless found an admirable employment for large optical power. Mr. Burnham has added many new doubles to our catalogue, but apparently finds a sufficient field for his energy in the re-measurement of recognised doubles. Throughout the United States a vast number of observers are interested in double stars, but in their work it is impossible to recognise any well-developed plan. On this side of the Atlantic, besides the excellent work that is being done at the Royal Observatory, which again demands large aperture, we have an army of amateurs, headed, we may say, by Mr. Maw, the late president of the Royal Astronomical Society, whose contributions to the general store would be increased in value if designed to form part of a definite scheme. Too often double-star measurement is the refuge of the leisured amateur, who finds in this kind of work an agreeable occupation. Such irresponsible observers stand particularly in need of direction, and if some scheme of cooperation could be formulated, Prof. Burnham's intimate acquaintance with the subject would be of immense assistance. He has admirably arranged the material that is to be observed; he has made us apprehend the extent of the field of labour and the abundance of the harvest; he has shown what can be done by unwearying industry and painstaking perseverance; let him complete his work by organising the labourers and infusing into their work system and continuity.

FOOD INSPECTION AND ADULTERATION.

SIR JAMES CRICHTON BROWNE, as president of the Association of Sanitary Inspectors, delivered last week the customary address at the annual meeting of the association. His remarks, devoted largely to the question of purity in foodstuffs, were a forcible presentation of matters which, well known to those concerned in the problem of food-control, deserve the serious attention of a wider circle, since as consumers and as citizens all are interested in the points brought forward.

The most important topic dealt with was that of a pure milk supply. It is "the primary and paramount food question." There is no need to enter here into details of adulteration, but it may be stated that according to the Local Government Board reports ten per cent. of our milk is either adulterated with water or impoverished by the abstraction of fat, or both; whilst a much larger proportion is so manipulated as to leave it only just within the official limits taken as criteria of genuineness. Moreover, the practice of sophistication appears to be extending.

Unfortunately, however, milk is a product which, naturally, varies much in quality. As a consequence there are difficulties, well known to those who administer the Sale of Food and Drugs Acts, in the way of preventing the manipulation mentioned. To avoid punishing the innocent some latitude must be allowed to the guilty—and the guilty take full advantage of it. It does not follow that less latitude should be given. Careful consideration will show that as regards the official "standards" by which milk is judged, the balance is held as evenly as is practicable between the consumer on the one hand and the producer on the other.

At the moment, what seems to be the most pressing question of milk supply is the matter of cleanliness. Whether the milk is genuine or whether it is watered, at least the introduction of filth ought not to be tolerated. Dirty byres, dirty cows, dirty hands; an atmosphere of dust and micro-organisms; tuberculous udders and uncleanly churns; these may each and all have a part in contaminating the foodstuff which, as Sir James puts it, "enters into the diet of a vast majority of the population, and forms the almost exclusive food of its most susceptible units." There is here a very real need for improvement. Nor does it appear certain that any new legislation is necessary. The Public Health Act and the Dairy, Cowsheds, and Milkshops Order would perhaps suffice as regards the machinery; but there is often local reluctance to put the machinery in motion.

In the matter of butter, to which Sir James devoted a part of his address, the hands of the authorities will be materially strengthened by the new Butter and Margarine Act. It was quite time. The chief malpractices to which this article of food is subjected were described some months ago in the columns of this journal (NATURE, vol. lxxiii., p. 466). One or two examples from the report of the principal chemist of the Government Laboratory may be cited to illustrate the recent history of the matter. During last year a creamery in this country was visited under the authority of a search-warrant, and the process of adulterating butter with lard was found in full swing on the premises. Other such places are known to use condensed milk for incorporation with butter. Again, an unscrupulous individual was found offering for sale a process for the "scientific" manipulation of butter by blending it with beef-fat or lard; and eventually he was indicted for inciting to commit a misdemeanour. He was sent for trial, but the Old Bailey never saw him; the authorities had to be content with estreating his bail for 800*l.*

As remedial measures Sir James Crichton Browne mentions provisions that were either previously existent or have been included in the Butter and Margarine Act of last session. The importer is held responsible for the genuineness of the butter he imports, and must find his remedy against the foreign producer. All butter factories must be registered, and be subject to inspection. Any oils or fats found that are capable of being used in the adulteration of butter are to be considered as intended to be so used unless the contrary is proved, and their presence constitutes an offence under the Act. Though not all that could be wished, the measure will be a valuable one in many respects, and should do much to check fraudulent manipulation of butter.

But a much more drastic and far-reaching enactment is just now coming into force in the United States, and the working of one of its provisions in particular will be watched with much interest in this country. Its effect is to ensure that articles of food and drugs shall be labelled so as to show the purchaser, within limits, exactly what the articles are. The description must not "be false or misleading in any particular," whether as to composition, quality, origin, or what not. Thus an article must be stated on the label to be "prepared with glucose," "coloured with sulphate of copper," "dyed with aniline dye," or to be "composed of fragments and scraps from a mushroom cannery," and so on, as the case may be. Moreover, in the case of certain drugs—morphia, cocaine, chloral, chloroform, and others—the proportions must always be stated on the label. If the preparation is found not to agree with the description it is deemed to be "misbranded," and offends against the Act. It is too early yet to say exactly what the effect of this compulsory candour will be, but obviously it affords a powerful means of enforcing commercial honesty. This, however, is not all that is being done. So long as a substance is left undefined, so long is it possible for a "trade custom" to be alleged in defence of malpractices. Witness, for instance, the discussions upon "what is whisky?" and "what is brandy?" which have recently arisen in this country. Hence the new American law is being supplemented by a series of schedules defining the various food products and fixing certain "standards" in respect of them. The appointment of a committee to draw up similar regulations for the United Kingdom has been urged, but at present little more has been done in the matter.

Another point of much importance touched upon by Sir J. Crichton Browne is the open or veiled antagonism of some local authorities to anything like reforming zeal on the part of their medical officers, analysts, and inspectors. The personal interests of influential councillors may clash with the public welfare, and an official may find his tenure but short if he becomes too zealous. How, it is asked, can a public official act impartially if the fearless performance of his duty brings him into the position of having to prosecute his employers?

"Vice," says Sir James, "is mind in the wrong place." Perhaps our present system of local government often puts men in the wrong place.

C. SIMMONDS.

SCIENTIFIC WORK IN INDIA.

THE Asiatic Society of Bengal continues to make satisfactory progress, its membership having increased from 343 in 1904 to 407 in 1906. In his annual address for the latter year the president, Sir A. Frazer, Lieutenant Governor of the Province, expressed his disappointment that so few civilians and members of other services have joined the society. He suggested that the society did not make itself sufficiently known; that the increasing use of English in Bengal discourages the use of the vernacular tongues; but he chiefly attributes the lack of official interest in the work to what he calls "the prevalence of mere officialism." He therefore proposes to appoint a joint committee of savants and officials to investigate the question, and to endeavour to bring about more satisfactory relations between the society and the services.

It is well that the attention of the authorities has been directed to this important subject. Such a committee is, however, hardly likely to throw much new light on the matter. The causes enumerated by the president have no doubt tended to increase the prevailing indifference felt by Indian officials to scientific inquiry and the study of the people, their languages, superstitions, and beliefs. But, in spite of the cheerful optimism of the Lieutenant Governor, the causes of this failure lie nearer home than he would be disposed to admit. All services naturally take their tone from their leaders, and, as a matter of fact, the Indian Government has always regarded investigations, scientific or literary, beyond the immediate range of official routine, with some degree of suspicion. They claim all the time and powers of mind which their servants possess for their own special work; they have hitherto been unable fully to realise the value of a personal knowledge of the country and its people; they suppose that any studies of this kind tend to divert attention from the continuous desk work, the compilation of statistical reports which they consider the main duty of the civilian, or the supervision of his men which is the business of the soldier. With this is combined the impression that men of genius are out of place in the Indian bureaucracy, which prefers the safe person, who meekly follows the codes and circulars of the Revenue Board, to one who is disposed to raise awkward questions and inquire into matters beyond the narrow range of official duties. Hence the scientific inquirer, the linguist, naturalist, or anthropologist, rests under a certain suspicion that he is neglecting his real duties.

Fortunately, the present political situation is tending to modify this old-fashioned official view, and it is becoming obvious that the Government servant needs, above all things, an insight into the little-known beliefs and prejudices of the peasantry, while an officer destitute of scientific training, with no interest in the country and its development, is an unprofitable servant. It may reasonably be suspected that many of the present difficulties in Bengal are due to a fact which Sir A. Frazer mentions incidentally, without apparently realising its importance—that junior officers in Bengal fail to master the vernaculars of the people because most of their work on municipal and other boards is done in association with native gentlemen who prefer that the business should be conducted in English.

In spite of this lack of cooperation on the part of the official classes, the out-turn of the society's work for the past year is excellent. Dr. Annandale continues his studies of the fresh-water fauna, discussing the little-known Polyzoa which are found in fresh and brackish pools, with some undescribed fresh-water sponges from Calcutta and other parts of the country. He also deals with a specimen, recently discovered by accident in the museum, of that rare cat, *Felis tristis*, and Major Anderson describes *Breynia Vredenburgi*, a new Echinoid from the Indian Ocean. Botany is represented by Mr. Burkill's notes on the pollinisation of Indian flowers, with a special account of *Gentiana coronata*. In the zoological field Lieut.-Colonel Phillot deals with various varieties of falcons, and translates the chapters on hunting dogs and cheetas from an Arabic treatise on falconry of the tenth century. The chemical laboratory of the Presidency College contributes notes on a new way of preparing mercurous iodide, and on nitro-ethane as a solvent of iodoform.

The anthropological and numismatic supplements are as interesting as usual, and the materials collected in the late Tibetan expedition are being worked up by Rai Sarat Chandra Das and other native scholars.

The society also continues its useful series of independent memoirs. M. M. A. Gruvel contributes a learned monograph on "Cirrhipèdes operculés de l'Indian Museum de Calcutta," and Mr. E. R. Watson discusses the fastness of the indigenous dyes of Bengal. On the ethnographical side Mr. E. H. C. Walsh contributes a paper on the coinage of Tibet, and Dr. Annandale and Lieut.-Colonel Phillott, in the second part of their "Miscellanea Ethnographica," deal with Malayan weapons and the plan of a Persian gentleman's house. The most important contribution to this department is the monograph by Mr. R. B. Bainbridge on the Saorias of the Rajmahal Hills. These are but an isolated fragment of a widely-spread, broken tribe found in Orissa, Chota Nagpur, Western Bengal, Madras, and the Central Provinces. The author speaks rather vaguely of their ethnical character. He seems to identify them with the Malé, and he adds that the Santals call them Munda and the Hindus Paharia or hillmen. He notes that they combine, as many Dravidians do, a high nasal index with dolichocephaly, but, in opposition to Sir H. Risley, he endeavours to distinguish them from typical Dravidians, like the Santals and Oraons, and suggests that among the Saorias the original Dravidian type has become modified by admixture with Aryan blood. But considering the isolation of their territory from the plains of Bengal, cross-breeding with high-caste Hindus does not seem probable. The author is obviously well acquainted with the people whom he describes, but his lack of literary skill and of anthropological training makes his memoir disappointing in comparison with the accounts of the same people by Sir H. Risley and Colonel Dalton. At the same time, he has collected much useful information on their social customs and religion which will furnish a basis for a full account of the tribe by some more competent writer.

THE CULLINAN DIAMOND.

THE Cullinan diamond, which the Transvaal Government, acting upon the proposition of the Prime Minister, General Botha, has recently decided to present to the King, was discovered at the Premier Mine near Pretoria, in the Transvaal, on January 25, 1905. The stone was found projecting from the side of the open-working or excavation in the "pipe" area about 18 feet from the surface. After a preliminary cleaning it was found to weigh $3024\frac{3}{4}$ carats, or 1·37 lb. avoirdupois; consequently it is more than three times the weight of the largest diamond previously known—the famous stone found in 1893 at Jagersfontein, in the Orange River Colony, which weighed 972 carats. A few days after its discovery the stone was examined and measured by Dr. F H. Hatch and Dr. G. S. Corstorphine, who published a description of it in the Transactions of the Geological Society of South Africa (vol. viii., pp. 26–7, 1905) and in the *Geological Magazine* (April, 1905, pp. 170–2).

According to this description the stone measures 4 by $2\frac{1}{2}$ by 2 inches. It is bounded by eight surfaces; four of these are faces of the original octahedral crystal, and four are cleavage faces parallel to the octahedron. Evidently the stone is a portion only of the original crystal, which had the shape of a distorted octahedron. The original octahedral faces are distinguished by typical striations, the bands varying in width from 0·1 to 0·4 centimetre, by mammillations and by triangular pittings, like deeply-etched figures, the largest of which has a side of 0·65 cm. On the other hand, the cleavage surfaces are characterised by greater smoothness and consequently by a more perfect reflection of light. Parallel to the largest cleaved surface there is an air layer between two internal cleavages, producing a "rainbow" or Newton rings.

The crystal is of remarkable purity. Two spots are visible, one on the surface, the other about 1 cm. within the crystal. The colour approximates to a blue-white. The stone was named after the chairman of the Premier Diamond Company. It is the joint property of the company and of the Transvaal Government, the latter being entitled to a share in the profits made by the company.

NEW LABORATORIES AT QUEEN'S COLLEGE, BELFAST.

On Friday last, September 20, the buildings recently erected to provide much-needed additional accommodation for the scientific departments of Queen's College, Belfast, were formally opened. These buildings include the Donald Currie laboratory and lecture-room for chemistry, the Musgrave laboratories for pathology and bacteriology, the Jaffé laboratory for physiology, the Harland laboratories of physics and engineering, and rooms for the departments of biology, pharmacology, and surgery.

Lord Kelvin had promised to visit the city of his birth and early life in order to perform the opening ceremony. Unfortunately, a few days before the date fixed, the sudden and serious illness of Lady Kelvin made it impossible for him to fulfil his engagement. Lord Kelvin sent to Belfast the text of the address which he had prepared for the occasion, and this was read to the meeting by his nephew, Mr. James Thomson, whose father, Prof. James Thomson, formerly occupied the chair of engineering in the college. The buildings were declared open by Sir Otto Jaffé, chairman of the committee in charge of the "Better Equipment Fund," and a prominent benefactor of the college. The meeting was afterwards addressed by Sir Christopher Nixon, vice-chancellor of the Royal University of Ireland, and by Prof. Letts.

In the beginning of his address Lord Kelvin traced the development of university education in Belfast from the foundation, about 1815, of the "Academical Institution," of which the collegiate part was afterwards merged in the Queen's College. He expressed the hope that the college would soon receive the full status of an independent university. After enumerating the laboratories to be opened on that day, the address proceeded as follows:—

Now that you have them open and ready for use, what are you going to do with them? Your chiefs in the different departments, professors, assistant professors, assistant workers, and students, will, I am sure, soon give very good and useful answers to that question. None of your chiefs will be likely to follow the example of a good old university professor of a bygone age in the sister island, who was the happy official possessor of many very fine and costly instruments, in which he took great pride. He devoted himself whole-heartedly to keeping them in order.

Your seven laboratories extend over the whole field of lifeless matter and of matter associated with life. We may be sure that in none of them will there be any lack of useful occupation. Personally, I need hardly say, I envy most the workers in the laboratories of physics, chemistry, and engineering.

At the present stage of the era which commenced with Henri Becquerel's discovery of radio-activity in salts of uranium and in metallic uranium, the very thought of physics and chemistry, a now united science, compels us to think of radium, in which Madame Curie discovered the element of Becquerel's wonderful radiation. I hope the physical and chemical laboratories of Queen's College, Belfast, will try to find if the radium element does occasionally explode into fragments. If they find that it does, the laboratories will, I trust, hold an official conference with the professors of Greek and logic, and come to a conclusion whether or not it is a convenient fiction to call the radium element an atom. It may remain quite convenient to continue calling radium an element. Indeed, I well remember a time in Belfast when we used to call earth, air, fire, and water "the four elements."

Whatever may betide, I hope the physical and chemical laboratories of Queen's College will be full of radio-activity until we have more intimate knowledge of radium than we have of iron, with its magnetic quality.

I have many happy recollections of Queen's College in the 'fifties and 'sixties, when my brother was professor of engineering there. What would he not have given for the admirable and useful engineering laboratory of which Queen's College takes possession to-day?

I have somewhat later recollections of Queen's College, full of personal and scientific interest, when Thomas Andrews was making his immortal discoveries in it regarding the continuity of the gaseous and liquid states, now celebrated throughout the scientific world. I well remember, too, his showing me, on a promisingly practical scale of magnitude, the electrical transmission of power through a pair of copper wires, from one Gramme dynamo driven by hand to another taking the work from it. No doubt Andrews showed this to his students at a time when, by most engineers and scientific men, engineering applications of electromagnetism were looked on as chimerical fancies of ingenious, non-practical professors or other weak persons. Who can say whether the seed thus sown, about 1870, or 1871 or 1872, through university action in the north of Ireland, may not have germinated in the Portrush electric railway, which has given to Ireland the first historic title to the utilisation of water-power by electric transmission to many miles, instead of to a few yards, as shown to the students of Queen's College in Andrews's lecture-room?

PROF. L. F. VERNON-HARCOURT.

The death of Prof. Vernon-Harcourt, following so soon after that of Sir Benjamin Baker, not only deprives the civil engineering profession of another illustrious member, but leaves experimental science the poorer for the loss of one of her most devoted sons. The branch of civil engineering work with which Prof. Vernon-Harcourt was most closely associated was that concerned in the maintenance and construction of waterways. Harbours, docks, rivers, canals—all and everything, in fact, which appertains to the provision and improvement of routes and termini for water-borne traffic is included under this head. In this special domain Prof. Vernon-Harcourt was an acknowledged authority, and the treatises thereon which came from his pen, and the opinions which he expressed, invariably carried with them that conviction which is the rightful due of sound knowledge and ripe experience.

He came of distinguished ancestry. The son of an admiral, the grandson of an archbishop, he could scarcely fail to leave his mark in any profession he might take up. A brilliant career at Oxford (he graduated in 1861 with a first class in mathematics, and the following year in natural science) was followed by three years of steady, persevering study in the practice of civil engineering under the late Sir John Hawkshaw. Then came ten years of responsible executive work, first at the South-West India Dock, then on Alderney Breakwater, on Rosslare Harbour, and the railway to Wexford. Finally, in 1878, he established himself as a consultant, with offices in Westminster, and four years later he was appointed professor of civil engineering at University College, London. His active connection with University College was maintained practically up to the time of his death.

Prof. Vernon-Harcourt will perhaps be best remembered by his writings, which have won for their author a deserved and unquestioned reputation. In 1882 appeared "Rivers and Canals" (second edition, 1896), followed in 1885 by "Harbours and Docks," in 1891 by "Achievements in Engineering," and in 1902 by "Civil Engineering as applied to Construction." All these works are characterised by lucidity of style and soundness of thought, and they are to be found to-day on the bookshelves of most practising engineers. In addition thereto, Prof. Vernon-Harcourt contributed to the "Encyclopædia Britannica," and wrote copiously for various learned societies—the Institution of Civil Engineers, the Royal Society, the

Society of Arts, and the International Association of Navigation congresses. He was president of the mechanical section of the British Association meeting of 1895, and a number of distinctions were conferred upon him from time to time, including a commandership of the Imperial Franz-Josef Order of Austria-Hungary, in recognition of his services on an International Jury on Canal Lifts.

There is no novel or startling departure in theory or practice, no gigantic masterpiece of constructive skill, associated with Prof. Vernon-Harcourt's career, but his name will long be held in respectful remembrance by those who can understand and appreciate the solid and enduring character of his unobtrusive work. His investigations in 1886 in regard to the Seine estuary, and the patient care with which, from a number of artificial models, he deduced the probable effect of various systems of training works, commanded the attention and interest of the profession, such that his position as an expert authority on fluvio-maritime works henceforward became preeminent. In 1896 he made an inspection of the River Hooghli, and drew up for the Calcutta Port Commissioners a valuable report on the means of improving the navigable channel. Only last year he was consulted by the Mersey Docks and Harbour Board in regard to certain training works proposed for the estuary of the Mersey.

Prof. Vernon-Harcourt did not reach the allotted span of man, and the announcement of his death at the age of sixty-eight is received on all hands with unfeigned expressions of sorrow and regret.

NOTES.

THE celebration of the centenary of the Geological Society of London is to commence this morning with a reception of delegates by the president, Sir Archibald Geikie, K.C.B., F.R.S., at the Institution of Civil Engineers. The history of the society is traced in a review which appears elsewhere in this number, and we hope to give an account of the centennial celebrations in our next issue. The president will deliver an address this afternoon on the state of geology at the time when the Geological Society was founded, and a banquet will be held at the Hôtel Métropole this evening. To-morrow will be chiefly devoted to visits to museums, galleries, &c., concluding with an evening reception at the Natural History Museum. On Saturday, short excursions will be made to places of geological interest within easy reach of London; and on Monday the visitors will divide into two sections, one of which will go to Oxford, the other to Cambridge. At both universities there will be further hospitalities, and honorary degrees will be conferred upon a few of the guests.

THE fourteenth International Congress of Hygiene and Demography was opened at Berlin on Monday in the presence of the Crown Prince and representatives of the Diplomatic Corps, the Prussian Ministry, the Berlin Municipality, and other official bodies. The congress was formally welcomed in the name of the Emperor William by the Prussian Minister of the Interior, Herr von Bethmann-Hollweg.

THE Scottish Arctic Expedition under Dr. Bruce arrived at Tromsö on September 22, all well. Dr. Bruce's companion, Mr. H. Johansen, will stay at Spitsbergen for the winter, together with Mr. Lerner. The *Times* correspondent at Ottawa reports that Dr. Stefansson, of the Anglo-American Arctic Expedition, has arrived at Victoria. He left Captain Mikkelsen and the other members of the expedition well on Herschel Island in July.

A CONFERENCE for the purpose of discussing subjects connected with the work of museums and art galleries and kindred institutions will be held at the Royal Museum and Art Galleries, Salford, on Friday, October 18, and will be attended by members of the Museums Association and other persons interested in museum work.

THE Berlin correspondent of the *Globe* states that during the ensuing four months, that is, from now to January 15, the German Army authorities intend to carry out an important series of experiments in wireless telegraphy at Metz and Strasburg, and at the six leading fortresses of Königsberg, Thorn, Danzig, Posen, Cologne, and Mainz. One thousand reservists, who have served as military telegraphists, have been called up to work with the military telegraphists now serving with the Army.

SPEAKING at Liverpool on September 19, at the Liverpool Imperial Products Exhibition, Mr. Haldane, M.P., again took the opportunity of urging the importance of a scientific foundation for our Empire. He reminded his hearers that the secret of prosperity, the secret of winning the fruits of the earth, lies in mind, in knowledge, and in the direction applied to the energies which abound around us, and can be turned to the service of man. What is true of ordinary industry is true of the great enterprise of making the best of the possibilities of those vast tracts of the world which constitute the British Empire.

THE official results of the International Balloon Race of September 15 show that six balloons travelled more than 800 kilometres before descending. The following particulars are given, among others:—

Order	Name of Balloon	Cubic capacity, metres	Nationality	Hour of ascent	Hour of descent	Distance travelled, kilometres
				Sunday	Monday	
1	Pommern ...	2,200	Germany ...	17 48	22 30	935
2	Le Cognac	1,700	Switzerland ...	18 02	18 03	870
3	Zéohir ...	2,200	Great Britain	17 09	17 30	860
4	Britannia ...	2,200	Great Britain	17 43	18 06	840
5	Bamler ...	1,437	Germany ...	18 37	18 30	830
6	Milano ...	2,000	Italy	17 07	14 30	810

THE autumn meeting of the Iron and Steel Institute was opened at Vienna on Monday in the hall of the Austrian Society of Engineers and Architects. The Ministers of Commerce and Agriculture, with their Under-Secretaries of State and many prominent officials, as well as the general managers of the principal Austrian iron works, were present to welcome the institute. Sir Hugh Bell, the president, returned thanks for the cordial welcome extended to the members by the Austrian Government and the civic authorities. A selection of papers was then read and discussed. On Monday evening a special performance at the Imperial Opera House was arranged. On Tuesday the morning was devoted to the reading and discussion of papers, and the afternoon to a visit to the Imperial Palace at Schönbrunn. To-day, September 26, will begin the excursions to the works to be visited in (1) Bohemia; (2) Styria; and (3) Moravia and Silesia.

THE second Engineering and Machinery Exhibition at Olympia was opened on September 19 by Sir Alexander Kennedy, F.R.S. The body of the hall and part of the annex are filled with the stands of engineering and other firms closely connected with engineering, but the chief feature of the exhibition is the fine collection of machine tools. The British machine-tool manufacturers are well represented, and hold their own with the American and

Continental firms, which could not have been said of the previous exhibition. The importance and adaptability of electric driving is well illustrated by the machine-tool section, and individual operation is greatly in evidence. This is especially the case in one exhibit, as the whole of the machines are individually driven, and the absence of complicated belting as compared with neighbouring exhibits adds greatly to the attractiveness of the machines. Modern electric-tool equipment of every description is well represented, and the heavier machines are also provided in most cases with electric motors, such as plate-bending, girder notching, shearing machines, as well as pumps, winches, &c. Motor starters, iron-clad switches, and electric fittings suitable for workshop use are also exhibited. The exhibition should do much towards helping the electrical industry in workshop practice. Power is obtained for all the motors driving the various machinery shown from the local borough supply, and no independent steam units are employed, their place being taken by single-phase motor generators supplied direct at 2200 volts, converting to 220 volts continuous current.

WE learn from the Allahabad *Pioneer Mail* of September 6 that the programmes of work of the various scientific departments for the current year, as settled by the Board of Scientific Advice, have been published. The following points are of general interest:—(1) schemes have been completed for the establishment of a central research station and agricultural colleges at Poona, Lyallpur, Cawnpor, Bhagalpur, Coimbatore, Nagpur, and Mandalay, and a staff of three European specialists has been sanctioned for each; (2) new agricultural stations are to be started (*a*) at Aligarh for the improvement of cotton, (*b*) at Partabgarh for the study of rice and sugar-cane, (*c*) at Jullundur, (*d*) at Bassein, and (*e*) at Bhagalpur and Bankipur (Bengal). The special investigations connected with the improvement of Indian cottons and wheats will be continued, but the scheme for the improvement of Indian tobacco will largely remain in abeyance until the appointment of a specialist for this purpose. The study of sugar-cane diseases and of practical measures for the suppression of cotton boll-worm in the Punjab will also be continued. The lead mines of the southern Shan States, the tin deposits in Mergui, Tavoy and Karenni, the oil beds in the Irrawaddy valley and the Arakan districts, the volcano of Popa in the Myingyan district, Burma, the copper beds of Singhbhum, and the manganese mines in the Central Provinces, are all to be the subject of geological investigation.

DR. A. GRAHAM BELL has erected on his estate at Benin Breagh, N.S., a tower, 80 feet in height, built of the tetrahedral cells which he invented to secure great strength and lightness in the construction of kites. The engineer was Mr. F. W. Baldwin, of Toronto, who stated at the opening ceremony that the tower weighs less than five tons, and will carry a weight of 50,000 lb.

FROM the report for last year we learn that the collections in the Albany Museum, Cape Colony, are making exceptionally rapid progress, the number of specimens received in the zoological department being in excess of that in any previous year. It is likewise stated that the value of the institution as a means of education is also steadily increasing.

WE have received a copy of a report on trials of the South African locust-fungus in India, by Messrs. E. J. Butler and H. M. Lefroy, issued by the Agricultural Research Institute, Pusa (Bulletin No. 5 of 1897), and published at the Government Press, Calcutta. Unfortunately, little or no success has attended the attempt, the effects of the fungus on several species of locust being *nil*, while in the case of the migratory locust of the north-west such effects as were produced appear to be of no practical value. As regards the last-mentioned species, the authors observe that "the conditions of nature are much more in favour of the insect, and against the fungus, than those under which the experiments were made, and if we can only anticipate a small percentage of infections the method will certainly fail."

THE trophy shown in the accompanying illustration is offered by the *Scientific American* for competition for heavier-than-air flying machines. In order that the competition might be held under the auspices of experts, the trophy has been given under a deed of gift to the Aëro Club of America, to be competed for annually by both American and foreign inventors. The first competition was announced to be held at the Jamestown Exposition on September 14 for a flight of 1 kilometre in a straight line, but the result has not yet reached us. The competition is to be progressive in character, that is to say, if the flight of the predetermined distance has been accomplished this year, next year a longer flight will be required. After every competition the name of the winner will be inscribed on the trophy. If it is won three times in different

The *Scientific American* flying machine trophy.

years by any competitor, the trophy will become his personal property. This fine example of the silversmith's art is of real beauty. From a green onyx base with a silver cartouche rises the massive silver trophy, measuring 32 inches over all. At the summit, projected away from the earth, is an aëroplane in high relief, standing away from the silver globe, with its frame held together by silver guy ropes. The trophy is valued at 500*l*.

THE life-history of a trypanosome infesting the alimentary canal of a leech (*Pontobdella muricata*) parasitic on skates and more rarely angler-fish is discussed by Miss M. Robertson in the Proceedings of the Royal Physical Society of Edinburgh, 1906–7, part iii. Possibly, despite a marked disparity in point of size and appearance, this trypanosome may be the earlier stage of *Trypanosoma raiae*, but this has still to be confirmed. After describing in detail (with a number of coloured illustrations) all that is at present known concerning the development of the trypanosome in the leech's intestine, the author proceeds to discuss its methods of division, which exhibit considerable diversity. Some of such divided individuals suggested the conjugation of a male and female element (gamete), but further examination negatived this interpretation, and showed that division is the sole factor in the phenomenon. This suggests caution in regard to other alleged instances of conjugation among Protozoa, although theoretical considerations render it probable that such a process really occurs at some stage of development.

IN connection with the preceding paragraph, reference may be made to a paper by Miss H. D. King, in the June issue of the Proceedings of the Academy of Philadelphia, on a new sporozoan parasite (*Bertramia bufonis*) found in "Bidder's organ"—a rounded body at the fore-end of the testis—of the common American toad. The interest of the discovery lies in the fact that hitherto scarcely any sporozoans have been recorded in amphibians; but, as the author observes, these creatures are probably as much subject to parasitic infestation as other vertebrates, and they may accordingly be expected to yield many new forms if thoroughly examined.

FROM an article on the history of the tomato, contributed by Mr. W. Dürkop to *Naturwissenschaftliche Wochenschrift* (September 1), it appears that the plant was introduced into Europe, probably into Spain or Portugal, from Peru, shortly before the year 1560, and was first cultivated for its ornamental appearance. Fruits of different colours and shapes were grown in the sixteenth century, but the cultivation declined until the last century, when the fruit came into favour as an esculent.

MR. T. H. GATES has published in the *Botanical Gazette* (February and July) two interesting papers dealing with the cytology of *Oenothera Lamarckiana* and the mutant *Oenothera lata* raised by de Vries. The author investigated the development of the anther in *Oenothera lata*, but was unable to discover why the pollen fails to mature, although it appears to be connected with the early disintegration of the tapetal cells. The pollen of *Oenothera Lamarckiana* was used for raising a hybrid in which the sporophyte stage showed twenty or twenty-one chromosomes, thus differing remarkably from the parents, which both contain only fourteen chromosomes in this stage.

THE July number of the *Indian Forester* opens with a brief appreciative notice, contributed by Mr. S. Eardley-Wilmot, referring to the work of the late Sir Dietrich Brandis, the founder of the Indian Forest Department, and friend of many senior officers in the service. A record of the flowering of the bamboo *Cephalostachyum pergracile* in Lower Burma is reported by Mr. E. V. Ellis. The flowering, although not quite complete, was observed over several hundred acres, and the plants were of two different ages, but neither mature. Gregarious flowering over a few acres had been noted previously. Mr. A. M. Burn-Murdoch communicates a note on damar collection in the Federated Malay States, and Mr. M. Hill provides an account of the introduction of the mahogany tree, *Swietenia mahagoni*, into India.

THE first translator into modern Persian of Morier's famous novel, "Haji Baba," was Haji Shaikh Ahmad-i-Kirmani, a member of the so-called "heretical" sect of the Babis. He retired from Persia to Constantinople in order to continue his studies, and when the Sultan became alarmed at the assassination of the late Shah, Nasr-ud-din, the Turkish authorities basely surrendered the Babi to his hereditary enemies, by whom he was slain at Tabriz. When his version of "Haji Baba" reached Ispahan, it was welcomed with enthusiasm by the Persians as the first great novel written in their language; but when they became acquainted with the English original it ceased to be popular, and was regarded as a satire on all grades of Persians from the Shah downwards. This translation has now been reprinted in Calcutta by Lieut.-Colonel Phillott, Secretary to the Board of Examiners, who has added a brief grammar of modern Persian and a body of valuable notes explaining, not only the slang and popular expressions which abound in the book, but many usages, superstitions, and beliefs of the people. In its present form the book is certain to become popular among all who desire to learn, not so much the classical language, as that now spoken in Persia.

AN exhaustive monograph on the asbestos and manganese ore deposits of Ilocos Norte, by Mr. Warren D. Smith, is published in the *Philippine Journal of Science* (vol. xi., No. 3). The deposits occur in the northern portion of the island of Luzon, and are of considerable extent. The region is of special interest from the varied character of the geology. More diverse features are exhibited than in most parts of the archipelago. The region is primarily one of metamorphism, and this metamorphism is regional rather than local.

AN interesting note by Prof. Omori on the tilting of the ground during a storm appears in the August Bulletin of the Japanese Imperial Earthquake Investigation Committee. On October 10 and 11, 1904, a cyclone, the centre of which passed over the sea to the east of Tokio, was accompanied by a tilting of about $3\frac{1}{2}''$ towards the area of low pressure; on January 10 and 11, 1906, the track of a cyclone centre passed over land, close to Tokio, from south-west to north-east, and was accompanied by a tilting, first to the east and afterwards, as the low pressure passed eastwards, to the westward, the total change of inclination being about $2''\cdot87$. In the latter case the ground rose under the area of low pressure, in the former it sank. The difference is attributed to the fact, recorded in a previous paper, and noticed in NATURE of November 3, 1904, that the sea-level commonly rises by more than the amount necessary to compensate for the diminution of barometric pressure, so that the resulting pressure on the sea bottom is actually greater with a low than with a high barometer. This number of the Bulletin also contains, among other papers, a note on the long-distance records of the Turkestan earthquake of August 22, 1902, in which we notice that the word "mean" seems to have a peculiar significance in Japan, as the mean value is tabulated of a group of two observations, one of which is excepted!

THE engineering experiment station of the University of Illinois has published a Bulletin (No. 13), by Dr. N. Clifford Ricker, professor of architecture, describing an extension of the Dewey decimal system of classification applied to architecture and building. The decimal classification has been largely adopted in libraries in Europe and America, and the proposed extension should prove useful to architects and engineers for classifying collections of lantern-slides and photographs, and for a card index to technical periodicals.

THE Director-General of Indian Observatories has issued a memorandum, dated August 8, with reference to the probable monsoon rainfall during August and September, 1907, based on data obtained since the publication of the previous memorandum of June 8. Among the chief factors taken into consideration were the excess of pressure in South America in July, while in the Indian Ocean the deficiency still persisted. It has previously been pointed out that these conditions are favourable to Indian rainfall, and Dr. Walker thinks it likely that the total amount during August and September will reach or exceed the average.

SEPTEMBER has so far proved exceptionally fine over the entire country, and the whole period since the 5th or 6th of the month has been almost entirely rainless. At Greenwich rain fell on each of the first five days, the aggregate measurement being 0·44 inch, but no rain has fallen subsequently, the dry weather continuing practically for three weeks. At Yarmouth the rainfall to September 25 was 0·23 inch, whilst the average for the month is 2·41 inches, and at both Clacton-on-Sea and at Dover the rainfall amounts to 0·27 inch. The rain has been heavier and more frequent in the north, and at Sumburgh Head there have only been three days without rain, the total measurement to September 24 being 2·64 inches, which is only 0·68 inch short of the average for the whole month. Much mist or fog has prevailed during the past week in many parts of the country, and radiation frost has occurred at night. At Greenwich the exposed thermometer on the grass fell to 24°·7 on the morning of September 23, and there have already been four frosts in the open, as shown by the exposed thermometer, since the commencement of the month. A change in the type of weather is in progress, and the steadily falling barometer foreshadows the setting in of unsettled conditions.

IN accordance with the decision of the International Union for Cooperation in Solar Research that a re-determination of the wave-lengths of certain standard lines should be carried out by independent observers by the interference method of Drs. Fabry and Perot, Mr. A. H. Pfund, of Johns Hopkins University, has, according to a note in the *Physical Review* for August, recently measured the iron lines, and has obtained values which differ from those of Fabry and Perot by less than one part in a million. Mr. Pfund is now engaged in measuring the wave-lengths of the titanium lines.

THE *Zeitschrift für Instrumentenkunde* for August contains a short account, by Dr. von Rohr, of the life and work of the late Dr. S. Czapski, of Jena, so well known for his masterly article on Abbe's theory of optical instruments in Winkelmann's "Handbuch der Physik." He was born in 1861, and after a university education became Abbe's private assistant in 1885. He possessed a wonderful power of grasping the essential points of anything new brought to his notice, and Abbe found in him a friend to whom he ultimately entrusted the publication of his theories.

TWO papers from the pen of Dr. L. A. Bauer which have appeared recently serve to remind us of the prominent position which the United States is taking in the extension of our knowledge of the magnetic state of the earth. The first, in the *Technology Quarterly* for June, summarises the recent results obtained from a detailed survey of the United States and from the voyages of the survey ship *Galilee* across the Pacific. The second is the official report of the department of research in terrestrial magnetism of the Carnegie Institution of Washington, and deals with the voyages of the *Galilee* from October, 1905, to October, 1906, in greater detail. From the latter we gather that the charts of the Pacific at present in use give variations of the compass less than the true value by 1° or 2°, a very serious defect from the navigator's point of view.

SOME curious observations made a few years ago by Dr. A. Heydweiller as to the electrification of the human body by the bending or stretching of the knee or elbow joint receive their explanation in a paper by Drs. S. Tereschin and A. Georgiewsky in the *Physikalische Zeitschrift* for September 1. According to the latter, the electrification produced is due entirely to friction of the foot of the person experimented on on the insulating stand on which he is placed, or, if he is clothed, to the friction between body and underclothing or between under and overclothing. For the electric charges produced in these circumstances the human body is comparatively a good conductor.

IN the *Revue scientifique* for August 31, Dr. C. Féry gives a short illustrated account of the new methods of determining high temperatures in industrial operations. For temperatures up to 700° C. he recommends a thermo-electric couple of iron-constantan, from that to 1300° C. one of platinum and its alloys, in each case in combination with a self-registering arrangement. Where the thermo-couple would be injured if brought into direct contact with the source of heat, he advocates the use of his own pyrometer, in which the radiation from the source is concentrated by a concave mirror on to the thermo-junction. For sources of small dimensions at temperatures above 900° C., optical pyrometers, *e.g.* Wanner's, are the most useful.

THE question of the improvement of the "small power load," to which electric supply companies and borough electricity committees are perforce paying more attention at the present time than heretofore, is raised in an article by Mr. H. S. Hatfield in the *Electrician* of September 13. The difficulties attendant on the development of the small power load, and the inability of the private lighting consumer to avail himself of the offer of cheap power, have been up to the present very great, owing to the fact that the supply must be separately metered, and it is necessary either to instal duplicate wiring or to use submeters. The cost of a separate service generally bars the use of heating and power appliances by the small consumer. The submeter system is free from the objection of first cost to a great extent, and the meters may be removed and used elsewhere, but so far this system has not been adopted to any extent. The objections to the submeter system have been that, although the capital expended on meters would not be irrecoverable, still the cost of four or five trustworthy meters would be considerable; also the average electricity meter is very unsightly. A new submeter which overcomes a great many of the objections of the existing meters is, however, now obtainable, and should help largely towards the development of the small power load. The meter is of the mercury-electrolytic type, and has been proved to be very accurate; it fits over the ordinary two-pin wall plug. It is an inexpensive matter to fix this meter in several rooms wherever a consumer may wish to employ a heating appliance, and he is able to read the meter without trouble and know exactly what his radiator or kettle—as the case may be—is costing him.

UNDER the title "Probleme der katalytischen Forschung" (Leipzig: Veit and Co., price 1.20 marks) Dr. Gertrud Woker has published in pamphlet form an inaugural address delivered at the University of Bern. A suggestive review is given of such questions as the nature of the catalytic changes occurring in the oxidation of sulphur dioxide by nitrous fumes in the chamber process of making sulphuric acid, the problems of autoxidation, the action of the so-called oxydases within the organism, and the nature of the transformations brought about by enzymes in general; finally, the relationship between toxins and anti-toxins is discussed as a phenomenon of physical chemistry governed by the law of mass action.

THE first meeting of the new session of the Entomological Society of London will be held on Wednesday next, October 2, when a paper will be read on the butterflies of Mauritius and Bourbon by Lieut.-Colonel N. Manders.

WE have received from Messrs. F. Darton and Co. their illustrated price list of standard meteorological and other instruments. Some useful notes are given for the benefit of students and others, together with a list of text-books recommended; the latter might be revised with advantage. Before establishing new stations, observers would do well to consult recognised meteorological authorities, especially as regards the installation and proper exposure of the instruments.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN OCTOBER:—

Oct. 1. 18h. Jupiter in conjunction with the Moon. (Jupiter 1° 11′ S).
2. 12h. 58m. Minimum of Algol (β Persei).
4. Saturn apparently without rings.
5. 9h. 47m. Minimum of Algol (β Persei).
8. 6h. 36m. Minimum of Algol (β Persei).
14. 17h. Mars in conjunction with the Moon. (Mars 1° 47′ S.).
18. 6h. Saturn in conjunction with the Moon. (Saturn 2° 13′ N.).
18–22. Epoch of October meteors. (Radiant 92° + 15°.)
22. 22h. Mercury at greatest elongation, 24° 20′ E.
26. 19h. Venus in conjunction with α Libræ. (Star 0° 5′ S.).
28. 8h. 18m. Minimum of Algol (β Persei).
29. 9h. Jupiter in conjunction with the moon. (Jupiter 1° 41′ S.).

SPECTRUM OF DANIEL'S COMET (1907*d*).—Photographs of the spectrum of comet 1907*d*, taken with a Zeiss prismatic camera, were obtained by Herr H. Rosenberg at the Göttingen Observatory on August 9, 11, and 14, with exposures of twenty-five, twenty-eight, and eighteen minutes respectively. The results of the measurements of the spectrograms are uncertain to about ±10 Ångström units, but certainly show that the spectrum includes the chief hydrocarbon and cyanogen bands, with a continuous spectrum extending from about 505 $\mu\mu$ to 370 $\mu\mu$. The brightest bands are those coinciding with the two heads of the third cyanogen band at $\lambda\lambda$ 3883 and 3872 respectively; the third strongest band of the seven measured coincides with the fourth carbon band at λ 4737. Two bands at $\lambda\lambda$ 4055 and 4035 are as yet unidentified. The photograph of August 9 showed bands at 473, 438, 423, 404, and 388 $\mu\mu$ in the spectrum of the comet's tail, all of which were apparently of equal length and strength.

A continuation of the ephemeris of this comet, computed by Herr J. Franz from Dybeck's elements, appears in the same journal (*Astronomische Nachrichten*, No. 4200, p. 401, September 12); the following is abstracted therefrom:—

Ephemeris 12h. (M.T. Berlin).

1907	α (true) h. m.	δ (true) ° ′	$\log r$	$\log \Delta$	Brightness
Sept. 25	11 4·8	+5 47·1	9·8550	0·2085	4·89
29	11 21·9	+4 32·1			
Oct. 3	11 37·7	+3 20·7	9·9264	0·2453	3·00

THE LOWELL EXPEDITION TO THE ANDES.—A second communication from Prof. David Todd to Dr. W. J. S. Lockyer gives additional information concerning the work of the Lowell expedition, of which Prof. Todd is in charge. It appears that at the chief station of the expedition, Alianza, more than 7000 photographs of Mars were obtained during the period June 17 to August 1. Prof. Lowell's discussion of these will form a most important addition to areography, as they show, covering a complete round of the planet, the changing appearances of the two polar caps, a multitude of "oases," and hundreds of the "canals," many of which are plainly in the geminate form.

The photographed images of the planet, as enlarged by the Gaertner camera, are of about three-sixteenths of an inch diameter, and will admit of much further enlargement. Exposures of about two seconds were given on Seed and Cramer plates.

SEPTEMBER METEORS.—The appearance of several bright meteors during the present month is reported from various quarters, but no details of the paths are given. One very fine one was seen at South Kensington by Mr. H. E. Goodson at 11h. 20m. on September 9. The meteor itself disappeared behind a house-top, but left a splendid trail which persisted for fully one-quarter of a minute. Judging from this trail, the direction of the meteor's flight was along a line from β Ursæ Minoris, passing half-way between θ and ι Draconis. The meteor was very brilliant and swift, and was followed almost immediately by a less bright one, which pursued nearly the same path.

PHOTOGRAPHS OF PHŒBE.—Using the 30-inch reflector of the Greenwich Observatory, Mr. Melotte has obtained a series of photographs of Phœbe, Saturn's ninth satellite. The results derived from provisional measurements of the plates show that Dr. Ross's ephemeris, published in the second edition of the American Ephemeris for 1907, is essentially correct (the *Observatory*, No. 387, p. 366, September).

SOLAR ACTIVITY AND TERRESTRIAL PHENOMENA.—We have received from MM. Cirera and Balcells, of the Tortosa Observatory, Spain, a discussion of the relations observed to exist between the variations of solar activity and of terrestrial magnetism and electricity during the first three months of this year.

From this discussion the observers arrive at the following conclusions:—(1) the solar activity increased in January, passed a maximum in February, and decreased during March; (2) the regions of activity exhibited motions in the opposite direction to the sun's rotation; (3) the variations of activity often commenced in the chromosphere. Regarding the correlation of these variations with magnetic and electrical perturbations, the following conclusions were arrived at:—the perturbations either coincided with the appearance of a region of activity on the eastern limb of the sun, with the passage of such a region over the sun's central meridian, or with an extraordinary increase of activity near to the central meridian.

On March 22 an observed strong perturbation coincided, in time, with the central-meridian passage of a region which had been active during the previous rotation of the sun, and on certain dates in January and February the perturbations were more intense on the meridian passage of a region which, having been active before, was increasing in activity.

Three excellent drawings of the great January to April (1905) sun-spot made by Prof. Mascari are reproduced in No. 7, vol. xxxvi., of the *Memorie della Società degli Spettroscopisti Italiani.*

THE JUVISY OBSERVATORY.—An interesting description, illustrated with photographs, of the Juvisy Observatory appears in the August and September issues of the *Bulletin de la Société astronomique de France.* The observatory was founded in 1883 by M. Flammarion, and is principally engaged on planetary observations.

BOTANY AT THE BRITISH ASSOCIATION.

THE time of Section K was considerably occupied in joint meetings with other sections. Thus there was a joint discussion with Section D on "The Physical Basis of Heredity," of which an account will be found in "Zoology at the British Association" (NATURE, September 19, p. 530), and another with Sections D and L on "The Teaching of Biology in Schools," which is described in "Education at the British Association" (NATURE, September 12, p. 505).

A third joint meeting was held, with Sections C, D, and E, to hear an address by Prof. Conwentz, the Prussian State Commissioner for "Naturdenkmalpflege," on "The Preservation of Natural Monuments." Prof. Conwentz explained that the phrase "natural monuments" was new in Germany as well as in England, but we should recognise that there could be monuments of nature as well as of art. The constant inroads of cultivation and of industrial undertakings have led, and are leading, especially in countries with crowded populations, to the disappearance of scientifically interesting and even unique natural objects and types of scenery. A widespread feeling has arisen that as much as possible should be done to prevent such destruction, and this has recently led, not only to much local effort directed towards this end, but in Prussia to the institution of a special State department under the Minister of Education for the purpose of directing and coordinating such efforts. This department (of which the lecturer is the head) has no funds allotted to it for the actual purchase of land bearing natural monuments, nor is it considered that purchase is the right procedure except in special cases. The aim is rather to get private owners interested in the natural monuments on their property, and to induce them to be responsible for their safeguarding and preservation. In the case of Government land, the Forestry Department cooperates by making regulations prohibiting the felling of unique trees, the total clearance of particular types of woodland, &c. Prof. Conwentz's department is prepared to initiate all effort of this kind in Prussia. Its activity has already, during the single year of its existence, met with considerable success. Many areas of primitive marsh and water, heath and woodland, often containing rare and interesting characteristic species of animals and plants, have been saved from destruction, and arrangements made for their permanent preservation. The necessary work falls under three heads:—first, the cataloguing of the natural monuments of the country; secondly, the mapping and scientific description of such monuments; and thirdly, the undertaking of appropriate means for their preservation.

Prof. Conwentz directed attention to the numerous organisations in this country the work of which tends towards this general object, but pointed out that none of them have precisely the same ends in view as his Prussian department. He particularly mentioned the Commons Preservation Society, the Kyrle Society, the National Trust for the Preservation of Places of Historic Interest and Natural Beauty, and the Central Committee for the Survey and Study of British Vegetation. He suggested that the last-named organisation might add the preservation of British vegetation to its objects, and also that efforts in this direction might be helped by the British Association. He pointed out that love for and care of the characteristic natural scenery of the homeland was one aspect of true patriotism, and should act as a check on the purely materialistic development of modern civilisation. The lecture was illustrated by a beautiful series of lantern-slides showing types of protected scenery in Germany, and also of many British examples of a similar kind.

Discussion on the Cytology of Reproduction in the Higher Fungi.

This occupied most of Monday morning, August 5. Three papers were read, and were followed by a discussion.

In the first paper Miss Fraser and Miss Chambers described the development of the ascocarp in *Aspergillus* (*Eurotium*) *herbariorum.* The archicarp consists of a unicellular trichogyne, a unicellular ascogonium, and a septate stalk. An antheridium, divided into a stalk and antheridial cell, is present, and usually fuses with the trichogyne; both structures are cœnocytic. After normal fertilisation or its equivalent, the ascogonium becomes septate and produces ascogenous hyphæ. A sheath is developed, and finally asci are formed. In these, nuclear fusion takes place, and three divisions follow, giving rise to the nuclei of the eight spores.

The authors regarded the genus Aspergillus as primitive, and related its archicarp to that of other groups of Ascomycetes. They pointed out that the male organ closely resembles the antheridium of discomycetous forms; on the other hand, if the antheridial cell, instead of fusing with a neighbouring archicarp, were set free from its parent hypha, it would scarcely differ from the spermatium of the Pyrenomycetes. They held, with Wolfe, that a similar development had taken place among the Florideæ, and regarded the Ascomycetes as a monophyletic group.

Miss Welsford's paper dealt with fertilisation in *Ascobolus furfuraceus.* She confirmed Harper's statement that the archicarp, or scolecite, originates as a row of uninucleate cells. These subsequently become multinucleate, and one increases in size and gives rise to ascogenous hyphæ. Nuclei migrate into this cell and undergo fusion before passing into its branches. Miss Welsford regarded this process as a form of reduced fertilisation, and suggested two interpretations—either (1) the scolecite is a multicellular female organ and the fusions are those of female nuclei in pairs, or (2) the ascogenous cell only is female, the other cells of the scolecite being vegetative and representing a functionless trichogyne and stalk; in this case fertilisation probably consists of the union of a female and a vegetative nucleus.

In the third paper Miss Fraser gave an account of the cytology of *Humaria rutilans.* In this species sexual organs are not developed, but a reduced form of fertilisation obtains, the nuclei of the vegetative mycelium fusing in pairs. Asci are developed from hyphæ which contain fusion nuclei; these show sixteen chromosomes, the sporophytic number, in their mitoses. In each ascus three nuclear divisions take place; the first is heterotype, the chromosomes dividing *transversely*, and the second homotype. These bring about a reduction, related here, as in all other investigated organisms, to normal or reduced fertilisation. During the prophases of the heterotype division, a second nuclear fusion occurs; Miss Fraser suggested a mechanical explanation for this process, and showed that it was occasionally omitted. The sixteen chromosomes which are present throughout the meiotic phase represented the reduced number for two nuclei. The fusion in the ascus is compensated by a peculiar process of reduction taking place in the third division, and termed by Miss Fraser *brachymeiosis.* Sixteen chromosomes are formed from the spireme, and eight pass *without fission* to each daughter nucleus. The reduced number for one nucleus thus appears.

The author considered that this process probably occurred in connection with other asexual fusions also. She related her observations on *Humaria rutilans* to the facts described for Phyllactinia (Harper, 1905) and other Ascomycetes. In conclusion, she pointed out the close analogy between the two fusions in the life-history of Humaria, and suggested that the type of compensating reduction (whether meiotic or brachymeiotic) might be usefully employed to differentiate between sexual and asexual fusions.

The discussion was opened by Prof. Farmer, who agreed that the spermatium of the Florideæ, and no doubt of the Ascomycetes, was closely related to a freed antheridium. He suggested the existence of a further analogy in connection with the events which follow fertilisation. In Ascomycetes a second nuclear fusion takes place in the ascus; in the Florideæ cell fusions occur, but the nuclei are indifferent or repelled. The cases described by Miss Fraser in which ascus nuclei continued their development without fusion might be regarded as intermediate. Prof. Farmer emphasised the dual aspect of nuclear fusion; the process was not primarily originated to associate paternal and maternal characters, but possessed a deep physiological significance.

Prof. Blackman also accepted the theory put forward as to the phylogeny of the male organ. He regarded the variety of female organs among Ascomycetes as difficult to reconcile with their monophyletic origin. The occurrence of both cœnocytic and uninucleate structures was a specially difficult point. With regard to the sexuality of the Ascomycetes, a fairly complete series now existed, including Pyronema (Harper, 1900) and other forms with normal fertilisation; Lachnea (Fraser, 1907) and *Humaria granulata* (Blackman and Fraser, 1906), where the nuclei of the ascogonium fuse in pairs; Ascobolus, where fusion is probably between a female and a vegetative nucleus; and *Humaria rutilans*, where sexual organs are lacking and the vegetative nuclei fuse. Prof. Farmer, in a recent paper, had grouped such various forms of reduction under the general term pseudapogamy, but Prof. Blackman felt that a more detailed classification was required. A further stage would be that in which no fusion took place, and one would then expect a corresponding difference in the divisions in the ascus.

Prof. Blackman accentuated the importance of *Humaria rutilans* as the first case in which the behaviour of the chromosomes in asexual fusions had been elucidated, and dealt with the difference between synaptic and non-synaptic reduction, associating the latter with the fusion of undifferentiated nuclei. In Humaria there is no physiological difference between the two fusions, but the first is obviously the relic of a normal fertilisation. He regarded the definition of a sexual fusion as dependent on the origin of the process, and not on the subsequent behaviour of the nucleus.

Prof. Hartog considered the attempt to differentiate between fusions of sexual and of vegetative nuclei in the ascogonium as puerile, since the pronuclei lose their distinctive sexual characteristics before fusion. He pointed out that brachymeiosis differs from other known types of division in that a sorting, but no splitting, of the chromosomes takes place, and referred to the unexplained fusions of three gametes in the Volvocineæ.

Dr. Darbishire spoke of the complex structure of the multicellular ascogonia of Lichens, and Prof. Buller suggested that a study of the phenomena of spore distribution might throw light on the phylogeny of the Ascomycetes.

Miss Fraser, in replying, dealt with various points raised during the discussion, and pointed out that the difficulty of relating cœnocytic with uninucleate forms was lessened by the occurrence of both states in the scolecite of Ascobolus.

Physiological Papers.

Prof. H. E. Armstrong read a paper by Dr. E. F. Armstrong and himself on "Enzymes, their Mode of Action and Function," which, it is understood, will shortly be published in the *Annals of Botany*. The authors pointed out that the distinctive feature of the chemical changes going on in the bodies of organisms was the fact that they are under the *control* of the action of the bodies called enzymes. Great progress had been made in our knowledge and activity of these bodies within recent years, one of the outstanding conclusions being that all chemical equations involving their action are to be written as reversible changes. It has for a long time been usual to think of ferment action as mainly concerned with destructive metabolic action, but it is probable that the constructive activity of enzymes is really far more important biologically. The authors illustrated the probable structural relations of enzymes to the organic substances upon which they act by reference to the structural formulæ of various sugars, showing that when a given enzyme can act upon several different substances it is because it can work upon a group of atoms common to all these, and in each case holding together the other groups. In the case of albuminoids a complex enzyme is required, but the conception of a skeleton which can only be packed with atoms in a particular way enables us to see that it is unnecessary to assume a mechanism so complex as the structure that has to be produced. It is probable that we should conceive of the constructive activity of enzymes in this way—that the enzyme is a skeleton on which the complicated organic body can be built up. Dr. E. F. Armstrong replied to some questions put by Prof. Reynolds Green and others.

Prof. Bottomley communicated some results of his experiments on the inoculation of nitrogen-fixing bacteria in plants other than the Leguminosæ, and stated that tomatoes had been made to produce a greatly increased crop by this means, the bacteria having been first cultivated in tomato-juice; in wheat the bacteria had been induced to establish themselves in the cortex of the root, though no nodules like those on the roots of Leguminosæ are formed. The economic possibilities of these results, if capable of further development, are sufficiently obvious. Prof. Farmer remarked that this was a case in which we ought to have concluded that if the organism could be cultivated outside the plant it could be got to live upon other plant-cells containing carbohydrates. It had been shown that rusts could be induced to live on different hosts by special training. It was known that wheat can go on for an unlimited number of years producing about thirteen bushels to the acre, but this would probably be much exceeded without manuring if the wheat plants, by the aid of these bacteria, were enabled to fix atmospheric nitrogen.

Mr. F. Darwin read a paper on the cotyledon of Sorghum as a sense organ. It was directed towards confirming the belief that the cotyledon is the seat of geotropic sensitiveness, evidence for which was given in a paper read before Section K at Dover (1899), and published in the *Annals of Botany*. The results given in the present paper were obtained partly by Czapek's "glass-boot" method and partly by an adaptation of Piccard's centrifugal method. The conclusions, though not perhaps finally convincing, are strongly in favour of the view that the cotyledon is the geosensitive region. The paper also contains observations on the traumatic and heliotropic curvatures of Sorghum.

Morphological Papers on Pteridophytes and Pteridosperms.

Prof. Bower read a paper on the embryology of Pteridophytes, embodying the result of his recent work on this subject. He pointed out that there are two types of pteridophytic embryo:—(1) the Lycopod type, which agreed with the Bryophytes in having a suspensor; and (2) the fern type, in which there is no suspensor. The main point he wished to bring out was that there is a definite polarity in the embryo defined at once by the first segmentation, the centre of the "epibasal segment" forming one pole coinciding with the stem apex. On the other hand, the polarity of the embryo with regard to the axis of the archegonium is quite variable, as is the number and time of origin of the first leaves and roots, and also of the haustoria and protocorms. In Isoetes there is no suspensor; the initiation of the polarity is changed, and is even variable within the species. The embryo of Isoetes is inverted as compared with an ordinary Lycopod embryo, but is otherwise in line with the other Lycopods. The initial polarity of *Botrychium obliquum*, according to Lyon's account, is also exactly inverted as compared with Ophioglossum. Goebel's position, that the organs of a plant are laid down in the most suitable positions according to circumstances, is not confirmed by the study of embryos. After the first segmentation the polarity is definitely fixed. There was an interesting discussion, in which Dr. Scott, Prof. Oliver, Prof. Weiss, and Mr. Worsdell joined, and which displayed a general agreement with the author's conclusions.

Mr. Gwynne-Vaughan contributed a striking paper on the real nature of the so-called tracheids of ferns. The author was led by some observations on fossil Osmundaceæ to investigate the pitting of the xylem elements of modern ferns, and was led to the unexpected result that the "pits" are really quite open, placing the cavities of adjacent elements in free communication, while the pits themselves communicate with one another in the thickness of the wall, a "pit-closing membrane" being quite absent. In other words, the wall of the typical xylem element of a fern consists of corner columns joined by pairs of separate horizontal bars. In development the corner columns and bars are gradually lignified, while the pectic substance forming the rest of the primitive wall becomes granular and disappears. In *Pteris aquilina* the substance joining the two bars of each pair remains, though the pits themselves are open. The author exhibited preparations fully demonstrating the facts described in his paper.

Prof. F. W. Oliver read a paper on the structure and affinities of *Physostoma elegans* (Williamson), a pteridospermous seed from the Coal-measures, in which he gave a full description of the seed in question. Williamson afterwards called it *Lagenostoma physoides*, and it is certainly closely allied to the Lagenostomas. Nevertheless, it possesses certain curious and unique features which well warrant its separation, and lead to the conclusion that it represents one of the most primitive types of pteridospermous seed as yet discovered.

Mr. D. M. S. Watson described the cone of *Bothrodendron* (*Lepidodendron*) *mundum* as practically a Lepidostrobus with the radial extension of the sporophylls very much reduced, a state of things that would be expected from a consideration of the vegetative organs. It appeared that there had been a confusion with Miadesmia, the block containing the latter plant also having fragments of two other Lycopod cones, of which this is one. The idea of an immediate connection with Spencerites must be given up. In the course of the discussion Prof. Weiss remarked that we now know Bothrodendron more completely than any other fossil Lycopod.

Papers on Schizophyta.

Mr. David Ellis read a paper on the phylogenetic connections of the recent addition to the thread-bacteria, *Spirophyllum ferrugineum*, Ellis, in which he showed that the new species links the iron-bacteria with the genus Spiromonas, and suggested that the definition of Migula's order Chlamydobacteriaceæ should be modified so as to include both of these genera.

Mr. B. H. Bentley read a paper on cell-division in Merismopedia, in which he described a process like karyokinesis in the cells of this genus. The paper was somewhat adversely criticised by Mr. Wager.

Ecological Papers.

Prof. Yapp communicated a paper by Prof. H. H. W. Pearson (Cape Town) describing a botanical excursion to the Welwitschia desert. The conditions obtaining in this desert (German South-West Africa) are remarkably severe—the annual rainfall varies from zero to 3 cm., the illumination is very intense, and surface deposits of saltpetre and other salts are frequent. This severity of conditions, which must affect the germination of seedlings, results in an extreme paucity of vegetation. One may sometimes walk for miles without seeing a single flowering plant, while as regards species, in the British territory of Walfisch Bay, the total phanerogamic flora, excluding that of the Khusib river-bed, probably does not number more than twelve species. Welwitschia itself has a range extending from 14° to 23° S. latitude. It seems to prefer more or less sheltered and sloping valleys at an elevation of about 100 feet above sea-level. The author gave some interesting observations respecting the pollination of Welwitschia, adducing evidence to show that it is largely effected through the agency of a parasitic hemipterous insect (Odontopus), which is apparently never absent from the plant.

By comparing the Welwitschia plants of known age at Kew with the youngest seen in Damaraland, Prof. Pearson estimates that the latter cannot be less than forty to fifty years old. From this it follows that the conditions necessary for the successful germination of the seeds of Welwitschia occur but rarely. As there are not wanting indications that the rainfall of this area was once considerably in excess of the present one, it is to be feared that the effective reproduction of Welwitschia is now more rare than formerly, and that, with the continuance of the climatic conditions at present prevailing in western Damaraland, the species is doomed to become extinct in its native region.

Prof. R. H. Yapp gave a paper on the hairiness of certain marsh plants. A considerable number of plants found in damp or marshy habitats possess a more or less dense covering of hairs. Many of these plants, however, show seasonal differences in respect of hairiness. Thus the leaves formed in spring on low-growing shoots are usually small and glabrous, while the later leaves, especially those on the erect flowering shoots, are larger, and increasingly hairy. *Spiraea Ulmaria* was referred to in some detail. In spring this species successively forms glabrous, partly hairy and densely hairy leaves. The partly hairy leaves show a regular distribution of the tomentum on their lower surfaces, the leaves decreasing in hairiness from above downwards, while the margins are generally more hairy than the central parts of the lamina. This distribution of hairs is suggestive, in view of the fact that if *Spiraea ulmaria*, var. *denudata*, an entirely hairless variety, be grown in an exposed situation, its leaves suffer more than those of the hairy form, and that the withering due to exposure first begins in those parts of the leaf which, in the hairy variety, are the first to be covered with the tomentum.

Other Papers.

Mr. R. P. Gregory read a paper on the inheritance of certain characters in *Primula sinensis*, in which he dealt with experiments on the inheritance of long and short styles, leaf form, colour of stems and petioles, and, lastly, of flower colour. While some of these characters obey simple Mendelian rules, the colour inheritance presents very complex problems which are by no means completely elucidated. Two distinct classes of whites in flower colour were separated. Sutton's "Snowdrift," with pure green stems, is a true albino, but in all the other races of white-flowered plants a character occurs which inhibits the development in the flower of a colour potentially present in the plant. The results of crossing these "dominant whites" with coloured flowers are complex. Various partial explanations of the observed results were suggested by the author.

Local Papers.—A paper on Charnwood Forest, illustrated by particularly beautiful lantern-slides, was read by Mr. W. Bell, the local secretary, in which the scenery and vegetation of the forest were treated descriptively and historically, and by a comparison of old lists of species with those found at the present day the effect of drainage and cultivation on the native flora was brought out.

Mr. A. R. Horwood read a paper on the disappearance of certain cryptogamic plants from Charnwood Forest within historic times. In this paper the great impoverishment of the lichen flora was particularly noticed, and was attributed largely to the effect of smoke, a similar phenomenon to that observed in the region affected by the Lancashire and Yorkshire smoke-cloud.

Semi-popular Lecture.—Prof. Weiss delivered the semi-popular lecture on "Some Advances in our Knowledge of the Pollination of Flowers." The lecturer dealt with the newer work on this subject, and discussed its bearing upon the older views of the mechanisms of pollination.

Excursions.

By invitation of Mr. C. C. Hurst, an excursion (in conjunction with Section D) took place to Burbage to examine the results of his experiments on Mendelian heredity in rabbits, sweet-peas, &c., and also to witness a demonstration of the inheritance of eye-colour in man, for which about 100 school children from the families studied by Mr. Hurst were assembled. Most unfortunately, rain to some extent interfered with the success of these extremely interesting demonstrations, but Mr. Hurst very kindly repeated them in Section D at a later period of the meeting. The allelomorphic pair of characters in eye-colour studied by Mr. Hurst are the presence or absence of brown pigment on the front of the iris. Eyes with the former character are called *duplex*, with the latter *simplex*. "Duplex" is dominant to "simplex."

A successful excursion to Charnwood Forest, under the guidance of Mr. Bell, took place on the Saturday (August 3), and an excellent idea of the vegetation of the uncultivated portions of the forest was gained by the members of the section.

ECONOMIC GEOLOGY IN THE UNITED STATES.

STRIKING evidence of the work which the United States Geological Survey is carrying on for the direct advancement of mining interests throughout the country is afforded by a batch of eight Bulletins recently received. These Bulletins cover 1562 pages, and are copiously illustrated with plates and coloured geological maps. The most valuable of the series is Bulletin No. 315, dealing with contributions to economic geology in 1906, the object of which is to secure prompt publication of the economic results of investigations made by the survey. This Bulletin deals with the metals, structural materials, and other non-metals. A separate bulletin will be issued later dealing with survey work on coal, lignite, and peat. In investigations of ores during the year, reports are given by Mr. W. Lindgren on an interesting group of thin veins carrying wolfram in Boulder County, Colorado, which now constitute one of the most important sources of tungsten in the country; by Mr. H. S. Gale, on some new deposits of the uranium and vanadium-bearing mineral carnotite, which occur in the upturned Dakota sandstones east of the coal basins in Rio Blanco County, Colorado, deposits of importance as a further possible source of radium; and by Mr. G. F. Kay, on the deposits of silicate of nickel near Riddles, in Oregon. Much work was done in connection with iron ores, and reports are given on the red ores of the Birmingham district, Alabama, by Mr. E. F. Burchard; on the brown iron ores of the Russellville district, Alabama, by the same author; and on the grey iron ores of Talladega County, Alabama, by Mr. P. S. Smith. Mr. A. C. Spencer describes the magnetite deposits of Pennsylvania, and Mr. S. H. Ball the important iron-ore district at Hartville, Wyoming, and the titaniferous iron ore of Iron Mountain, Wyoming. An interesting investigation was made on glass-sands by Mr. Burchard. He gives the results of chemical and physical tests, not only of glass-sands now in use, but also of sands from undeveloped deposits which seem available for use as glass-making material. Prof. A. H. Purdue deals with the recently discovered phosphate fields of Arkansas, and Messrs. F. B. Weeks and W. F. Ferrier describe a new and important phosphate district at Montpelier, Idaho, in the western United States. The discovery has opened up a new industry in the West.

The progress of investigations of the mineral resources of Alaska in 1906 is dealt with in a separate report (Bulletin No. 314). An increase of nearly 50 per cent. in the value of the gold output of 1906 over that of the previous year is the best evidence of the advancement of the mining industry in Alaska. Copper mining has undergone a rapid expansion, and other mineral deposits, such as coal, marble, tin, and gypsum, have also received considerable attention. The progress has consisted in the development of the older districts rather than in discoveries of new mineral fields.

The Juneau gold belt, Alaska, forms the subject of a separate report by Mr. A. C. Spencer (Bulletin No. 287). This belt comprises the mainland strip of south-eastern Alaska from Berners Bay on the north-west to Windham Bay on the south-east, together with Douglas Island. The ores met with are mainly gold, though silver is usually present in small amounts. At the mines of the Treadwell group in Douglas Island, the methods of mining employed represent the highest possible attainment in the successful working of low-grade ores. For the last few years the average value of the material passing through the mills has been only about 8*s*. per ton.

The zinc and lead deposits of the Upper Mississippi Valley are described in great detail in a report by Mr. H. Foster Bain (Bulletin No. 294). The presence of ore deposits in this region was well recognised as early as 1687, but the early work was restricted to lead mining, the zinc ores being disregarded. The rise in the price of zinc ore in 1899 attracted attention to the district, and since 1903 its development has been rapid. The author gives an account of the present condition of the district and a statement of ideas relating to the formation of ores. The geology of the district is simple. The region is one of unmetamorphosed, little disturbed, sedimentary rocks of Palæozoic age, and there are no igneous rocks nor recent ones near it. The ore-bearing rock is a massive dolomite. The ores, consisting of blende, smithsonite with galena and marcasite, occur in crevices, in honeycomb masses, in pitches and flats, and as disseminations. The ore bodies are doubtless due to concentration or reconcentration through the action of underground waters.

A geological reconnaissance in south-western Nevada and eastern California is described by Mr. Sydney H. Ball (Bulletin No. 308). Ore deposits in the area described appear to be confined to the Palæozoic rocks, the post-Jurassic granitoid rocks, and the older Tertiary rocks.

The economic geology of the Independence quadrangle, Kansas, is described by Mr. F. C. Schrader and Mr. Erasmus Haworth (Bulletin No. 296), who present the substance of what is known concerning the distribution, occurrence, and development of petroleum and natural gas in the quadrangle, and note briefly the more important industries growing out of these natural resources. Mr. F. C. Clapp describes the economic geology of the Amity quadrangle, Eastern Washington County, Pennsylvania (Bulletin No. 300). The main interest in this area, which is situated near the centre of the north end of the Pittsburg coalfield, lies in the facts that it has been the seat of extensive petroleum and natural gas development, and that it is almost entirely underlain by at least one valuable seam of bituminous coal.

In the last report to be noticed Mr. E. C. Sullivan discusses the interaction between minerals and water solutions, with special reference to geological phenomena (Bulletin No. 312). Although not directly the result of geological field work, it has an important bearing on such work in that it is a chemical investigation of some of the problems most frequently met with in the study of the origin of ore deposits. Some of the changes that take place at ordinary temperature when water solutions are brought into contact with rock-forming minerals have been investigated. The result has been to make it apparent that chemical reaction between natural silicates and salt solutions is a very general phenomenon, taking place to a decided extent immediately upon contact, and that the outcome is mainly an exchange of bases in chemically equivalent quantities between solid and solution. The metal of the dissolved salt is precipitated, and an equivalent quantity of silicate is decomposed, and its bases enter the solution. Salt solutions as decomposing agents are much more active than pure water, and are comparable with acids in this respect.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Two courses, open free to teachers in London schools, have been arranged at Bedford College for Women (University of London) for the Michaelmas term; they are:—(1) "The Organisation of Nature-study Courses in London Schools," lecturer, Miss M. R. N. Holmer, Saturdays, 10.30, beginning October 5; (2) "Geology for Teachers of Physical Geography," lecturer, Dr. C. A. Raisin, Wednesdays, 6 p.m., beginning October 9.

IN connection with the garden produce, poultry, and honey competitions of the Kent County Council and of the National Potato Society at the South-Eastern Agricultural College, Wye, Kent, on Wednesday, October 2, a conference will be held, when an address will be given by the principal, Mr. M. J. R. Dunstan, to be followed by discussion.

SIX lectures, open to the public without payment or ticket, on the "History of Statistics and the Nature and Aims of Modern Statistical Methods," will be given at

University College by Mr. G. U. Yule on Wednesdays at 5.30, commencing Wednesday, October 9. A course of ten lectures will be delivered on Saturday mornings, beginning on Saturday, October 12, by Mr. F. L. Grant, on "Recent Developments in the Teaching of Arithmetic." This course is open, without fee, to all teachers in London schools. Teachers wishing to attend should apply for forms to the executive officer, London County Council Education Offices, Victoria Embankment, W.C. Forms should be returned by Monday next, September 30.

At the autumnal meeting of the Association of Chambers of Commerce, held at Liverpool last week, the following resolution was carried:—"That it is of the highest importance that the education of boys be continued after leaving school; that employers be urged to use their influence in inducing boys to attend evening classes and to give facilities for such attendance; that in every locality there should be schools provided for secondary and commercial education and for teaching the scientific and artistic principles underlying local industries to boys and domestic economy to girls." The association also carried unanimously a resolution urging the Government to bring in at an early date, as foreshadowed in the King's Speech in 1905, a measure for the conversion of the Board of Trade into a Ministry of Commerce on modern and representative lines.

The "Scholarships and Training of Teachers' Handbook" for 1907–8, just issued by the London County Council, gives particulars of the Council's scholarships and other scholarships open to London children, together with regulations for the admission of pupil teachers, bursars and student teachers, and for admission to training colleges, and a list of London secondary schools. The county scholarships of the Council provide a complete scheme under which a boy or girl may proceed by various stages from the public elementary school to the highest grades of education, whether at a university, technical college, or other institution providing advanced training for a professional career. The scholarships consist of junior county scholarships (ages of candidates, eleven to twelve), intermediate county scholarships (ages fifteen to seventeen), and senior county scholarships and exhibitions (ages, nineteen to twenty-two years). The first class (awarded to all candidates—about 2000—who reach scholarship standard) provides free education at public secondary schools approved by the Council, and a maintenance grant of 6*l*. a year; the second (not less than 100 scholarships), free education at approved secondary schools or technical colleges up to a fee of 25*l*. a year, and a maintenance grant of 25*l*. or 30*l*. a year; and the third class (fifty scholarships) provides a maintenance grant of 60*l*. a year for three years, and tuition and examination fees up to 30*l*. a year. In awarding these senior scholarships, regard is paid to the past successes of the candidates, the financial need, and the recommendations of the teachers under whom the candidates have worked. All candidates for scholarships may be required to present themselves for medical examination, and no award is confirmed if a candidate is found physically unfit to take advantage of a scholarship. In addition to the junior, intermediate, and senior scholarships, the Council awards a number of technical, industrial, and other scholarships, particulars of which are given in the handbook. All the scholarships are confined to candidates resident in the administrative county of London whose parents have incomes not exceeding 160*l*. a year in the case of the junior scholarships, and 400*l*. a year in those of the intermediate and senior scholarships.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 16.—M. A. Gaudry in the chair.—Observations on the electrical action of the sun and moon: Albert **Nodon**. This work was carried out at the observatory on the Pic du Midi, at an altitude of 2877 metres. The results generally confirm those obtained at lower altitudes; the sun induces a positive electric charge varying from 1 to 6 volts per minute, according to the state of the atmosphere. The solar charge is absorbed by passing through a cloud or layer of moist air. The full moon produced a positive electric induction analogous to that of the sun.—A new flying apparatus called the gyroplane: Louis **Breguet**, Jacques **Breguet**, and Charles **Richet**. The lifting force is supplied by rotating planes, driven by a 40 horse-power motor. The apparatus sustained its own weight, together with that of a man (540 kilograms in all), for one minute at a height of 0·6 metre above the ground, and descended slowly as the velocity of the plane was reduced.—A method for the rapid estimation of carbon and hydrogen in organic substances: Pierre **Breteau** and Henri **Leroux**. The vapours driven off by heating the boat containing the substance in a current of oxygen are burnt by an electrically heated spiral of platinum wire, a diagram of the arrangement being given. It is claimed that the time required for a combustion is only from fifteen to forty minutes, according to the nature of the organic substance. No test analyses are given.—The conservation of the arterial pressure in man after the application of high-frequency currents in the form of autoconduction: J. **Bergonié**, André **Broca**, and G. **Ferrié**. The apparatus used gave a frequency in the solenoid of between 400,000 and 410,000, with effective intensities of between 15 and 20 amperes, or from seven to ten times greater than those described up to the present. The conditions for the most advantageous use of the apparatus are given, together with details of experiments on ten subjects. The net result is that high-frequency currents are without action on the arterial pressure.—Remarks on the preceding communication: M. **d'Arsonval**. A discussion of the possible sources of the discrepancies between the results given by the authors of the preceding paper and those of earlier observers.—The agents of coagulation of the milk contained in the juices of *Broussonetia papyrifera*: C. **Gerber**.—The light-receiving terminations in the compound eyes of the Muscidæ: Pierre **Vigier**.

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THURSDAY, OCTOBER 3, 1907.

PROBLEMS OF ANCESTRY.

Vorträge über botanische Stammesgeschichte, gehalten an der Reichsuniversität zu Leiden. Ein Lehrbuch der Pflanzensystematik. By J. P. Lotsy. Vol. i., Algen und Pilze. Pp. iv+828. (Jena: Gustav Fischer, 1907.) Price 20 marks.

THE motive inspiring the production of this important work is indicated on the title-page in the "motto" quoted from Coulter:—

"The most difficult as well as most fascinating problem in connection with any group is its phylogeny. The data upon which we base opinions concerning phylogeny are never sufficient, but such opinions usually stimulate research, and are necessary to progress."

Its pages show how stimulating the inquiry has been to the author, and we have seldom met with a book more likely to awaken inquiry in its readers or to suggest further research. Very different values may be placed on the conclusions as to the phylogeny of several of the groups, and on the characters regarded as of chief importance in forming the system of classification, and further information on many points is very desirable; but there can be only one opinion as to the manner in which the information is conveyed to the reader. Under each group is an admirably clear and full, yet concise, statement of the investigations that have been made upon it, and of their results, while an extensive classified bibliography refers the student to the original and full sources of information. Numerous illustrations, original or after those of the best monographs, add greatly to the usefulness of the work, and to its worth as an exponent of the most recent researches into the structure and cytology of the algæ and fungi.

The form of the book appears somewhat artificial, its substance being divided into thirty *Vorlesungen* of very unequal length, *e.g.* that on Exoascineæ (xxvi.) of four pages, and that on Basidiomycetes (xxx.) of eighty-eight pages. As these could scarcely have each been the subject of a single lecture, and as the longer *Vorlesungen* in some cases include several groups, this arrangement does not appear so convenient as the more usual division into chapters and sections.

The course of lectures opens with the discussion of what constitutes a living being, and of the agreements and differences between plants and animals, but very soon passes to the consideration of the simplest organisms as individual "energids," the multiplication of these, and the bodies built up of the combinations of "energids." An outline of the scheme of classification given early in the first lecture derives all plants from Protomastigina, and traces the supposed derivation of the several groups from these early forms, and their relations with one another. The system of classification of the green algæ is stated by Dr. Lotsy to be largely based on that set forth by Blackman and Tansley in 1902 in the "New Phytologist." Great importance is attached to the number and arrangement of the cilia borne by the reproductive cells, or at least by the male gamete; and these characters are employed in tracing the relationships between widely different groups, *e.g.* the Isokontæ are regarded as representing the ancestral condition of the Pteridophytes and seed-plants.

Scarcely less importance is given to the study of the "energids," or very simple units of individual life, the progress being traced from the monoergid to the polyergid organisation within the larger groups, with resultant advance in complexity of structure. That the conception is one of much value in stimulating inquiry cannot be disputed, but it may be questioned whether it is not carried too far in practically identifying the energid with the nucleus. The very different behaviour of the nuclei of the reproductive cells within a single family, and even within a single genus at times, especially among fungi, may well suggest the need of caution in such matters.

It is stated in the preface that the plan of the work was resolved on after perusal of a lecture by Dr. Hugo de Vries, in which a higher plant is regarded as a double organism. Dr. Lotsy was led to endeavour to trace out in theory how the return to the stage of a single organism is effected, and thus arrived at the conception of the two generations denoted as x and $2x$. The book before us embodies the effort to determine the extent of each of these generations, and in which groups of Thallophyta it is possible to detect them, the essential distinction between them being the well-known reduction in the number of chromosomes in the nuclei of the one generation to one-half those of the other. With this as a clue, Dr. Lotsy seeks to determine the relations of gametophyte and sporophyte in the Thallophyta, extending to these the conception of the alternation of generations so familiar in its applications to the Archegoniatæ. He shows a remarkable familiarity with the results of the most recent as well as of the classical researches into the structure and reproduction of the various families, and applies his leading ideas in a very consistent and able manner. We think that the known is still too limited to permit of a secure foundation being laid for the universal employment of such a criterion; but such a theory, applied with the author's thoroughness and width of view, must stimulate further investigation, and thus do excellent service in the study of botany. The doubts that must be felt with regard to the validity of some of the assumptions and conclusions will themselves lead to inquiries that must advance knowledge still more effectively. Several very important discussions of wide interest are introduced in relation to certain groups that illustrate them, *e.g.* that on the asexual cells and the gametes in Chlamydomonas leads to the consideration of the part taken by the nuclei in inheritance and artificial development of the egg under the stimulus of inorganic salts in solutions. Volvox gives further occasion of discussion on heredity, as does also Hydrodictyon, in which the effects of sugar and other substances on the methods of reproduction receive notice, and the relations of the x and $2x$ generations are compared with what occurs in Uredineæ. Illustrations of similar kind are introduced from among animals also. The functions of the various structures in cells are also discussed; *e.g.* the "vacuole" in Codiaceæ leads to the consideration of its nature, of the "tonoplasts" of de Vries, and of the granules of which protoplasm is built up. So under the bacteria their relations to other organisms as foes or as friends, and their importance in many and different aspects, are well set forth.

But it is needless to multiply examples of the many questions of extreme interest that find a place in the book, such as the existence and significance of "physiological species" among parasitic fungi, the very complex series of forms and relations to their hosts in Uredineæ, and others too numerous to mention.

Nor is it possible in a brief review to attempt to supply any adequate notice of the system of classification employed, or of the links shown or suggested to exist between the groups. The algæ and the fungi are not kept apart, but are grouped together into a system under the ideas explained above. In conclusion, we have to express the hope that this volume may in no long time be followed by the other two, which are to treat of the archegoniate and seed-forming plants. The author has earned the gratitude of botanists by placing within their reach an altogether stimulating book which should do much to win new workers to the absorbingly interesting Thallophyta.

THE COMMERCIAL USE OF PEAT.

Peat, its Use and Manufacture. By P. R. Bjorling and F. T. Gissing. Pp. xii+173; illustrated. (London: C. Griffin and Co., Ltd.) Price 6*s*. net.

THIS book contains a practical account of the different methods of preparing peat for commercial purposes, and of the uses to which peat can be applied. In NATURE of April 18, 1901, the attention of our readers was directed to the peat industry of Sweden, and its use there as fuel for generating steam both for stationary and locomotive engines; also in the number of May 31, 1900, to the exhibits at the Vienna Exhibition of that year of carpets, blankets, and clothing made from this material.

According to the authors of the book now under notice, there are $3\frac{1}{2}$ million acres of peat land in Great Britain and 6 million acres in Ireland. The peat varies in depth from 2 feet to 40 feet. Peat is also abundant in Canada, Denmark, Holland, Germany, Russia, and other countries.

The chief importance of this material at the present time is its value as fuel in districts where coal is scarce. Its great bulk as compared with coal, and its high percentage of water, have, however, hitherto proved obstacles to its extended use. The valuable portion of fuel is its carbon content, and in this respect peat is inferior to coal. An average sample of peat contains 42·7 per cent. of carbon, 4 per cent. of hydrogen, 27·4 per cent. of oxygen, 1·6 per cent. of nitrogen, and 2·4 per cent. of ash. In some specimens the carbon reaches as much as 66·55 per cent. of carbon. Wood contains 52 per cent. of carbon, brown coal 66 per cent., Swedish coal 78 per cent., and English steam coal 81 per cent.

The following results are given of the testing of peat fuel as against coal at Horwich, in Lancashire, under a steam boiler. Coal got up steam to 10 lb. pressure in 2h. 25m., and to 25 lb. in three hours. Peat fuel got up steam to 10 lb. in 1h. 10m., and to 25 lb. in $1\frac{1}{2}$ hours. Twenty-one hundredweight of coal maintained steam at 30 lb. pressure for $9\frac{3}{4}$ hours, whilst $11\frac{1}{4}$ cwt. of peat fuel maintained steam at the same pressure for 8 hours.

Peat has been used on the Bavarian railways for more than sixty years, and has been found economical. It is claimed for peat that, being free from sulphur, it has a much less detrimental effect on the heating apparatus than coal or coke. As regards cost, pressed peat costs 7*s*. 4*d*. per ton, Saxony coal 4*s*. 9*d*., and Ruhr coal 5*s*. 5*d*.; but if cost of carriage be taken into consideration, the peat is 7*s*. 4*d*. against 8*s*. 11*d*. and 9*s*. 8*d*. for the coal.

Experiments were made on the Hartford and Springfield Railway, when a locomotive engine ran in express time 52 miles with 14,000 lb. of peat; and it was found that two-thirds of a ton of peat was equal to one ton of coal for locomotive purposes. Several other trials made with peat for locomotive purposes are given by the authors, and there is no doubt in countries where coal is scarce and peat plentiful the peat bogs may be utilised with very great advantage.

Gas has also been made from peat with very successful results, and in Sweden it has been used for regenerating, puddling, and open-hearth furnaces for the last thirty years. It has also given very satisfactory results for illuminating purposes in Ireland. From a single pound weight of peat one hour's light can be produced; in some peat there is as much as 14,000 cubic feet of gas per ton. In Sweden a ton of peat was found to yield 9295 cubic feet of gas of twenty-four candle-power, a ton of English coal tested at the same time yielding 7063 cubic feet of gas of fifteen candle-power, the by-products being also largely in favour of the peat. Paraffin for candle-making is also distilled from peat.

Another use to which peat has been largely applied is in the manufacture of paper, which dates back in Ireland to 1835. Yarn for weaving purposes is also made from peat. There is now being sold by Messrs. Doré and Son, of London, underwear manufactured from peat. It is also considered an excellent material for bandages and surgical purposes. The other uses to which peat can be applied are numerous, even alcohol being obtained.

The greatest problem encountered in the manufacture of peat fuel is the extraction of the moisture from the peat. There are three general processes in use—air, pressure, and heat. The former is best in a country where a sufficient period of dry weather can be counted on. The various methods resorted to are described by the authors of this book, and illustrations of the machinery given. The latest process for converting peat into fuel is by electricity, which has been tried in Ireland. The peat, after being raised from the bog, is delivered into a rotary hydro eliminator, in which it is subjected to a gradually increasing pressure. The eliminator is continuous in action, the wet material passing in at the top and leaving it at the bottom in a partially dried condition. It is then passed on to the electrifying machine, where an alternating electric current is passed through it, and is then again passed on to a kneading and moulding machine. The cost of manufacturing fuel by this process is such that it can be sold at a large profit. The fuel produced is hard, dense, and comparatively smokeless. Electro peat coal averages 30 cubic feet to the ton, ordinary coal averaging 45 cubic feet.

BOOKS ON WIRELESS TELEGRAPHY.

A Handbook of Wireless Telegraphy; its Theory and Practice. By Dr. J. Erskine-Murray. Pp. xvi+522. (London: Crosby Lockwood and Son, 1907.) Price 10s. 6d. net.

Notions générales sur la Télégraphie sans Fil. By R. de Valbreuze. Pp. vi+169. (Paris: *L'Éclairage Électrique*, 1907.)

THERE is a story, probably apocryphal, of a learned professor who undertook to edit the writings of a colleague. At the end of the first paragraph he started to write a footnote, with which he proceeded until he had completed a treatise in several volumes of far superior value to the work he was supposed to be editing. Dr. Erskine-Murray has adopted exactly the opposite system in writing his "Handbook of Wireless Telegraphy," as the following rough summary of its contents will show. He apparently started out with the good intention of writing the book himself, and in the first few pages has succeeded in presenting from a somewhat original point of view the similarities and differences between the various known systems of telegraphy. But on the ninth page appears the first sign of weakness in a half-page verbatim quotation from Sir Oliver Lodge; there is little harm in this, it is true, or in the quotation of equal length from Von Bezold three pages farther on. But it represents apparently the incubation stage of a disease which subsequently develops alarming severity. At p. 17 we find it establishing a firm hold in a five-page quotation from Hertz. Then for a time all goes smoothly, and we read a description of the earlier wireless telegraphy experiments from the author's own pen with feelings of relief. But on the sixty-second page there is a serious relapse in the form of a quotation twenty-eight and a half pages long from a paper on coherers published by Dr. Eccles in the *Electrician*. At the end of this quotation we are told that the results may be summarised in a few words—the summary occupies sixteen lines. We would suggest that in the next edition of the handbook Dr. Erskine-Murray retains only the summary and gives the necessary reference to the original paper.

After such an experience we are not surprised at meeting on p. 100 the first of three successive quotations occupying, with a dozen or so lines of interpolated reference, more than twenty pages; on p. 124 a three-page quotation from a paper by Lieut. Tissot; on p. 129 five pages from a paper by Mr. Duddell. Then, after a brief rest, comes a twenty-page description of the Lodge-Muirhead system from an article by Mr. Marillier in the *Electrician*, and immediately after this twelve pages descriptive of tests on the Fessenden system, including some very uninteresting official correspondence; and so the handbook proceeds to a finish with two more quotations fourteen and fifteen pages long respectively, and nine others varying from one and a half to six pages in length. The only thing that causes surprise in the latter part of the book is that, when Dr. Erskine-Murray refers to Euclid's "well-known work on geometry" in support of his contention that the *surfaces* to be kept clean in relay contacts are "thin, very thin," he resists the temptation to quote at length from that authority (with kind permission of the author).

It is hardly necessary to say that when in a book of 318 pages, 140 are verbatim quotations from other writers, the whole is not particularly coherent. With all due respect to Dr. Erskine-Murray, we submit that this handbook is a striking example of how not to write on wireless telegraphy or any other subject. Books on scientific or technical subjects have a quite definite function to fulfil, distinct from that fulfilled by publications in scientific journals or papers. One does not look to them for new discoveries, or rarely even new theories, but one expects, in a handbook at least, to find a clear *résumé* of existing facts and theories welded together into a consistent whole possessing some sort of literary as well as scientific homogeneity. He who takes up this handbook with such expectations is destined, we fear, to grievous disappointment, though he may find much of intrinsic value and interest, particularly, for example, the seventeenth chapter, on theories of transmission.

M. de Valbreuze's book is of a different stamp; there is nothing in it very novel, either in subject-matter or treatment, but it gives from start to finish a clear and carefully-thought-out account of electric-wave telegraphy. The author starts in a manner rather characteristic of French writers by a fairly full account of the most elementary electrical and magnetic principles. In fact, it is not until half-way through the book that we are introduced to wireless telegraphy proper. Nevertheless, room is left for a summary of the more important researches and descriptions of the leading systems. Though in no sense an advanced treatise, the book is likely to prove of interest to the expert as well as to the beginner; at least, it can be read through without tedium, and can be recommended to all who, possessing little or even no electrical knowledge, are anxious to become acquainted with the leading principles and practice of wireless telegraphy.

We have already, on more than one occasion, commented in Nature on the number of books which have been written on wireless telegraphy. Each year sees fresh ones added to the list, and still an insatiable public, its imagination fired by the mysterious mechanism of this newest art, is, Oliver Twist like, asking for more. The two volumes before us show how, in different manners, this craving may be allayed.

Maurice Solomon.

OUR BOOK SHELF.

Machine Design. By Prof. Charles H. Benjamin. Pp. vii+202. (London: Archibald Constable and Co., Ltd., 1907.) Price 8*s.* net.

FEW men are more qualified to speak with authority upon the experimental side of machine design than the author of this little book. Indeed, we are inclined to the opinion that it might well have been entitled "Experimental Machine Design," since it deals almost exclusively with Prof. Benjamin's classical experiments upon the behaviour of certain machine parts when tested to destruction. Our general opinion of the book can be summed up in a very few words—"excellent as a sample." We trust, however, that it is but a sample of what the author intends to give to the engineering world in the near future.

Regarded, however, as a general treatise on machine design, we are bound to confess that it is somewhat disappointing, since such a very small portion of the book is devoted to the correct proportioning of even the commonest constituent parts of machinery. The faults of the book are faults of omission rather than of commission; to a large extent the matter given is original and cannot fail to be of great value to designers of machinery. The analytical treatment of some of the problems dealt with is both new and ingenious.

We have noticed a few slips, but they are mostly unimportant. On p. 6 the modulus of elasticity for crucible or tool steel is given as 40,000,000 lb. per square inch. We have tested a great many specimens of such steel, but have never obtained a value of more than 32,000,000 lb. On pp. 11 and 74 the torsion modulus of a square shaft is given as $d^3/4{\cdot}24$, but according to St. Venant, Lord Kelvin and others, this should be $d^3/4{\cdot}81$. The value given for the elliptical section is also in error; it should be $ba^2/5{\cdot}1$.

The experimental investigations of Prof. Benjamin on the bursting strength of cast-iron cylinders, the strength of flat plates, gearing, fly-wheels, and pulleys are of the greatest interest. If only designers of machinery would take to heart some of the lessons taught by these experiments, we should less frequently hear of the disastrous failures of fly-wheels, &c. We trust that he will continue his researches in many directions and incorporate them in a future edition.

On the whole, the illustrations are good. They are clear without giving too much detail, which is so often a fault in many books of this type; but in some instances the diagrams are crude, and are, indeed, incorrect. For example, the stuffing-box shown in Fig. 36 is not such as one would expect to find in a treatise on machine design.

Some of the friction experiments quoted were carried out in a very crude fashion, and the results are liable to be very misleading. For an example of this see p. 107. Except for the minor faults that we have pointed out, we can heartily recommend the book to students and draughtsmen generally.

Flowers and Trees of Palestine. By Miss A. A. Temple. Pp. xii+172. (London: Elliot Stock, 1907.) Price 6*s.* net.

ARISING out of a tour in Palestine, Miss Temple has compiled for the benefit of other travellers a list of the principal plants of the country. The list, which is arranged alphabetically, furnishes the popular and scientific names, also the localities; certain features of some of the genera and species are added, but they are of little determinative value. Preceding the list are four chapters containing an account of the characteristic flowers, thorny, tropical, and subalpine plants, and of the trees. A number of good illustrations are provided which are taken from the author's photographs.

Miss Temple discusses the interpretation of the Biblical names, following as her guides in this matter Canon Tristram and Dr. Post. The interpretations are obscure, although there is unanimity in most cases. The identification of "the lilies" has given rise to controversy. The author favours the view that the flower signified especially as the "lilies of the field," is *Anemone coronaria*; Dr. Post for another reference inclines to the gladiolus; these flowers are more probably signified than *Lilium chalcedonicum* and *Lilium candidum*, which are found, although rarely. It seems unnecessary to introduce Acanthus for any reference to "nettles," and Jew's mallow is generally understood to be *Corchorus olitorius* or *capsularis*, not *Corchorus trilocularis*. Otherwise, except for one or two obvious mistakes, the identifications are acceptable. Although the information in the descriptive chapters is slight and lacks continuity, the reader can, with the help of the illustrations and the list of plants, obtain a fair idea of the brilliant nature of the flora, and the traveller should be able to identify the more conspicuous plants.

Familiar Indian Birds. By Gordon Dalgliesh. Pp. viii+71; illustrated. (London: West, Newman and Co., 1907.) Price 2*s.* 6*d.* net.

THAT many persons in India, especially new arrivals, feel the want of an easy means of identifying the commoner birds of the country is indisputable, and this want the author of the booklet before us has endeavoured to supply—largely in the form of reprints from notes in scientific and other journals. In the main, the notices are interesting and to the point; but there appears a lack of judgment in regard to the species selected for mention. The omission of the adjutant stork is a glaring instance of this; while in the section on herons it is obvious that the egret or "paddy-bird" should have figured as the main heading, in place of the ordinary British heron. Then, again, it is a mistake to have selected such birds as the heron, moorhen, and barn-owl as the subjects for pictorial illustration, when so few characteristic Indian species are depicted. Neither can much be said in praise of the illustrations themselves, that of the myna being specially poor. By the time the book reaches a second edition, it may also be hoped that the author will have learnt to write sentences of a more grammatical type than the one standing second in the account of the jungle-babbler, or the third and fourth (taken together) on the seventh page. R. L.

Progressus Rei Botanicae. Vol. i., part iii. Die Fortschritte der Immunitäts- und Spezifizitätslehre seit 1870. By R. P. van Calcar. Pp. 110 (533 to 642). (Jena: Gustav Fischer, 1907.)

THE third and final part of the first volume of this publication, issued under the auspices of the International Association of Botanists, is assigned to a survey of the study of immunity, compiled by Dr. R. P. van Calcar. Due credit is given to botanists for the early conceptions of the theory, and the gradual evolution of the subject by pathologists is traced up. The author presents an explicit and critical account of the experiments and views elaborated by Metschnitoff, Ehrlich, and Pfeiffer; he describes the phenomena of agglutination, and discusses the arguments in connection with toxins and antitoxins, the taxonomy of the tubercle bacillus and the *rôle* of ferments. Although the field has been explored chiefly from a medical point of view, a knowledge of the general theories regarding the action and nature of bacteria is also required by plant pathologists, and the summary is eminently suitable to a botanical publication.

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 intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

Science and Government.

No one will contest the principle that it is in every way desirable that the State should support liberally such kinds of scientific work as are beyond the means of private institutions or individuals. It is, for example, a scandal that the relatively small sum is not forthcoming which would bring our Ordnance Survey into touch with modern geodesy; but the importance of such matters will not be appreciated until the literary atmosphere in which our statemen and officials are reared is penetrated by a scientific way of thinking. Nor is there at present any widely spread educated opinion which might react on the Government. A member of the House of Commons stated in his place that the sooner coal is exhausted the better, as electricity will do its work. One of our important journals thinks it plausible that the Jamaica earthquake should have been predicted in Europe by the "weather plant," and that telegony may have some bearing on marriage with a deceased wife's sister.

But I am by no means convinced that the *argumentum ad hominem* contained in your issue for September 12 is very helpful. Taking the revenues of the United States and of the United Kingdom as approximately equal, the disparity between an expenditure of (say) $2\frac{3}{4}$ and $\frac{1}{4}$ millions on "science" is at first sight overwhelming; but a little analysis of the figures will, I think, put a somewhat different construction upon them.

Of the total, the Department of Agriculture and that of Commerce and Labour take 2,107,670*l.*, or say two millions. It is assumed that the whole of this goes to scientific work. It would be less inaccurate to describe it as applied to technical purposes; but even that would not quite correctly state the position.

The United States Department of Agriculture publishes an annual report in a bulky volume. Its contents deal largely with purely administrative matters; the rest is mostly educational, even popular, and can scarcely be regarded as adding much to agricultural science. Nor is it intended to do so. The object of the department is rather to disseminate and apply existing knowledge than to add to it by advanced research. The explanation is obvious; agriculture is the fundamental industry of a country which is still largely in the condition of an undeveloped estate, and cultivation is carried on by a population which is to a considerable extent only imperfectly instructed in the art. Agriculture in the United States is far from having reached its intensive stage; this may be illustrated by the fact that while the mean production of wheat in the United Kingdom is thirty bushels to the acre, in the United States it is only thirteen.

The expenditure of the United States Government on Agriculture is rather a political necessity than the outcome of sympathy for science. All other industries are protected by a tariff; but protection is useless for agriculture which has to export its surplus produce, and it is probable that by restricting the imports by which the exported produce is paid for, protection diminishes the exchange value of what the farmer produces. The United States Government is therefore compelled practically to subsidise the farmer in various indirect ways—by the free distribution of seed, for example—as it cannot directly protect him. The writer in Nature has omitted to set out in comparison what is done for agriculture in the United Kingdom. The Board of Agriculture and Fisheries has a vote of 130,355*l.*, and the Irish Department of Agriculture and Technical Instruction one of 190,146*l.*, or 320,481*l.* in all. Now the area of the United Kingdom is one-thirtieth that of the United States; but our State expenditure is per square mile $4\frac{1}{2}$ times as great. It should be noted that this includes Kew and the Ordnance Survey.

But this is not the only omission on the *per contra* side of the account which appears to me likely to be extremely misleading to foreign readers of Nature. I shall not attempt to make Table II. complete, as I have not the means at hand. But there is no mention of the Royal College of Science (including the School of Mines) in London or of the similar institutions in Dublin; one of the science museums, the Government Laboratory, the Standards Department, the Patent Office Library, the Oxford Forest School, the Botanic Gardens at Edinburgh and Dublin, and the research work of the Local Government Board. Nor should the ethnographic department at the British Museum (Bloomsbury) be overlooked.

The first three heads in Table I. represent what the United States Government does for pure, *i.e.* for non-technical, science. They amount to 382,690*l.*, after deducting the casual and temporary item of 250,000*l.* for building; but a further deduction of 107,000*l.* must be made for surveying public lands and forest reserves, as these are merely administrative services. This brings the expenditure on pure science down to 175,090*l.*, an amount which does not strike me as anything to be particularly proud of.

The fact is that the attitude to science of American statesmen is not very different from that of our own; indeed, on the whole, I doubt if it be not even less sympathetic. The Smithsonian Institution has become an independent trust something like our British Museum, and the fact may be recalled that it owes its foundation to the munificence of an Englishman. It is by no means liberally subsidised by the Government. Nor has the United States any national botanic establishment on the scale of Kew.

What one would like to find imitated in this country is the noble idealism which impels those who are possessed of great wealth in the United States to place it at the disposal of the community for the advancement of learning. Our own Royal Society might be entrusted with funds which it would know how to apply to purely scientific purposes. This would be more useful than giving of medals and scholarships to distribute. Our ancient universities, Oxford and Cambridge, are in urgent need of endowments, which would enable them to strike out their own line unhampered by the purely educational aims of the colleges; but State aid dries up the streams of private liberality, and brings with it the cramping atmosphere of official supervision. W. T. Thiselton-Dyer.

Witcombe, September 17.

Sir W. T. Thiselton-Dyer agrees, at all events, that the attitude of British statesmen towards science leaves much to be desired. Statistics can, of course, be treated in many different ways, but, despite the criticisms in the above letter, the general conclusion of the article referred to remains substantially correct. The data are avowedly incomplete; only those who have attempted to collate the material scattered throughout Government publications appreciate wholly the difficulty of the task.

Although Sir W. T. Thiselton-Dyer maintains that but a small part of the grant to the U.S. Department of Agriculture is devoted to scientific research, the facts of the case seem to support the conclusions of the article. For the fiscal year ending June 30, 1905, the expenditure on investigation work alone, exclusive of the salaries of permanent officials, was at least 201,000*l.* The annual report for 1905–6 of our Board of Agriculture and Fisheries on the distribution of grants for agricultural education and research shows that the grant for agricultural research amounted to 355*l.*! Since "agriculture in the United States is far from having reached its intensive stage," there is surely less need for grants in aid of agricultural research there than in this country.

Grants to colleges and universities were omitted intentionally—and special attention was directed to the omission—since this subject has been dealt with so often in Nature; consequently, the administration by the Board of Agriculture of the Treasury grant for the purposes of agricultural education, much of the work of the Irish Department of Agriculture and Technical Instruction, the activities of the Royal Colleges of Science in London and Dublin, and the university colleges, fell outside the scope of the article. Had the subject of grants for higher educational purposes been under consideration, an equally great disparity between the amount provided from public funds in the United States and in this country would have been exposed. The latest report of the U.S. Commissioner of Education deals with the year ending June 30, 1905. The total income for that year of American institutions of university rank, excluding benefactions, amounted to 8,355,000*l*., an increase of 289,200*l*. over the preceding year, and of this amount 23·6 per cent. was from State appropriations and 6·9 per cent. from Federal appropriations. That is, more than 2,506,500*l*. was provided from American public funds for higher education during the year with which the report deals. A very generous estimate of the amount provided here from public funds for higher education of every kind, including the Royal Colleges of Science of London and Dublin, the universities and the university colleges, would be to place it at a quarter of a million pounds sterling, so that the British case is in no way improved by importing the question of the amounts provided for higher education.

Sir W. T. Thiselton-Dyer is doubtful only about the greater belief of American statesmen in the need for the introduction of scientific methods in the solution of problems of government, but of the need of scientific ways of thinking on the part of our legislators he is quite convinced, and that is really the important matter.

A. T. S.

The Interpretation of Mendelian Phenomena.

Apropos of the discussion on the interpretation of Mendelian phenomena, may I seek enlightenment on one or two points from your readers? Mendelian phenomena are possible only when reproduction is bi-parental. They cannot occur, of course, when it is parthenogenetic. I believe I am right in thinking that Mendelian workers suppose or hope that they have found a master key to the problems of heredity. Now, I am able to understand that the study of alternative inheritance may ultimately shed a light on the function of sex, but I find it difficult to conceive how it can shed a light on any other biological problem of importance; for example, the problems of the alleged transmission of acquirements, of the causation of variations, of the retrogression of characters which have lost selection value, and of the mode of development (whether or not by the recapitulation of the phylogeny). All these problems are of at least equal importance to the problem of sex. I have sought information from my Mendelian acquaintances, but I am always told that we must await the accumulation of data—a somewhat Micawber-like attitude, as it seems to me. I hope I make myself clear. The information I seek would be contained in the answer to the following question:—If Mendelism has a bearing on any biological problem save that of sex, what is that problem? If, as I anticipate, no one is able to name another problem, I venture to suggest that Mendelians are engaged in nothing more than the investigation of sex.

Mendelian phenomena have been observed principally in crossed artificial varieties of animals and plants. Crossed natural varieties usually blend their characteristics. This is conspicuously the case with man, the animal who, so far as is known, has crossed more often than any other, and whose hybrids may be observed up to the tenth or twelfth generation in South America and elsewhere. It has been said that "human skin-colour is the only character that is known to blend perfectly"; but this statement is certainly incorrect. With the exception of eye-colour, and possibly one or two other traits, such as the Mongolian eyelid, human hybrids appear to blend every character as perfectly as skin-colour. The transmission of no character is Mendelian. Thus mulattos have the black eye of the negro, and when they breed *inter se* continue to reproduce it indefinitely. There is no segregation. May I mention one other fact which is of considerable interest, but which seems to have escaped the attention of Mendelian workers? Crossed artificial varieties usually reveal latent characters in abundance. I am aware that the correctness of the term latency has been disputed, but it will serve to indicate what I mean. So far as I have been able to ascertain, no single instance of a latent character resulting from the crossing of natural varieties has been recorded. Certainly crossed human varieties reveal no such traits. A very significant passage bearing on this matter may be found in "Animals and Plants" (vol. ii., pp. 24–5). It would appear, then, that characters become latent only under conditions of artificial selection, that is, when mutations are selected. It has been maintained that nature also selects only mutations, but, to say the least, this has not been demonstrated as yet.

Bearing in mind, then, the facts that latent characters appear only when artificial varieties are crossed, and that crossed natural varieties usually blend their characters, the question arises whether Mendelians, so far from investigating even the whole problem of sex, are engaged in anything more than the investigation of those abnormalities of sexual reproduction which occur under conditions of artificial selection.

G. Archdall Reid.

Southsea, September 17.

On Correlation and the Methods of Modern Statistics.

Prof. Karl Pearson's letter in Nature of September 19 gives me a welcome opportunity of explaining what was not intelligible in the condensed report of my remarks in the discussion at Leicester, on methods of modern statistics.

Prof. Pearson communicated to the Royal Astronomical Society (Monthly Notices, May, 1906) a paper by Miss Winifred Gibson, giving an account of a research conducted in the statistical laboratory of University College, London. The first part of this paper discussed the relation between parallax and magnitude of the stars. I confessed to some misgivings as to the astronomical value of the results, and raised two questions, first, as to the method, and second, as to the matter.

Prof. Pearson thinks that I am on safer ground in the second than in the first. I will therefore examine first his reply to my second point, which was that the parallax material contained in Newcomb's table (appendix to "The Stars") is quite unsuitable for discussion by a general statistical method, since it relates very largely to stars selected for investigation because of abnormal proper motion.

Prof. Pearson "fancies that astronomers have been guilty of a considerable amount of circular reasoning. They start from the hypothesis that magnitude is very closely related to parallax. . . . The fundamental hypothesis that the brighter stars are much the nearer as yet awaits statistical demonstration. . . . Surely the hypotheses of high relationships between magnitude and parallax and proper motion are of sufficient importance to deserve *proof*, rather than to be taken as axiomatic." In this matter Prof. Pearson is under a misapprehension. Astronomers do not believe that magnitude is very closely related to parallax; very obviously it is not. But they do believe that parallax is somewhat closely related to proper motion. There are seventeen stars in the sky brighter than mag. 1·5, and their parallaxes have been determined with the heliometers at the Cape and at Yale. Here are the results.

Seven have proper motions (on a great circle) less than 0″·1 per annum:—

	P.M.	Parallax	Mag.
	″	″	
Canopus	0·00	0·00	-1·0
Deneb	0·00	0·00	1·3
Rigel	0·01	0·00	0·3
Betelguese	0·03	0·02	0·9
Antares	0·03	0·02	1·3
Achernar	0·09	0·04	0·5
β Centauri	0·09	0·05	0·8
Mean	0·04	0·02	0·6

Six have proper motions between 0″·1 and 1″·0:—

	P.M.	Parallax	Mag.
	″	″	
Aldebaran	0·19	0·11	1·1
Regulus	0·27	0·02	1·3
Vega	0·36	0·11	0·1
Capella	0·43	0·09	0·2
Pollux	0·64	0·06	1·2
Altair	0·65	0·23	0·9
Mean	0·42	0·10	0·8

Four have proper motions greater than 1″·0:—

	P.M.		Parallax		Mag.
	″		″		
Procyon	1·25	...	0·30	...	0·5
Sirius	1·31	...	0·37	...	−1·4
Arcturus	2 28	...	0·03	...	0·3
α Centauri	3 67	...	0·75	...	0·2
Mean ...	2·13	...	0·36	...	−0·1

It is clear from the first group that low magnitude alone has no very close association with large parallax, and in the other groups Arcturus is the only star with considerable proper motion that has not a considerable parallax, as parallaxes go.

I think that in forming his low estimate of the established relation between parallax and proper motion Prof. Pearson must have been misled by Miss Gibson's results. She has calculated the correlation between parallax and the *separate components* of the proper motion in right ascension and declination, and so has naturally obtained a smaller result than if she had used the whole proper motion in seconds of arc on a great circle, as is usually done.

I have plotted the material used by Miss Gibson in two ways, parallax against magnitude and parallax against proper motion on a great circle, and it seems to me that the second diagram shows considerable correlation.

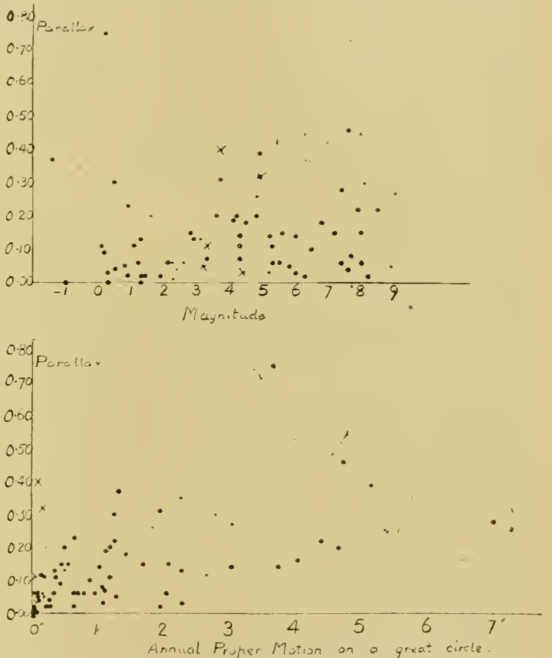
Some of the parallaxes are marked by Newcomb as doubtful; these I have shown by smaller dots. Five which depend on absolute right ascensions observed with the meridian circle may be considered too doubtful for use in this discussion; I have struck them through with a cross.

The seventy-two parallaxes grouped in means by whole magnitudes give a "curve of regression" with three peaks and two valleys, to which Miss Gibson thinks that it might be possible to fit a quartic curve. I suggested a simpler explanation, and Prof. Pearson asks for details of the reason why this curve of regression has such a switchback form if it is not real. It is easy to answer this question. Consider, for example, the second-magnitude group; it contains six stars, only one of which has a moderately large proper motion. Four of the stars were observed in the early days of photography as part of the late Prof. Pritchard's scheme to determine the parallaxes of all second-magnitude stars. One of the stars is Polaris, of small proper motion, observed just because it is Polaris; the sixth is α Gruis, of small proper motion and parallax. The group contains no star specially selected in anticipation of finding a large parallax, and naturally the mean of the group is small, because it is more or less representative of the second-magnitude stars in general.

On the other hand, the fourth-magnitude group includes several stars observed because of large proper motion, η Cassiopeiæ, τ Ceti, 70 Ophiuchi, and is helped out by a large parallax assigned to η Herculis which is certainly spurious. Hence the mean parallax of the group is large.

And so on. It would be tedious to examine each group in detail, but the almost fortuitous value of the mean parallax for each of these small magnitude groups is amusingly illustrated by the first two. The first contains two stars, parallaxes 0″·37 and 0″·00; mean, 0″·19. The second contains five stars; four have parallaxes of 0″·09, 0″·00, 0″·03, and 0″·11, but the group is translated from the valley to the peak because the fifth parallax is 0″·75. This, the largest known parallax, belongs to the double star α Centauri, the components of which have magnitudes 0·4 and 1·9. We might add the fainter component to the second-magnitude group discussed above; this would bring the mean parallax of the group up with a bound from 0″·08 to 0″·18, make a new peak, and remove one of Prof. Pearson's difficulties.

Probably there is no need to justify more minutely my remark at Leicester that a statistician who attacks astronomical problems must be as intimately acquainted with technical astronomy as with the use of his modern statistical tools. If any doubt remains, it will be dispelled by reading further in Miss Gibson's paper. "The next stage in the work was to inquire whether magnitude was more markedly correlated with any other character than parallax. Colour suggested itself as a character for which definite data were available. In vol. ix. of the 'Annals of the Cape Observatory' will be found a catalogue from which the colour of 159 stars can be extracted. . . ." Prof. Pearson quotes in his letter one of the results of this section, "that colour and magnitude are related at least as closely as parallax or proper motion and magnitude." And Miss Gibson concludes "that we have a suggestion, even if it be only of the vaguest kind, that the bulk of the lucid stars may belong to a separate universe within which magnitude is not mainly determined by parallax or distance, but is more closely associated with colour, and thus probably with chemical or physical conditions." On examining the basis of this far-reaching suggestion about the "bulk of the lucid stars," one is struck with the remarkable fact that "white had no frequency in the record"! A search in the Cape volume shows that the list in question is entitled "Coloured Stars observed during the Revision of the 'Cape Photo-



Correlation between (1) parallax and magnitude; (2) parallax and annual proper motion on a great circle, for the seventy-two stars in Newcomb's Table.

graphic Durchmusterung.'" This revision was chiefly an examination of all cases in which stars found in other catalogues are missing from the C.P.D. Sometimes they were hidden by photographic defects; sometimes they were variable or had large proper motion; in a great many cases they were red, and photographically faint. Hence attention was concentrated upon a particular class of stars, near the limit of the C.P.D., which had escaped registration owing to some abnormality, generally redness. This specially selected material has been further specialised, for at the top of the list we read:—*Very few stars of a lighter shade than deep yellow have been recorded because of their frequency*. And this is the material from which Prof. Pearson and Miss Gibson extract their conclusions about the stars in general.

I think that an astronomer may be allowed to express his dissent from these applications of modern statistical methods.

I should like, in conclusion, to refer briefly to the theoretical point:—Should not the correlation ratio be used in preference to the coefficient of correlation? The former expresses the degree of approximation to a smooth curve, the latter the approximation to a straight line. It will rarely happen that the curve of regression for two absolutely correlated astronomical quantities is a straight line, and the range of the quantities is generally so large that we are concerned with much more than an elementary portion of the curve. It appears to me, therefore, that it would be better in all treatment of astronomical statistics to use the correlation ratio. ARTHUR R. HINKS.

Cambridge Observatory, September 23.

The Relation of Man to the Animal World.

IN the short notice given of my "booklet" in NATURE of September 12 on the "Relation of Man to Animals," the writer seems quite to have misunderstood the object of my writing it. I am aware that an author has no right to discuss a fair criticism with a reviewer, but in the present case, when the latter says that he is at a loss to discover the object and aim of my pamphlet, I trust you will allow me to give its true explanation to your readers.

I may state in a few words that if we read the report of the Vivisection Committee which has been lately sitting, we shall see that there are witnesses who confess their ignorance of the many kinds of cruelty being inflicted on animals in their very midst. This ignorance has always been considered a very important point with the advocates of experimentation as showing that the anti-vivisectionists shut their eyes to everything connected with the use of animals except that which is for the attainment of knowledge. This knowledge some of their leading advocates declare is no value.

When I was chosen by my college to give an address on the subject before the Church Congress, I made the present position of the animal world my basis of argument for experimentation. This feature of the question is considered most important at the present time, and therefore I have very willingly re-published and expanded it in my pamphlet. This is my sole object of writing it. It would be quite out of place to give my own opinion as to our treatment of animals generally; in fact, it would be of no value considering the difference of opinion on the subject, and especially at the present time, when vegetarianism seems largely increasing.

Hampstead, September 27. SAMUEL WILKS.

Meteoric Shower, from near β Aurigæ.

ON September 27 at 9h. 54m. I saw a very swift meteor of about $1\frac{1}{2}$ mag. shooting through Cygnus, and leaving a streak of about 10° near α and γ Cygni. The sky was clouding over at the time, and a portion of the luminous course of the meteor must have been hidden, but the observed path was from $306\frac{1}{2}° + 45°$ to $299° + 32\frac{1}{2}°$.

The line of flight traced far backwards carries us to the point $88° + 43°$, and this, I believe, formed the radiant position of the object. There are showers from near β Aurigæ in August, September, and October, and later months also supply indications of activity in the same centre. This particular system of Aurigids appears to be unusually rich from about September 21 to 27. On 1879 September 21 I recorded eight meteors from a radiant at $87° + 43°$, and on 1878 September 25 the radiant near β Aurigæ was re-determined from five meteors. The members of this stream are exceedingly swift, and they usually leave streaks, their appearance being very similar to that of the Leonids. W. F. DENNING.

Bishopston, Bristol, September 28.

A New Stratigraphical Fact in the Thames Basin.

IT will interest geologists to learn of the occurrence in this neighbourhood, below the Tertiary plateau gravels, of a bed (not a boulder) of marly, lignitiferous, glauconitiferous limestone, full of fossils, about the Upper Eocene or Oligocene age, of which there can scarcely be a doubt. Fuller particulars are reserved for a later communication either to NATURE or the *Geological Magazine*, when the fossils have been exactly identified and the investigation completed.

This is, I believe, the first definite record in the Thames basin of pre-Miocene strata younger than the Upper Bagshot Sands. A. IRVING.

Bishop's Stortford, September 25.

Bees' Stings and Rheumatism.

IT appears to be a familiar and widespread belief in many countries that the stings of bees act both protectively and as a cure for "rheumatism." I have recently been able to collect some definite evidence in support of the belief in question.

This is of interest and importance, not only on general grounds, but also on account of the connection which I believe to exist between rheumatic fever and an abnormal production of formic acid (the acid of bee poison) in the human body (*British Medical Journal*, September 19, 1903, and May 25, 1907).

May I, therefore, be permitted to request any of your readers who possess information on the subject, and are willing to assist the present inquiry, to favour me with answers to the following questions?—

(1) Are you acquainted with the belief that bees' stings cure and prevent rheumatism?

(2) Do you know of any case in which rheumatism is believed to have been cured by this means?

(3) Do you know of any person who suffers from rheumatism although frequently exposed to the stings of bees? E. W. AINLEY WALKER.

University College, Oxford, September 27.

The Country Child in Education.

IN your interesting *résumé* of the educational meetings at the British Association in NATURE of September 12 (p. 505) one could not help being struck by the absence of any allusion, near or distant, to the *country* child.

I suppose it is correct to say that, physically, country children are, or will be, the backbone of the nation. If half as much were done educationally for them as is lavished on the town—and particularly the London—child, they would speedily become the nation's brain.

Manual training in all its branches, cookery lessons, swimming baths—what effect would these not have on our slow but sturdy village youngsters? With them nature-study is coming along—but even gardening lessons on scientific principles are all too rare.

Our school buildings and furniture in country districts slowly improve, but our playgrounds are still mostly loose beach, utterly useless for physical exercises or organised games.

It is time for enlightened educationists to urge the needs and claims of the country child. H. J. GLOVER.

Council School, Westham, Sussex, September 18.

[We hope this matter will not be lost sight of in arranging the agenda for next year's meeting of the Educational Science Section of the British Association.—ED. NATURE.]

THE CENTENARY OF THE GEOLOGICAL SOCIETY OF LONDON.

UNDER the presidency of Sir Archibald Geikie, K.C.B., the celebration of the centenary of the Geological Society of London has been carried out with conspicuous success. While the proceedings throughout were characterised by an air of dignified gravity, a feeling of quiet enthusiasm pervaded the meetings. On no previous occasion have so many illustrious geologists been gathered together from all quarters of the globe, and a noteworthy feature in the assembly was the presence of many women who have achieved distinction in the pursuit of geology.

Although the actual date of the foundation of the society was November 13, 1807, it was necessary to hold the centenary meetings a little in advance of the actual birthday, in order to suit the convenience of the foreign members and correspondents, as well as the visitors from abroad and from all parts of the British Isles, who have university duties that commence in October.

The apartments of the Geological Society at Burlington House had undergone a great transformation. Easy-chairs and lounges, curtains and floral decorations served to make attractive the otherwise sombre-looking chambers. The council room, with its historic geological portraits, was set apart for the ladies. The museum, usually so desolate, was the principal reception-room, and it became a busy and animated scene where conversation and writing were seasoned with the fragrant odour of tobacco. Exhibits of certificates of membership of some of the great geological masters, early MSS. and published maps, and other documents of interest were displayed in cases or suspended from the walls. For all these arrangements so happily carried out, the society was indebted to the indefatigable labours of Prof. Watts and Prof. Garwood, the secretaries, to Mr. Belinfante, assistant secretary, and the other permanent officials, and to Mr. F. W. Rudler.

Thursday, September 26, was fixed for the main centenary proceedings, and the fine meeting-room of the Institution of Civil Engineers was courteously placed at the service of the society for the reception and the president's address. At 11 a.m. the delegates were received in the alphabetical order of their countries, and it was arranged that one representative only of each country should speak. Space will neither permit of the insertion of a full list of the delegates who came, nor of any record of the eloquent and warm-hearted remarks with which they accompanied their presentations of the addresses of congratulation to the president. It was to be regretted that no time or opportunity could be given for the display of these elaborate and beautiful documents, but no doubt a special exhibition of them will be made at some future meeting of the society.

Austria-Hungary was represented by Dr. Tietze, director of the Imperial Geological Survey; the Argentine Confederation by Prof. Aguirre, of the University of Buenos Aires; Belgium by M. Mourlon, director of the Geological Survey; Denmark by Dr. Steenstrup; Egypt by Capt. Lyons, director of the Geological Survey; France by Prof. Gosselet, Prof. Barrois, and Prof. de Lapparent; Germany by Prof. Zirkel, Prof. Credner, and Prof. Rothpletz; Greece by Prof. Skouphos; Holland by Prof. Wichmann and Dr. Molengraaf; Italy by Prof. Hughes (who spoke in the absence of Prof. de Lorenzo); Japan by Prof. Omori; Mexico by Dr. Aguilera, director of the Geological Survey; Norway by Prof. Brögger, and Dr. Reusch, director of the Geological Survey; Portugal by Prof. de Lima; Russia by Dr. Tchernyshew, director of the Geological Survey, Prof. Pavlow, Prof. Lœwinson-Lessing, and Dr. Sederholm, director of the Geological Survey of Finland; Sweden by Prof. Nathorst and Dr. Gunnar Andersson, director of the Geological Survey; Switzerland by Prof. Heim and Prof. Baltzer; United States by Dr. Hague, Prof. Iddings, and Prof. Morris Davis; Canada by Prof. Adams; India by Mr. La Touche; South Africa by Mr. Rogers and Dr. Hatch; Australia by Prof. Hill and Mr. Johnston; New Zealand by Mr. Denham.

Numerous delegates represented the universities, the scientific societies, institutions, and field-clubs of Great Britain and Ireland, and on their behalf Prof. Sollas and Prof. Hughes made brief remarks, the latter speaking in Latin the address of congratulation from the University of Cambridge. Mr. A. B. Kempe represented the Royal Society, and Lord Avebury the Society of Antiquaries.

An interesting incident was the award to Sir A. Geikie of the gold medal of the Institution of Mining and Metallurgy, which was handed to him by Mr. C. J. Alford, in recognition of the services rendered by the Geological Society to the mining industry.

In the afternoon the president delivered his address on "The State of Geology at the Time of the Foundation of the Geological Society." He dwelt especially on the important aid towards the foundation of the science of geology given by Guettard and Desmarest in France, by Werner in Germany, by Hutton and Jameson in Scotland, and by William Smith in England. The results of their labours gradually attracted more and more attention, as did also the controversies that arose between the followers of Werner and Hutton, the one school (the Neptunists) attributing too much to the influence of water, the other (the Plutonists) attributing too much to the agency of heat. Thus it came about that a number of earnest students well versed in mineralogy determined to meet together and gather facts in illustration of the new science of geology. In due course they established the Geological Society of London, to the origin and history of which reference has already been made in the pages of NATURE (September 26, p. 537). G. B. Greenough, one of the founders, was the first president, and his geological hammer with a whalebone handle was exhibited by a relative, Mrs. Bowen-Colthurst, of Dripsey Castle, co. Cork. To this interesting relic Sir Archibald Geikie directed brief attention.

In the course of his address he pointed with pride to the publications of the society, and concluded by expressing the opinion that they might with confidence look forward to a career in the future not less successful and useful than that which they were now met to celebrate.

A hearty vote of thanks to the president, proposed by Prof. de Lapparent, was seconded by Prof. Rothpletz.

In the evening a brilliant assembly gathered in the Whitehall Rooms of the Hotel Metropole for the official banquet. The company numbered 291. The president was supported by two veteran geologists, on his right Prof. Gosselet, and on his left Prof. Zirkel. It is noteworthy that not a single peer, baronet, or bishop was present among the fellows of the society or its guests. A brief grace was said by Prof. Bonney, hon. canon of Manchester, and the company then proceeded to the consideration of the menu. The card was illustrated by portraits of Greenough, the first president, and of Sir Archibald Geikie, but, curiously enough, the date of the meeting was printed 1908 instead of 1907. The toasts were taken without interruption at the conclusion of the dinner. Those of the King and of the heads of foreign States were proposed by the president. Then followed the Geological Society of London, proposed by Prof. de Lapparent, with response by the president;

the Universities and other Educational Institutions by Prof. Bonney, and reply by Prof. Credner; the Academies and Learned Societies by Prof. Miers, and reply by Prof. Barrois; the Geological Surveys by Prof. Lapworth, and reply by Prof. Heim; Engineering and Mining Institutions by Prof. Hughes, and reply by Prof. Beck; the Delegates and other Guests by Dr. Marr, and reply by Prof. Stevenson; and the Ladies by Prof. Watts, and reply by Prof. Walther.

On Friday, September 27, visits were paid to the British Museum at Bloomsbury and to the Natural History Museum at South Kensington, to the Geological Survey and Museum of Practical Geology at Jermyn Street, and to the Victoria and Albert Museum at South Kensington. Demonstrations on objects of interest were given by the officers at these institutions, and especial interest was manifested in the new model of Assynt in the north-west Highlands (recently added to the Museum of Practical Geology), which was explained by Dr. B. N. Peach. A number of the foreign and colonial visitors were also invited to St. Paul's Cathedral, and were conducted through the edifice by Canon Scott Holland and Dr. Grabham (delegate appointed by the Royal College of Physicians). The party was afterwards entertained at tea by Dr. Grabham in the Chapter House.

In the evening the foreign and colonial delegates were entertained at dinner at the Criterion Restaurant by the Geological Society Club. This club was founded in 1824 by Buckland, Fitton, Greenough, Lyell, Warburton, and others, with the object of affording to a limited number of the leading members of the society an opportunity of dining together on the evenings of the society's meetings. The proceedings on the present occasion lacked some of the exuberance and animation that we read of in early records of the club, when Buckland and Sedgwick and other geological giants of old made merry. On the present occasion, however, the proceedings had to be curtailed.

The party, as in the case of the official dinner, was photographed, and a congratulatory telegram was sent to the distinguished veteran and past president, Dr. H. Clifton Sorby, now in his eighty-second year, and still engaged in scientific research. It may be mentioned that other veteran fellows of the society, Prof. T. Rupert Jones, now eighty-eight, and the Rev. Osmond Fisher, in his ninetieth year, bear testimony to the healthy character of geological labour. Nor should we forget the father of the society, the Rev. W. H. Egerton, a brother of the late Sir Philip Egerton, who was elected a fellow in 1832, and at the age of ninety-six is still rector of Whitchurch, in Shropshire. A letter received from him during the present year, in which he mentioned that he had been a pupil of Buckland, was exhibited in the society's museum.

After the club dinner the party proceeded to the conversazione, which was held at the Natural History Museum. There a numerous company was received by the president in the Central Hall, and the proceedings were enlivened by a good programme of music, performed by the string band of the Royal Engineers.

During the week prior to the centenary reception a number of excursions were made with the view of exhibiting to the foreign members, correspondents and others who came from abroad, the main features of British geology. The longer excursions were arranged to occupy a week.

The Palæozoic formations were seen in the English Lake District, famed for the early researches of Sedgwick; in South Wales, where Murchison established some of his Silurian divisions; and at Bristol, Weston-super-Mare, and Cheddar, amid geologic scenes described by Buckland and Conybeare. The Jurassic and Cretaceous rocks were viewed along the Dorset coast at Lyme Regis, Bridport, and Weymouth, a region full of associations with the work of De la Beche and Buckland; and in the Isle of Purbeck at Lulworth and Swanage, where Thomas Webster in early days so admirably depicted the geological structure. The excursion to the Isle of Wight was abandoned, while that proposed for the Edinburgh district was replaced by one to the north-west Highlands, to Assynt, Inchnadamph, and Loch Glen Coul for the purpose of studying the displaced rock-masses brought forward by the Glen Coul and Moine thrusts. This last excursion was the more appropriate considering that the long-looked-for Geological Survey memoir on the North-west Highlands, embodying the researches of Dr. Horne, Dr. Peach, Dr. Teall, Mr. Clough, and other colleagues, has just been published under the editorship of Sir Archibald Geikie.

Some shorter excursions for two days were made to May Hill, Westbury-on-Severn and the Forest of Dean, to Derbyshire, and to the Crag District of Suffolk.

On Saturday, September 28, there was a series of day excursions, all well attended, to the Northampton iron-ore district, to Aylesbury, to Dover, to Box Hill, Leatherhead and Dorking, to Reading, to Erith and Crayford, and to Sudbury. Thus opportunity was given of seeing many important and interesting geological sections.

On Monday, September 30, and following days, the foreign and colonial visitors were entertained at the Universities of Oxford and Cambridge. At Oxford the degree of D.Sc. *honoris causa* was conferred upon Prof. Charles Barrois, of Lille, Prof. Albert Heim, of Zurich, Prof. Alfred Lacroix, of Paris, Dr. Albrecht Penck, of Berlin, Dr. Hans Reusch, of Christiania, and Prof. (Geheimrath) Ferdinand Zirkel, of Leipzig. At Cambridge the degree of Sc.D. *honoris causa* was conferred upon Prof. Waldemar Christofer Brögger, of Christiania, Prof. (Geheimrath) Hermann Credner, of Leipzig, Prof. Louis Dollo, of Brussels, Prof. Albert de Lapparent, of Paris, and Prof. Alfred Gabriel Nathorst, of Stockholm. Prof. (Geheimrath) Heinrich Rosenbusch was unfortunately prevented from attending.

All the recipients of the degrees are foreign members of the Geological Society. Thus was honour done to the society and to many of its distinguished representatives abroad.

H. B. W.

THE FOURTEENTH INTERNATIONAL CONGRESS OF HYGIENE AND DEMOGRAPHY.

THE fourteenth International Congress of Hygiene and Demography, which meets every four years, was held this year in Berlin from September 23 to September 29, under the presidency of Prince Heinrich zu Schönaich-Carolath, the vice-presidents being Profs. Rubner and von Mayr. It was organised in nine sections, comprising every branch of hygiene and demography—bacteriology, parasitology and preventive medicine; general, industrial and school hygiene; port-sanitary and military and naval hygiene; dietetics, life-saving and statistics. Some 4000 members of all nationalities attended the sittings, and were received everywhere with the utmost courtesy and kindness. The meetings were held in the Reichstag buildings, which are central and admirably adapted for the purpose. The question naturally suggests itself, would the British Government pursue the enlightened policy of placing the Houses of Parliament or similar buildings at the disposal of such a congress meeting in England?

The weather throughout was delightful, and many social functions, including excursions, receptions by Prince Heinrich and the British Ambassador, a banquet, a gala performance at the Opera, concerts, &c., served to make the time pass pleasantly. In addition, visits were organised to all the principal scientific institutions, and were much appreciated. These included the laboratories of the Imperial Board of Health and of the University, the hospitals, sanatoria, schools, &c. It is impossible to do more than glance at a few of the more important communications; the full papers will be published hereafter in a volume of Transactions.

There was an important debate on tuberculosis, and some difference of opinion existed as to the most usual mode of infection in man. Prof. Arloing, of Lyons, discussed the question of the existence of different types of the tubercle bacillus. He said that he had become convinced that the bacillus of this disease is but one, and that the species or types described by several observers are but temporary races or varieties, the apparent fixity of which does not survive the conditions of their surroundings. He considered that:—

(1) The types are rarely defined in a perfect manner; (2) they are blended together in an almost indefinite series of individuals which in growth, shape, and virulence admit of a gradual passage from one to the other; (3) variability is sufficient to explain the usual characteristics of tuberculosis in Mammalia and in birds; (4) there would be real danger, from the medical as well as the hygienic point of view, in making such unstable differences a basis for laying down principles for the prophylaxis of tuberculosis.

Dr. Ravenel, of Philadelphia, considered that:—

(1) The alimentary tract is a frequent portal of entry for the tubercle bacillus.

(2) The tubercle bacillus is able to pass through the intact mucous membrane of the alimentary tract without producing a lesion. This takes place principally during the digestion of fats.

(3) The bacilli pass with the chyle through the lacteals and thoracic duct into the blood, which conveys them to the lung, where they are retained largely by the filtering action of the tissues.

(4) Infection through the alimentary tract is especially frequent in children.

(5) Milk from tuberculous cows is the source of infection in many cases. Our present knowledge does not enable us to state the exact proportion of cases of tuberculosis due to this cause, but it is probably considerable.

Prof. Flugge, of Breslau, said that he had performed experiments which showed that tuberculosis could be communicated to animals by inhalation, and that the dose of bacilli required to infect by the respiratory tract was very far less ("millions of times") than that required to infect by the alimentary tract. The mode of infection in man doubtless varied, and children may be infected by the digestive tract by tuberculous food, particularly milk, but the most extensive source of infection is the number of droplets of tuberculous expectoration coughed up by consumptives; these float in the air and serve as sources of infection to others. Prof. Ribbert, of Bonn, and Prof. v. Schrötter, of Vienna, also from the evidence of autopsies considered inhalation as the chief mode of infection in man. Prof. Calmette, of Lille, believed that in the young, infection by the digestive tract, particularly by tuberculous milk, is the most frequent, and attached little or no importance to dry dust containing tubercle bacilli as a source of infection.

Another important discussion was on typhoid and paratyphoid infections of man and the campaign against typhoid fever. Prof. Löffler, of Greifswald, discussed the classification of the causative micro-organisms of these diseases, and their isolation and differentiation by means of sugar nutrient media containing a small percentage of the anilin dye malachite green. Dr. Lentz, of Berlin, pointed out that the bacteria of typhoid and paratyphoid fevers pass by the lymphatics from the digestive tract to the spleen, bone-marrow and blood, and are excreted by the kidneys, in some cases for long periods. Of great importance also are mild cases, sometimes amounting merely to slight indisposition; though the individual may be but little, if at all, ill, he at the same time excretes the bacillus, and thus may be a source of infection to others. Some of the paratyphoid fevers of man seem to be caused by organisms which produce diseases in the lower animals. Anti-typhoid inoculation was discussed by Prof. Wright, Col. Leishman, R.A.M.C., and Dr. Muschold. The latter, from Prussian statistics, considered the method very promising.

Plague naturally attracted some attention, and Dr. Giemsa, of Hamburg, discussed the best methods of ridding ships of rats. He preferred to expose the hold to a mixed gas, produced in a generator, consisting of 5 per cent. carbon monoxide, 18 per cent. carbon dioxide, and 77 per cent. nitrogen. Dr. Strong, of Manila, discussed the subject of preventive inoculation in plague. He considered that this was the mode of combating the disease which held out the most likelihood of success, and made out a strong case for the use of living but attenuated cultures of the plague bacillus as the prophylactic material. Prof. Gaffky, of Berlin, considered the spread of plague to be due primarily to rats, vermin transmitting the bacillus from rat to man.

In a paper on insects as carriers of disease, Dr. Dönitz pointed out that the ticks are intermediate hosts of spirochætæ and piroplasmata; the parasites pass through a developmental stage, and it is not until this has occurred that they can again infect man and animals. He referred to the present lack of knowledge concerning the structure and developmental history of the ticks, and to the confused nomenclature of these insects now existing.

Many papers were devoted to a consideration of parasitic protozoa. Dr. Doflein discussed the nature of spirochætes, as to whether they are bacteria or protozoa, and their mode of division. Prof. v. Wasielewski, of Heidelberg, believed that all parasitic protozoa can act occasionally as pathogenic agents. The Leishman-Donovan body of the Indian disease kala-azar seemed to be a flagellated protozoon; the piroplasmata also seemed to be allied to the flagellates. Prof. Hewlett, of London, considered the parasites of the different malarial fevers to be distinct species, and the piroplasmata, or some of them, to be more nearly allied to the hæmoflagellates than to the hæmosporidia.

The campaigns against malaria and yellow fever were fully discussed. Prof. Ross, of Liverpool, gave a history of the institution of anti-malaria measures and of their results in Sierra Leone, Lagos, Federated Malay States, Panama, and Ismailia; Prof. Savas, of Athens, described the malaria campaign in Greece; and Prof. Celli, of Rome, that in Italy. The latter advocated drainage, mechanical means to render the mosquitoes innocuous, *e.g.* by the use of netting, &c., and the regular prophylactic use of quinine. Prof. Agramonte, of Havana, described the epidemiology of yellow fever and the campaign against the disease in Havana. He considered that the results obtained in the control and extinction of recent epidemics of this disease confirm the truth of the doctrine of mosquito transmission in its propagation.

Under the heading of dietetics, the subject of the necessary minimum of proteins for alimentation naturally came up for discussion. Prof. Forster, of Strassburg, gave the following as his conclusions:—

(1) Besides albumen, fat, and carbohydrates, man requires for his nourishment certain substances which are contained in animal and vegetable food in varying quantities. These substances are both in quantity and quality related to the nitrogenous ingredients of food.

(2) Digestive and other ferments, the internal secretions, protective matters, &c., are nitrogenous substances or descendants of such; their production must therefore be dependent to a certain extent on the intake of albumen and the conversion of the same in the body.

(3) Until the relations both of quantity and of quality are better understood, it will be advisable for general biological and hygienic reasons to favour an ample proportion of protein in practical nutrition, and not to limit the amount of protein to the minimum with which nitrogenous equilibrium can apparently be maintained.

The alcohol question also was to the fore, but a somewhat guarded opinion seemed to be expressed regarding its supposed evil effects when used in moderation. Dr. Triboulet, of Paris, considered that alcoholic drinks had an unfavourable action in cases of tuberculosis, and that alcohol diminishes resistance and predisposes to tuberculosis. Dr. Moeli, of Berlin, considered that alcohol is not a food, is not necessary, and in many cases is detrimental, and that its use should be discouraged in every way, not only by teaching the masses the evil effects of its use, but by instituting other interests so that the lack of it should not be felt.

Industrial diseases, particularly lead and mercurial poisoning, and those arising from dust, strain, &c., were the subject of several papers, and many suggestions were made to mitigate these evils. Lighting, ventilation and water supplies were also dealt with, and likewise statistics. According to Prof. Ballod, the recent Prussian mortality tables show that as regards mortality the country has a decided superiority over the towns, but that this superiority is only distinctly noticeable among the male sex, and at ages 40–50 years the towns appear to be slightly more favourable than the country.

At the general meeting telegrams of congratulation were received from the German Emperor and Empress, Lord Lister, and others, and three special lectures by English, French, and German men of science respectively were delivered. Dr. Haldane discussed his researcheson the effects of high pressures and temperatures in underground workings on man. No ill effects result with pressures below about three atmospheres, but above these, unless the pressure is increased or decreased step by step, as the case may be, grave effects may be produced. As regards temperature, it is the wet-bulb temperature which determines the suitability of atmospheric conditions in mines. The optimum wet-bulb temperature is below 27° C., the maximum that can be sustained without danger being 31° C. Prof. Chantemesse (Paris) discussed the serum treatment of typhoid fever. By growing the typhoid bacillus in a spleen broth medium for a week, heating to 55° C., and injecting into horses, the serum of the latter acquires properties which usually act favourably on the course of the disease when injected into the patient. Thus, in the Paris hospitals from 1901–7, among 5621 cases the mortality was 17 per cent., but during the same period in 1000 cases treated by Prof. Chantemesse with his serum the mortality was only 4·3 per cent. Prof. Schattenfroh, of Vienna, lectured on the hygienic care of water supplies, and the chemical and bacteriological examinations of drinking water. He urged that an international commission should be formed to devise standard methods for carrying out the latter.

The museum arranged in connection with the congress was of the greatest interest. The exhibits of the Imperial Board of Health and of the Institute for Infectious Diseases were especially noteworthy. They consisted of cultivations of pathogenic micro-organisms and drawings and photographs of the same, pathological specimens of tuberculosis and other diseases, series of specimens demonstrating agglutination and precipitin tests for blood, travelling laboratories, &c. All the principal Continental firms showed chemical and bacteriological apparatus, microscopes, and other instruments, and many of the casts showing pathological conditions were marvels of modelling. The exhibit of the Bacteriological Institute of Rio de Janeiro also was a large and comprehensive one, showing what good work is being done abroad, and it is to be regretted that exhibits from the British Empire seemed to be almost entirely wanting.

Demonstrations on the use of apparatus were given, and one interesting exhibit under the microscope was that of living active spirochætes, minute micro-organisms which occur in relapsing fever, syphilis, and certain animal diseases.

THE HARD AND SOFT STATES IN DUCTILE METALS.

WHEN the early craftsmen first observed that the metals they worked in were made harder by hammering, and that the original softness could be again restored to the hardened metal by heat, it probably did not occur to them that any explanation of these useful properties was called for. At a later period, when an interest in the reasons for things became more general, it is probable that hardening was attributed to the compacting of the substance by the driving of its particles closer together so that the mass as a whole became less open or porous. In the same way heat annealing was probably assumed to act by permanently expanding the metal and opening up its texture. So many analogies to these operations were ready to hand from the most common and everyday experiences that it is not surprising that even on closer inquiry this explanation should continue for a time to be accepted as sufficient, the more so as it was obviously true that in some cases unworked metal had an openness or porosity which could be removed by hammering or working. While the researches of chemists on the density of the metals showed plainly that increase of density does not always result from compacting by pressure, these researches were probably too far removed from the ken of those who were most intimately concerned with the working of metals to arouse them to the insufficiency of the existing explanation of hardening.

In the latter part of the past century the views of physicists and chemists on the influence of molecular structure on the properties of matter began to find application in the field of scientific metallurgy. In particular, much attention was directed to the study of the crystalline constituents of alloys and to the influence of heat treatment on their equilibrium. The study of the iron alloys also led to the development of the view that iron itself can exist in several allotropic forms; thus the idea of allotropy was introduced into practical metallurgy.

Mr. G. T. Beilby's researches,[1] which form the subject of the present article, indicate *that all crystalline substances can also exist in a non-crystalline or amorphous form, and that the properties of these two forms are so distinct that they must be regarded as definite allotropic modifications.* Observations on the stability of these forms, and on the conditions under which the one form can pass into the other, confirm this view. As these general principles have been found to apply

[1] "The Hard and Soft States in Ductile Metals." By G. T. Beilby F.R.S. Paper read before the Royal Society on June 27.

without any exception over a wide range of substances, it appears justifiable to conclude that they are universally applicable. The subject is therefore a very extensive one, and the immediate researches which are dealt with here refer to only a small corner of a very wide field.

In the light of present knowledge it would now seem as if the phenomena of the hard and soft states are so striking that they might have been expected to stimulate inquiry into their true meaning at a much earlier date. One of the most obvious of these phenomena has been perfectly familiar ever since metals were first drawn into wire—that is, that the tenacity of the metal is enormously increased by the operation. By the simple operation of wire-drawing, the power of pure soft iron to resist stretching is raised from twenty tons per square inch to more than eighty tons. Recent researches with metals in the highest state of purity have shown that the resistance of gold to stretching may be raised from $4\frac{1}{2}$ tons per square inch to more than 14 tons, while silver and copper are affected to an even greater extent.

Until very recently the adjective "crystalline," when applied to a metal, at once suggested hardness and brittleness, and even yet among practical metallurgists this association of ideas is not easily got rid of. It is no paradox, however, to say that *in the pure ductile metals the crystalline state is actually the soft state.* In what follows it will be shown that a very large part of this softness is directly due to the instability of the crystalline structure. Conversely, the non-crystalline or amorphous state is the more stable mechanically, and is therefore the harder. Not only the softness, but also the malleability and ductility of a metal, largely depend on its crystalline condition. When the metal is mechanically worked, as by hammering or rolling it into sheets or bars, or by drawing it through dies into rods or wires, some of the crystalline is broken down and passes into the non-crystalline form, and as the metal thereby becomes harder it is also reduced to a lower condition of malleability and ductility.

It has been concluded from a long series of experimental observations that in the passage from the crystalline to the non-crystalline state there is an intermediate stage during which the molecules have the freedom and mobility of the liquid state, and that the amorphous state results from the sudden congealing of this mobile phase. It is well known that when a substance passes from the liquid to the solid state, time is required for the molecules to marshal themselves in the orderly formation which is the essential feature of the crystalline state. If a liquid can be congealed with sufficient suddenness, the solid which results is non-crystalline or amorphous, *e.g.* glass, sugar-candy, &c. If we were able to see the actual molecules we may imagine that the amorphous solid would present the appearance of an instantaneous photograph of a liquid in which the molecules would appear as if transfixed in the midst of their rapid movements. It follows from the above that if it were possible in a mass of metal simultaneously to break down all the crystalline units of structure with sufficient suddenness, the whole mass would for an instant be in the liquid condition, and on re-solidification would appear in the non-crystalline state. A little consideration, however, will make it plain that these conditions cannot be fulfilled in the ordinary mechanical operations on metals in the solid state. In a mass of metal, any stresses which are applied mechanically must be applied from the outside, and can only reach an internal point or surface after passing through all the intervening layers. It follows that the breaking down and "flow" of the crystalline elements must take place step by step, so that the mobile condition occurs at successive surfaces within the mass. A wave of mobility can in certain cases be seen as it passes along a stressed rod, but it is instantly followed by a wave of congelation which leaves the metal behind it in a harder and more resistant condition. In some cases a second wave of mobility may be started by the application of a greater stress, but as a rule each successive application of a uniformly increasing stress produces less and less effect. The portions of metal which have yielded and flowed and again congealed protect those portions which still retain their crystalline structure. There appear to be good grounds for believing that even in a gold leaf, in which the metal has been beaten to a thickness of only 1/280,000 of an inch, there are still minute units in the crystalline state which have escaped destruction owing to the protective action of the harder, non-crystalline metal in which they are embedded. Gold wires which have been drawn through a wire plate until they are fifteen times their original length show a microstructure in which deformed and broken down crystals are embedded in non-crystalline substance. *The hardened metal is a complex structure built up of crystalline and non-crystalline substance;* in studying its properties, therefore, it is necessary to remember that no specimen, however drastic may have been its mechanical treatment, can be entirely in the non-crystalline condition.

Though an increase of hardness and tenacity is a very conspicuous feature of the change from the one state to the other, it is only one among a number of equally definite indications of change. A comparison of the heat of solution of a metal in the two states shows that the molecular energy stored in the non-crystalline form is greater than in the crystalline. In this case the difference in solubility which results from this greater energy is further accentuated as the two phases of the metal act towards the solvent as a galvanic couple. A thermoelectric couple made by twisting together the ends of wires in the hard and soft condition is affected by changes of temperature in the same way as a couple made of two different metals would be. In the case of silver a thermocouple of this description can develop an e.m.f. of 27 microvolts for a temperature difference of 83°. *In all these cases the single chemically-pure metal behaves like two distinct metals.*

When hardened metal is heated to a certain temperature, its softness is completely restored. The microscope shows that when this occurs complete crystalline rearrangement has also taken place. The micrographs, Figs. 1 and 2, from the paper by Mr. Beilby read before the Royal Society on June 27, show the two types of structure, the hard and the soft. In Fig. 1 the original crystalline grains have been completely broken down and destroyed by wire-drawing, giving place to masses of deformed and shattered crystal units cemented or concreted together by that part of the metal which has flowed and congealed. In Fig. 2 a new crystalline structure has been developed by heat, and all traces of the other structure have disappeared. This re-crystallisation in hardened metal occurs at a temperature far below the melting point of the metal. In gold the re-crystallisation temperature is about 280°, while its melting point is 1080°; this profound change of structure, therefore, occurs 800° below the melting point.

In the crystalline state the molecules are disposed in sheets or lamellæ of uniform orientation, like soldiers in a battalion. In the liquid state the molecules are in free movement; they do not maintain fixed positions with respect to each other. The effect of sudden congealing probably is to bind the molecules into a rigid mass quite irrespective of any special polar attractions which they may have for each other. They are bound together by the general cohesive force, and their freedom of movement is much curtailed. This is evident not only because they cannot move sufficiently freely to take up the regularly oriented arrangement, but

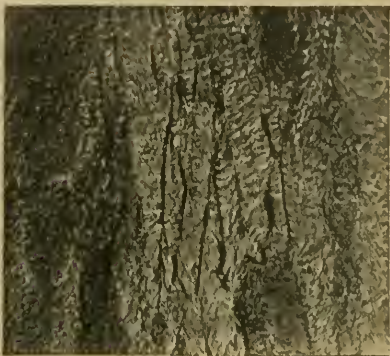


FIG. 1.—Hard-drawn gold wire. Magnification ×700.

also because their elasticity in this state is much less perfect than it is in the crystallised state; the molecules cannot vibrate freely in the amorphous state.

The effect of raising the temperature to the crystallising point is to raise the kinetic energy of the molecules, and therefore to neutralise a part of the cohesive force, thus weakening it and enabling the

FIG. 2.—Hard-drawn gold wire after crystallisation at 280°. Magnification ×700.

molecules to spring into their uniformly oriented position; the crystalline state is thus restored and the internal energy of the mass is reduced. The present observations show that crystallisation occurs over a short and definite range of temperature—short, that is to say, compared with the ranges above and below the crystallisation range. Below the crystallisation range the amorphous or non-crystalline form of the metal is known by direct observations to be perfectly stable down to −180°, while above that range the crystalline form is stable up to the temperature of liquefaction.

The changes in the electrical, mechanical, and other properties, which occur when the crystallisation range is reached, amply confirm the microscopic observations, and all point to the occurrence of an important change in the molecular structure.

By means of an acoustical method it has been found possible to detect the minute changes in elasticity which occur as the temperature is gradually raised to the crystallising range. In this way it has been made evident that there are two distinct stages in the relief of the molecular strains which are caused by hardening. In the first stage no important alteration in the other properties of the hardened metal occurs, while in the second and more important stage the complete restoration of elasticity exactly corresponds with the other changes which occur at the crystallisation temperature.

OCTOBER METEORS.

OCTOBER is a month when meteors are decidedly numerous. They are particularly abundant from October 15 to October 25, and this period includes the well-known shower of Orionids, but the conditions will be unfavourable this year owing to the full moon of October 21.

Early in the month there is occasionally a rich shower near the northern boundary of Boötes at $230°+52°$, and on October 8 there are many meteors from Aries about $42°+20°$, from Auriga, $77°+32°$, and from about this date to October 20 there is a well pronounced morning shower of long-pathed meteors from $154°+39°$.

Before sunrise the observer will also trace radiants at $101°+1°$, $100°+13°$, $108°+13°$, $121°+0°$, $133°+68°$, $133°+48°$.

Thirty years ago, viz. in 1877, during the first week in October there were very well pronounced showers at $133°+79°$ and $313°+77°$; the former gave swift streak-leaving meteors, the latter slow faint meteors.

October furnishes several radiants of Perseids, and one of the most notable of these agrees precisely in its apparent position with the centre of the great display of August Perseids on the date of maximum. Between October 8 and 14 I have recorded a number of slow meteors from a well defined radiant at $45°+58°$.

The principal shower in the last half of October is one of Arietids from near ϵ. On 1877 October 28–November 1, I saw thirty-one meteors from $43°+22°$, and on 1887 October 11–24, forty-five meteors were registered from $40°+20°$. The members of this system are white, rather slow, and occasionally brilliant, with trains of yellow sparks. As they were very active in 1877 and 1887, they may periodically recur at intervals of a decade, and be numerously manifested again in 1907.

W. F. DENNING.

MR. HALDANE ON SCIENCE IN COMMERCE.

A VERBATIM report of the speech on scientific commercial education in relation to the successful pursuit of trade, delivered by Mr. Haldane at Liverpool on September 19, and briefly mentioned in last week's NATURE, appeared in the *Liverpool Daily Post* of September 20. The two main points developed by Mr. Haldane in the course of his remarks were the domination of mind over matter and the value of organisation. Expressed briefly, brain-power was described as the chief factor upon which commercial progress must depend. Subjoined is a summary of the parts of the speech concerned with this subject:—

We live in a time when we shall fall behind in the race if we do not possess as a nation the gift of organisation. Capital has become the instrument in the hands of the directing brain; and the directing brain for huge concerns of to-day is only big enough if it can embrace in its survey the whole of the competing civilisation. Germany, France, the United States, and other countries are pressing us hard, and it is only by the possession of ideas, by the willingness to work as our forefathers never worked, with the same concentration, we can hope to hold our own in the race. At the bottom of great ideas comes great capacity to organise if they are to succeed; and with great capacity to organise great capacity to think. It is the thinker, the man of ideas, who can translate thought into action, that wins the race of to-day—a race far stiffer, far harder, far nobler, than the easy race of our forefathers. Our universities are growing; our tropical schools are starting; our organisation of commerce is going to be on a larger scale; and yet it is none too soon, because other nations are doing the very same thing. So it comes that the great lesson which this nation has to learn appears to be this—to recognise that mind dominates matter, that brains lie at the root of things, and that upon their working out and the results which brains have provided no progress can be made without that secondary but emphatically valuable faculty is added—the faculty of organisation.

The creation of the Committee of Imperial Defence carried scientific principles into the sphere of government, and was the first step toward getting military and naval notions into order. We now have a general staff which is a body, not to exercise command, but to give advice in a thoroughly practical fashion and in a fashion which can be enforced. The speculation may be indulged in whether one of the great reforms of government to which we are coming—because we have been driven to it—will not be the creation in an organised fashion of just such a general staff for departments of government, and not merely for the Army. A concrete instance may be given of the value of scientific advice. In two parts of the dominions of the Crown there are diseases of a terrible character raging at this moment. One is understood, because it has been dealt with by the scientific experts of the Government, but the other is not, because there are no scientific experts to deal with it. The first case is in India, where research work is carried out by experts whom the Indian Government has organised, and who are out working in the subordinate departments of the Government, exercising no authority, but giving advice and reporting to headquarters. These investigators and advisers have brought the plague in India within compass. Then, to give a second case, in one of the West Indian islands, possibly in more, there flourishes what is called tropical anæmia, which, although not fatal to life in the ordinary sense, reduces the working power of its victims by 30 per cent. or 40 per cent. This is a sheer loss to the State, and yet the disease can be and has been combated in other parts of the world. This disease, which also exists in our mines, where it is known as ankylostomiasis, was recently very familiar in Westphalia, and the German Government, working on general staff principles, dealt with the scourge on scientific principles from the beginning. The disease exists in our Cornish mines, but we have not extirpated it as thoroughly as the Germans have.

If people were but aware what can be accomplished and what can be saved to the State, and the extent to which our community can be made more efficient by dealing with these things on a scientific footing, the nation would be wiser and better. This may seem to be the bureaucratic point of view, but when it is founded on science it is the right point of view; and the governments of the future will find more and more work of this kind forced upon them.

THE REV. DR. JOHN KERR, F.R.S.

JOHN KERR, the discoverer of the Kerr effect in magneto-optics, was born at Ardrossan, Ayrshire, December 17, 1824, and received part of his early education at a parish school in Syke. He graduated M.A. with honours in 1849 at Glasgow University, where he greatly distinguished himself, especially in mathematics and natural philosophy. He completed the usual course in theology at the Free Church College in Glasgow, but, instead of entering on a clerical career, became in 1857 mathematical lecturer in the Free Church Normal Training College for Teachers in Glasgow, an institution which has recently passed under the direct control of the Scottish Education Department. Here for forty-four years he trained in mathematics and physics thousands of our youth who afterwards filled important scholastic positions. On his retirement in 1901 his old pupils entertained him at a banquet, when Prof. Magnus Maclean in their name presented him with a tea and coffee service, and made a graceful reference to his great work.

In 1867 Kerr brought out an "Elementary Treatise on Rational Mechanics" (Hamilton, Glasgow), which deserves more than a passing notice. While adhering to the usual mode of treatment at that time, namely, first statics and then dynamics, he introduced what was then a novelty in English books, a separate chapter on kinematics as a preliminary to the chapters on kinetics. Numerous examples are appended to the various chapters, and it is doubtful if among the many more modern treatises of similar standard a better working book for the student exists. Every here and there the physical mind of the author is in evidence, especially in an appendix or "Note," the object of which "is to give a sketch of some of the simpler facts connected with the manifestations of force in nature." Elasticity, cohesion, capillarity, electricity, magnetism, physical optics, and sound are briefly commented on; and the conservation of energy is discussed under that name. The book was written before the formal appearance of Thomson and Tait's "Natural Philosophy," but no doubt under its influence. It is interesting to note that Kerr returns to Newton for the true foundation of dynamics.

In 1875 Kerr published his first paper "On a New Relation between Electricity and Light: Dielectric Media Birefringent" (*Phil. Mag.*, vol. l., pp. 337–348 and 446–458). Accepting the Faraday theory of electric strain, he constructed a remarkably simple form of apparatus in which the ends of two terminals in connection with the open secondary circuit of an induction coil were brought to within a quarter of an inch of each other in the heart of a plate of glass. Nicol prisms were arranged for extinction with their principal axes at angles of 45° with the line of terminals. When the induction coil was set in operation light was restored by the birefringent action of the electrified glass. The investigation was soon extended to liquids, such as bisulphide of carbon, benzol, paraffin, &c. By an extremely neat and simple use of a compensator of mechanically strained glass inserted in the path of the polarised ray, he proved that electrified glass acted upon transmitted light like a negative uniaxal crystal with its axis parallel to the lines of electric force. Quartz acted like glass, but resin acted like a positive uniaxal, as if it were extended along the lines of force. In later papers, published at intervals in the *Philosophical Magazine* between 1879 and 1882, he continued this research with more elaborate apparatus, and extended it to a great many substances, establishing, among other things, the law that the optical effect varies as the square of the resultant electric force.

At the meeting of the British Association in Glasgow in 1876, the president, Prof. Andrews, made a pointed reference to these early experiments of Dr. Kerr, but little dreamed that in a few days the whole scientific world would be positively "electrified" by the announcement of the great discovery known as the Kerr effect. Not only did Kerr announce the discovery, but he demonstrated it with the simplest of apparatus before the meeting of Section A. The paper containing a full account of these experiments was published in 1877 (*Phil. Mag.*, vol. iii., pp. 321–343). The great fact established was that the plane of polarisation of a ray of plane polarised light reflected from the end of the iron core of an electromagnet is rotated under influence of the magnetising current, in a direction contrary to the conventional direction of the current. In a later paper (*Phil Mag.*, vol. v., pp. 161–177) the like phenomenon was established for light reflected from the sides of the magnetised iron. These remarkable experiments form the starting point for a prolonged series of delicate measurements in magneto-optics by several experimenters, of whom we may mention specially Righi, Kundt, Du Bois, Sissingh, Zeeman, and Drude.

On the theoretical side Fitzgerald (*Phil. Trans.*, 1880) was the first to attempt a discussion of the Kerr effect. In this effort he broke "new ground," as Maxwell expressed it; and although the theory was not comprehensive enough, nevertheless (to quote from Larmor, who has himself greatly developed the whole electromagnetic theory) "Fitzgerald's analytical work still remains applicable. The extension to metallic media is now formally made, as Ohm's law indicates, by taking the refractive index to be a complex quantity; with this generalisation the analysis has been extended by various writers, including Lorentz, Goldhammer, and Drude, but most completely by Leathem and Wind, and shown to embrace satisfactorily all the mass of detail that has been brought out in recent years in experimental magneto-optic investigations."

Dr. Kerr's latest paper on this subject (*Proceedings of the Royal Society*, 1894) described experiments on a fundamental question in electro-optics: "Reduction of Relative Retardations to Absolute." In 1888 (*Phil. Mag.*, xxvi., pp. 321–341) he published a well-planned and carefully-executed series of experiments on the birefringent action of strained glass. His last contribution to scientific literature was a note read before the British Association in 1901 on the "Brush Grating and its Optical Action."

Before the great scientific events of his life the University of Glasgow showed their appreciation of Dr. Kerr as an educationist by conferring on him in 1868 the honorary degree of Doctor of Laws. He was elected F.R.S. in 1890, and was awarded a Royal medal in 1898. He died August 18, 1907, after enjoying six years' retirement from official duties in the Normal College. Here, in limited accommodation, with still more limited apparatus, and only by devoting evening hours and precious holidays to research, John Kerr made the discoveries which have linked his name for all time with that of the immortal Faraday.

C. G. K.

NOTES.

Prof. M. H. E. Tscherning, director of the ophthalmological laboratory of the Sorbonne, Paris, has accepted the invitation of the council of the Optical Society to deliver the first Thomas Young oration on Thursday, October 17, and has chosen for its title "The Development of the Science of Physiological Optics during the Nineteenth Century." The oration has been established for the purpose of providing an annual lecture on some subject connected with physical, geometrical, or physiological optics, and thus to further the development of those branches of science with which the name of Thomas Young is intimately associated. The orator is elected annually by the council of the Optical Society from persons eminent in these branches of science or technology.

A very interesting and instructive exhibit has just been added to the public galleries of the geological department of the British Museum (Natural History) in the form of an enlarged wax model of the Silurian arachnid *Eurypterus fischeri*. Remains of these creatures are found in such a wonderful state of preservation in the Upper Silurian strata of Oesel, in the Baltic, that Prof. G. Holm has succeeded in freeing from the matrix considerable portions and mounting them on glass slides in Canada balsam. The original chitin is preserved in an almost unaltered condition, and even the most minute details of the external surface are retained. From these materials it has been possible, under the superintendence of Dr. Calman, to construct the model now exhibited, which is double the natural size, and appears to be between 7 inches and 8 inches in length. The model is temporarily placed in the central hall.

We learn from the *British Medical Journal* that a movement for the foundation of an institution which is to bear the name of Prof. Robert Koch is on foot in Germany, and a committee has been formed with the object of collecting money for the purpose. The chairman is Dr. von Studt, Prussian State Minister; the vice-president, Privy Councillor Althoff; the secretary, Prof. Schwalbe, editor of the *Deutsche medizinische Wochenschrift*; the treasurer, Dr. Paul von Schwabach, General Consul, Berlin. The institution, which is to be applied to the furtherance of research in all directions for the discovery of means of checking the diffusion of tuberculosis, is intended to be a permanent memorial of the discovery of the tubercle bacillus by Prof. Koch twenty-five years ago. Appeal is made for contributions sufficient to make the institution a tribute of gratitude to Koch, similar to those with which the name of Pasteur has been honoured in France and that of Lister in England.

It is announced in the *Times* that the Government has completed negotiations for the purchase of the estate of Inverliver, Argyllshire, with a view to its conversion into a State forest. The estate, which has an area of about 12,530 acres, extends for about nine miles along the western side of Loch Awe, stretching across to Loch Avich. It will be of much value as a centre of education in forestry, and arboriculturists in Scotland are gratified that their desires for the establishment of a demonstration area are about to be realised. The afforestation of Inverliver will at once be proceeded with according to a general scheme, which provides for a certain number of acres being planted each year. The estate will be under the management of the Office of Woods and Forests, and, though it will yield no immediate return, it is expected that it will ultimately cease to be any financial burden to the State.

Mainly at the instigation of the Hon. John Ferguson, C.M.G., the Government of Ceylon has granted to Dr. A. Willey, director of the Colombo Museum, a sum of 3000 rupees (200*l*.) to secure the services of a British anthropologist for the study of the Veddahs during 1908. Dr. C. G. Seligmann, who has made most admirable investigations in British New Guinea, has been invited to undertake this research, and we have the pleasure of stating that he has accepted the commission. The Cousins Sarasin have published a fine monograph on the physical anthropology of these interesting people, in which they have also given valuable information concerning their habits and customs; but the cultural life of these hunter folk has never been thoroughly investigated. Dr. Seligmann will mainly study the sociology and religion of the Veddahs, but he will also make his researches as complete as possible in other directions, and will pay especial attention to the old stone implements of the Veddahs, the recent discovery of which was duly announced in Nature. He will receive cordial assistance from Dr. Willey, who has a practical knowledge of the Veddah country, and with this, and other help and information which will be offered to him, there is every reason to hope for a successful expedition. Dr. Seligmann, who will be accompanied by his wife, expects to sail at the end of November.

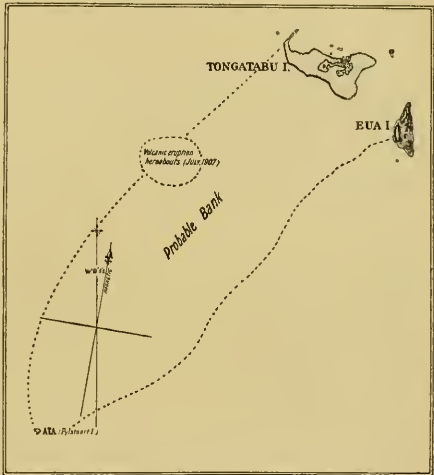
The first exhibition of the Society of Colour Photographers, open free to the public, is being held at the offices of the *British Journal of Photography*, 24, Wellington Street, Strand, W.C. In organising the exhibition the society is appearing before the public for the first time since its formation a year ago, but its first year of active existence opportunely coincides with the appearance of simplified methods of colour photography, already described in these columns.

Dr. W. S. Bruce, Mr. Stewart Ross, and Mr. Gilbert Kerr returned to Edinburgh on Monday on the conclusion of the Scottish expedition to Prince Charles Foreland. Dr. Bruce told a Reuter representative that they have been able to make a detailed survey of the whole of the west coast of Prince Charles Foreland, of the interior with its mountains, and of a considerable portion of the east coast. Good zoological collections have been obtained, including a specially fine set of bird skins, a few seal skins, and the skeleton of a whale. Valuable geological and botanical collections have also been secured. A Reuter representative has also obtained details of the Arctic expedition undertaken by the Duc d'Orléans, who, together with Dr. Recamier, the surgeon and naturalist of the expedition, arrived in England on Monday. The expedition, which was on board the duke's Polar yacht *Belgica*, under the command of Captain de Gerlache, returned to Hammerfest on September 15. The scientific work accomplished will, it is said, prove of great interest.

We have to acknowledge the receipt of a copy of the report of the museums of the Brooklyn Institute of Arts and Sciences for 1906, in which it is stated that the most important additions to the natural history department comprise a collection of sponges and corals made by the late Prof. H. A. Ward in Japan and Australia, and another of shells, late the property of Phebe L. Mumford. Considerable progress has been made in the mounting of realistic groups of mammals and birds, of several of which illustrations are given.

Bulletin No. 5 of the entomological division of the experiment station of the Hawaiian Sugar Planters' Association (published at Honolulu, August 2) is devoted to the sugar-cane leaf-roller, the caterpillar of the moth *Omiodes accepta*. The moths of this genus are regarded by Sir George Hampson as inseparable from Phryganodes, but this is not accepted by Mr. O. H. Swezey, the author of the report, who states that they agree more nearly with the diagnosis of Nacoleia. The caterpillars are very destructive to grass crops, rolling up and glueing together the edges of the blades, and then devouring the softer tissues.

Captain T. H. Tizard, F.R.S., assistant hydrographer of the Admiralty, sends us a copy of a notice to mariners, issued on September 14, relating to a volcanic eruption near the Tonga or Friendly Islands, South Pacific Ocean. The notice states:—"Information, dated July 29, 1907, has been received through the Government of the State of Victoria, that the Government of the Tonga Islands has given notice that a volcanic eruption is in progress about



Volc.nic eruption near the Friendly Islands.

thirty miles south-west of the western point of Tongatábu (Niuanofo)." The approximate position of the disturbance is lat. 21° 25′ S., long. 175° 45′ W. All the information received has been given in the notice, but probably fuller details will be eventually published. The accompanying illustration from Admiralty chart No. 3421 shows the approximate position of the eruption, and also that it appears likely that a bank runs south-west from Tongatábu towards Pylstaart Island, and that the eruption is situated near the edge of this bank.

According to the report of the Government Museum and Connemara Library, Madras, for the year 1906–7, issued by the Educational Department of Madras, July 19, the erection of a new room for the prehistoric collection made by Mr. R. B. Foote is in contemplation. Considerable progress has been made in the anthropological and ethnological section, both in the matter of collections and publications. Unfortunately, the superintendent, Mr. E.

Thurston, has to deplore the loss, by theft, of a number of valuable gold and silver coins, mostly consisting of Roman Imperial solidi and denarii.

In the third part of vol. ii. of the *Agricultural Journal of India* Mr. H. M. Lefroy gives coloured illustrations, with descriptive letterpress, of the various developmental stages of the two species of Indian locusts. Of these, the north-west locust (*Acridium peregrinum*) is normally a migratory species, inhabiting dry districts, and giving rise to annual swarms. The Bombay locust (*A. succinctum*), on the other hand, is typically a native of the moist Western Ghats, and only occasionally assumes migratory swarms, the members of such flights assuming an abnormal red colouring. In the description of these different phases, on p. 241, the references to the figures are unfortunately incorrect. As to the black-spotted grasshopper (of which figures are also given), there is no evidence of its ever assuming migratory habits. The proper identification of migratory locusts from different parts of the country is a matter of some importance in connection, not only with the distribution of the species, but with agriculture.

In the *Journal of Economic Biology* (vol. ii., No. 2) Mr. E. R. Burdon publishes particulars regarding the efficacy of spraying spruce trees in winter to destroy the Chermes or aphids that cause the pine-apple galls. The wash consists of an emulsion of soft soap and paraffin or a solution of soft soap. Dr. R. S. MacDougall communicates the results obtained in rearing broods of the pine-sawfly, *Lophyrus pini*, from unfertilised eggs, and Mr. C. G. Hewitt presents an account of the life-history of the root maggot, *Anthomyia radicum*.

In his annual report for 1906–7, Mr. J. H. Hart, superintendent of the Botanical Department, Trinidad, notes that there has been a large demand for sugar-canes, cacao and rubber plants, also for young cedar, Honduras and native mahogany trees. A considerable quantity of budded stock of various citrus fruits was distributed, and an attractive variety of seedless orange, locally raised, was secured and budded, according to usual practice, on sour-orange stock to avoid the root-rot that is prevalent in the island. Hevea, Funtumia, and Castilloa were the rubber plants chiefly in request; the consignments of Castilloa rubber from Trinidad and Tobago attained to commercial quantities, and realised good prices. A number of camphor seedlings were successfully raised from imported seed, and date palms have received attention. A list is given of more than twenty palms that flowered in the gardens at St. Clair during the year.

The scientific papers in the *Kew Bulletin*, No. 8, consist of a decade of diagnoses of new plants from the herbarium, an article by Mr. G. Massee on degeneration in potatoes, another on the cricket-bat willow by Mr. W. J. Bean, and a note by Mr. N. E. Brown defining the genus Pergularia. Mr. Massee refers to the experience of growers that "seed" potatoes often fail to form sprouts, and attributes the sterility to two causes, *i.e.* to arrest of development of the vascular system in the tuber, and to a want of sufficient diastase. The information regarding the willows is based on the collaboration of the cricketer, Mr. John Shaw, with the Rev. E. R. Linton, a leading exponent of varieties of willows. On this authority Mr. Bean states that *Salix alba*, var. *caerulea*, bearing pistillate flowers, yields the best timber, and that *Salix viridis* is suitable, although inferior to the former. Since, under favourable conditions, trees grow to a merchantable size in twelve years, the cultivation affords a prospect of profitable remuneration.

The "Flora of the Presidency of Bombay," prepared by Mr. T. Cooke, makes good progress, as the fourth part of the second volume, issued in July, deals with the concluding orders of the dicotyledons from Urticaceæ to Ceratophyllaceæ, the gymnosperms and the monocotyledons from Hydrocharitaceæ to Typhaceæ. Under the Urticaceæ the genus Ficus is prominent with eighteen species, one, *Ficus Talboti*, being endemic. Only two gymnosperms, *i.e. Ephedra foliata* and *Gnetum scandens*, are regarded as indigenous; the conifers, ten in number, and the two cycads noted are exotic, although *Cupressus glauca* receives the name of the Goa cypress. The Orchidaceæ, with thirty-one genera, include a number of species confined to the western peninsula, and several are endemic. The Scitamineæ and Palmæ contain numerous economic plants, many of them introduced, that are briefly described. Mr. Cooke has also given a key to Drummond and Prain's identifications of species of Agave and Furcræa.

The writer of the article on "Archæological Discoveries in Egypt," which appeared in Nature of September 12, desires to add that when the article was written nothing was yet known of the results of Prof. Petrie's excavations, which were therefore not mentioned. Since the proofs were corrected, the annual exhibition at University College has been held, and has shown that Prof. Petrie's discoveries of this year, though by no means very exciting, have been interesting enough. The best things found are some splendid interments of the Twelfth Dynasty, with fine coffins and models of ships, &c., in perfect condition, from a tomb at Rîfa, near Asyût. From other tombs in this neighbourhood Prof. Petrie recovered an interesting series of what he calls "soul-houses," which are the small clay models of dwellings often found in tombs of the VIth–XIIth Dynasty period. They are well represented in our museums, but Prof. Petrie has obtained some new and fine types. Prof. Petrie also excavated at Gîza.

We have received a long letter from the Rev. J. W. Hayes, West Thurrock Vicarage, Grays, Essex, with regard to the so-called "twin-chamber denehole" at Gravesend, recently described in the *Times*, and referred to in our notes on September 19 (p. 522). According to Mr. Hayes, the two chambers were originally two distinct deneholes, each with its own shaft, and being in close proximity were brought into communication by a breach in the dividing wall, made after the excavation of the chalk. There is no true platform in either cavern, but a great quantity of sandy loam occupies the floor. In Mr. Hayes's opinion, the pick-marks on the roughly hewn walls could have been made only by an implement of metal, not by one of horn, bone, or flint; whilst he believes that the caves were certainly not used either as a dwelling or as a storehouse for grain.

In a communication to the *Ceylon Observer* of August 10 Mr. J. Pole records the discovery of numerous Palæolithic stone weapons on hillocks at Imboolpittia, Ceylon. Similar discoveries have been made by the brothers Sarrasin, who have hitherto monopolised the study of that interesting forest race, the Veddahs. Mr. Pole, on rather shadowy grounds, attempts to connect the implements which he has discovered with the same tribe.

An interesting report on the borax deposit of Lake Salinas, Peru, has been published by Mr. A. Jochamowitz (*Boletin del Cuerpo de Ingenieros de Minas del Peru*, No. 49). The so-called lake is dry for the greater part of the year, and the borax deposit is about 3 feet in thickness. It consists of ulexite, containing 30 per cent. of boric acid. The bed is impermeable, so that water cannot reach the lake at places where borate occurs. The borate is extracted by means of shallow pits, which become filled with water when the borate is removed. Reports have also been issued by Mr. W. Turner and Mr. J. J. Bravo on the geology of the River Chillon (*Boletin* No. 48), and by Mr. H. C. Hurd on the water supply of the valley of Lambayeque (*Boletin* No. 47).

The current issue of the Proceedings of the American Philosophical Society (vol. xlvi., No. 185) covers two hundred pages, and contains seventeen papers of very varied interest. The most important memoir is a detailed account of the geology of the San Francisco peninsula, by Mr. Roderic Crandall. It describes the Montara granite, the Franciscan series, the Merced series (Pliocene), the Pleistocene beds, the serpentines, the igneous intrusive rocks, and the schists represented on the peninsula. The age and origin of the rocks are discussed, and an excellent coloured geological map is appended. Another paper of great interest is that by Mr. E. B. Titchener and Mr. W. H. Pyle on the effect of imperceptible shadows on the judgment of distance. Careful experiments show that such shadows, raised almost to the limit of perceptibility, exert no influence upon the judgments of distance by five observers. Mr. M. D. Ewell gives the results of a preliminary study of some modern micrometers. He collected a number of stage micrometers, and measured five to ten spaces on each with great care. The results show that no advance in precision has been made during the last twenty-five years. Indeed, the results do not seem to equal those of the former period. The papers of chemical interest deal with the measurement of the action of water on metals, the production of synthetic alcohol, and the association theory of solutions.

The September number of *Symons's Meteorological Magazine* contains a useful paper by Mr. R. H. Curtis on the distribution of bright sunshine over the British Isles. Two forms of recorder have been in general use, the photographic and burning instruments; their records frequently differ considerably, and not always in the same direction. For the sake of uniformity, the Meteorological Office now only publishes records from the burning instrument, and these alone have been used in Mr. Curtis's discussion. Latitude being an important factor, we naturally find that the sunniest parts of the United Kingdom are the most southern, the annual total of hours' duration decreasing from 1900 hours in the Channel Islands to 1200 over the north of Scotland. A very clear map shows, however, that the lines of equal duration have a strong tendency to follow the coast lines both in east and west, and that a large portion of the central area of England and of the south-west of Scotland is adversely influenced by smoke and dust; in winter the largest totals of sunshine are obtained in the south-west. A great part of Ireland, central Wales, and the Highlands of Scotland are still very inadequately represented by sunshine recorders.

September has proved an exceptionally fine and dry month over the entire kingdom, and in England the period without rain continued for about three weeks. Of the stations reporting to the Meteorological Office, the least measurement of rain for the month was 0·28 inch at Yarmouth, which is only 12 per cent. of the average, whilst at Bath the percentage was 18, and at Liverpool 19. At many places in different parts of the kingdom there was less than 50 per cent. of the average. In London the aggregate measurement was 0·58 inch, which is 28 per cent. of the normal. The total measurement of rain since the commencement of the year is deficient, except in the extreme north and west. In London the deficiency amounts to 4·88 inches, and, so far, April is the only month with an excess of rain; the greatest deficiency in any month is 1·48 inches, in September. The duration of sunshine so far this year is, in London, fourteen hours more than the average, the excess occurring in January, February, March, and September. There were in all during the six summer months from April to September sixty-one days at Greenwich with the temperature 70° and above, and only two days with a temperature of 80°. The only years since 1841 with fewer days of 80° and above are 1860, when the thermometer did not once touch 80°, and 1862 and 1879, when there was only one instance of so high a temperature. The type of weather which prevailed with such persistence throughout September has now completely changed, and with October rains have become general.

A summary of the paper on the effects of heavy pressures on arc spectra, communicated by Mr. W. J. Humphreys to the American Physical Society, appears in the *Physical Review* for June. Pressure seems to increase the width of all lines and displace most of them towards the red by amounts approximately proportional to the pressure. The extent of the shift varies from line to line, and is practically independent of the amount of material used. The intensities of some lines are increased, of others decreased, by the pressure.

Mr. E. F. Northrup directs attention in the *Physical Review* for June to the magnitude of the forces exerted by the parts of a non-electrolytic liquid carrying an electric current on each other, and describes several striking experiments in illustration. One of these consists in sending a large current through a narrow channel of mercury connecting two small reservoirs of mercury. With a current of 800 amperes a V-shaped depression half an inch deep formed at the centre of the channel, the mercury flowing into the reservoirs. A slight increase of the current broke the continuity of the mercury in the channel. On the liquid flowing together again the circuit was re-made, the arrangement thus constituting a slow and irregular interrupter.

In the *Physikalische Zeitschrift* for September 15 Dr. K. E. F. Schmidt has an article on the "barretter," *i.e.* the bolometer when used to detect and measure rapid electrical oscillations. He shows that by enclosing the instrument in an oil bath the necessity for using two similar instruments is obviated. The "barretter" in series with a galvanometer of low resistance forms one arm of a resistance bridge, the other arms of which are wound so as to have considerable inductance, and thus confine the oscillating current to the "barretter," the terminals of which are connected to the circuit in which the oscillations are to be measured. The oscillating current heats the fine wire of the instrument, and thus disturbs the balance of the bridge by a measurable amount. The conditions for maximum sensitiveness are considered by Dr. Schmidt, and the results expressed in the form of curves.

Under the title "Grandeur et Décadence des Rayons-N: Histoire d'une Croyance," M. Henri Piéron gives in the

Année psychologique (vol. xiii., p. 143) a review of the history of the mysterious *n*-rays from the time when their discovery was first announced by M. Blondlot in 1903. A complete bibliography of the subject is appended which comprises in all 176 original papers, very unequally distributed as regards date, nineteen being published in 1903, 139 in 1904 (103 in the first half of the year), seven in 1905, and fifteen in 1906. After the surprising statement had been made that it was possible to chloroform metals, and thus, by a process of anæsthesia, destroy their power of emitting the rays, and largely in consequence of Prof. R. W. Wood's letter in NATURE (vol. lxx., p. 530) throwing doubt on the existence of the rays, the *Revue scientifique* instituted an inquiry to ascertain whether other physicists who had worked on the subject had succeeded in verifying the remarkable statements made by MM. Blondlot, Charpentier, and Jean Becquerel. This inquiry, which has been briefly referred to in NATURE (vol. lxxi., pp. 113, 132, 157), showed that practically all those who had attempted to establish even the existence of the *n*-rays had entirely failed. A simple method of settling the question once and for all was then proposed by the *Revue scientifique*. A number of wooden boxes of exactly the same size and appearance were to be sealed up after enclosing in some of them small pieces of lead, in others rods of tempered steel, the latter being one of the recognised sources of the rays. It was to be left to M. Blondlot or his assistants to ascertain by experiments, made in presence of a committee of witnesses, which of the boxes contained the active material. This crucial test was, however, declined by M. Blondlot, who stated that "the phenomena were far too delicate for such a trial," and left "everyone to form his own opinion on the *n*-rays either from his own experiments or from his confidence in those of others." The subject was thus withdrawn from the region of fact and transferred to that of opinion. It is significant that from this time forward publication of further experiments practically ceased. A few attempts were made to obtain photographically objective evidence of the existence of the rays, but these did not withstand the test of criticism. It appears now established that the *n*-rays and their wonderful effects had no real existence, but that the results published in so long a series of papers were due to illusion caused by a species of auto-suggestion based on preconceived ideas. The matter forms, indeed, one of the most curious chapters, not only in the history of physical science, but also in that of psychology.

PAGES 1–78 of vol. ix. of the Proceedings of the Washington Academy of Sciences contain a very useful compilation, by Mr. James W. McBain, of all the experimental data referring to the quantitative measurement of electrolytic migration. Abstracts are given of all papers bearing on the subject between the years 1814 and 1905, the numerical results being summarised in the form of tables. In the introduction a brief discussion is given of the probable degree of accuracy of the determinations, of the errors introduced by the use of diaphragms and by the methods of calculation adopted; the interpretation of the results is also dealt with, a number of anomalous cases which are not in accord with the prevalent theory of solutions being considered separately, as well as the questions of hydrated and complex ions. The matter is arranged chronologically, but for convenience of reference indexes of substances and authors are appended. The compilation appears to be very complete, and its value is enhanced by the fact that a very large number of the papers bearing on the subject have titles which give no indication that they contain experiments on electrolytic migration.

MESSRS. J. GRIFFIN AND SONS, LTD., have sent us a specimen of their new Bunsen burner, which they call an "Improved Teclu Burner." The Bunsen, as a matter of fact, is a slightly modified Marshall burner, the chief feature of which was that the air passes up from beneath the burner instead of being drawn in at the sides of the tube. The gas, on the other hand, passes in at the side, and not up the centre. The novelty in the burner is the arrangement for regulating the air supply, which is cone-shaped. We have tested the burner, and find it gives a good non-luminous flame, and can be turned extremely low without striking back. Even when at its lowest the flame is quite non-luminous.

THE new session of the Institution of Mechanical Engineers will be opened on Friday evening, October 18, when a paper on the indicated power and mechanical efficiency of the gas-engine, by Prof. B. Hopkinson, will be read.

OUR ASTRONOMICAL COLUMN.

NEW ELEMENTS AND EPHEMERIS FOR COMET 1907*d*.—The following set of elements has been calculated for comet 1907*d* by Herr Kritzinger, from observations made on June 15, July 20, and August 28:—

$$\begin{aligned} T &= 1907 \text{ September } 3{\cdot}9792 \text{ M.T. Berlin.} \\ \left.\begin{aligned} \omega &= 294^\circ\ 21'\ 37{\cdot}7'' \\ \Omega &= 143^\circ\ \ 2'\ 33{\cdot}7'' \\ i &= \ \ 8^\circ\ 58'\ \ 6{\cdot}1'' \end{aligned}\right\} & 1907{\cdot}0. \\ \log q &= 9{\cdot}709663. \end{aligned}$$

This appears in No. 4201 of the *Astronomische Nachrichten* (p. 15, September 20), and is followed by a daily ephemeris computed therefrom by Herr Spohn; the following extract gives the calculated positions and magnitude for every eighth day:—

Ephemeris 12h. (M.T. Berlin).

1907	α 1907·0 h. m.	δ 1907·0 ° ′	log *r*	log Δ	Magnitude
Oct. 3	11 38·5	+3 17·9	9·9265	0·2458	6·9
11	12 6·9	+1 6·3	9·9908	0·2776	7·4
19	12 31·7	−0 49·9	0·0472	0·3051	7·8
27	12 53·6	−2 30·8	0·0967	0·3290	8·1
Nov. 4	13 13·2	−3 58·9	0·1399	0·3492	8·5

The magnitudes are derived from the magnitude at the time of discovery, which is taken as 8·0.

An ephemeris extending to December 30 is given by Herr J. Franz in No. 4200 of the *Astronomische Nachrichten* (p. 401, September 12).

An excellent reproduction of Mr. Plaskett's photograph, obtained at Ottawa on July 20, appears as the frontispiece to the current issue of the Journal of the Royal Astronomical Society of Canada (vol. i., No. 4).

SEPTEMBER METEORS.—A magnificent bolide was observed at South Kensington by Mr. F. E. Baxandall at 10.40 p.m. on September 19. Its path lay from near Saturn, where it first appeared, to a little south of Cassiopeiæ, where it was seen to explode and divide into two well-defined portions. The object was intensely brilliant, and travelled very slowly along its path of nearly seventy degrees.

THE ELECTRIC ACTION OF THE SUN AND OF THE MOON.—The results of some experiments on the electric action of the sun and moon, carried out by Dr. Nodon on the summit of the Pic du Midi, appear in No. 12 (September 16, p. 521) of the *Comptes rendus*, and are exceedingly interesting. Using an aluminium-leaf electrometer, so insulated that a charge of 1500 volts was retained for a week, Dr. Nodon found that the sun induced a positive charge, which varied considerably from one moment to another between one and six volts per minute. This charge was completely absorbed by clouds passing before the solar disc, but showed itself when a black card coated with paraffin was interposed between the sun and the instrument. An earth-connected metal screen absorbed the charge.

Dr. Nodon's experiments also indicated that the potential of the soil depends upon the variable electrical state of the upper layers of the atmosphere, for when the indicated potential of the solar charge received remained constant, that of the soil was also constant, but with a varying solar potential the terrestrial potential varied several hundred volts per minute, attaining its maximum when the former ceased to manifest itself. This action is much less marked at sea-level than at the altitude of the summit of the Pic du Midi. It is suggested that the rapid variations of the terrestrial potential may indicate approaching tempests, storms, and even earthquakes, and actual observations by Dr. Nodon tend to confirm this. With this method improved, prognostications of atmospheric and seismic troubles may become possible. On August 21, between 8 p.m. and 10 p.m., Dr. Nodon also detected a positive induction produced by the full moon analogous to the solar charge, and varying from one to five volts per minute.

Perth Catalogue of Standard Stars.—In "A Catalogue of 420 Standard Stars, mostly between 31° and 41° South Declination, for the Equinox 1905·0, from Observations made at the Perth Observatory, Western Australia," Mr. W. Ernest Cooke, the Government astronomer of Western Australia, appears to have done an excellent piece of work, though one might wish that the details had been given somewhat more fully.

When some of the South American observatories failed to fulfil their engagements with reference to the International Photographic Chart of the Heavens, the gap was to some extent bridged by the Perth Observatory undertaking to observe the zone 32°–40° S. The catalogue plates for this zone are now practically complete, but the measurement of the star images and the necessary reductions are delayed by the want of a sufficient number of known stars to furnish the plate constants. For this reason it is proposed to observe some 10,000 stars, appropriately scattered throughout the zone, and for reasons which are not explained the method of absolute determinations has been abandoned in favour of zonal observations. Unfortunately, Auwers's catalogue, which has been accepted as the basis of the system, does not contain a sufficient number of standard stars, and it has been necessary to choose others to act as secondary standards, and to observe these repeatedly. The present catalogue gives the places of 420 stars, which will be adopted as fundamental in the zone reductions.

The number of observations of each star is usually ten, and, judged by the probable error of a single observation, the accuracy of the mean result should be sufficient for the purpose.

VIENNA MEETING OF THE IRON AND STEEL INSTITUTE.

The autumn meeting of the Iron and Steel Institute was held in Vienna on September 23 and 24, under the presidency of Sir Hugh Bell, and was largely attended, there being about 450 members present. The proceedings opened with addresses of welcome by the chairman of the reception committee, by the Minister of Agriculture and Mines as representative of the Austrian Government, by the Mayor of Vienna, and by the president of the Austrian Society of Engineers and Architects, in the building of which the meeting was held. The addresses of welcome, which were delivered in German, having been translated by the secretary, Mr. Bennett H. Brough, the president, Sir Hugh Bell, responded in an eloquent German speech, and incidentally announced that the Archduke Frederick of Austria, who had acted as patron of the reception committee, had accepted honorary membership of the institute. The technical business then began.

Mr. W. Kestranek read the first paper. It recorded the progress made in the Austrian iron industry during the twenty-five years that have elapsed since the institute last met in Vienna. In 1882 Austria-Hungary produced 600,000 tons of pig iron, and the annual output has now risen to 1,900,000 tons. The country suffers from a scarcity of coking coal. It has nevertheless been able to maintain its position among the iron-producing countries of the world.

In the second paper read, Prof. H. Bauerman described the Erzberg of Eisenerz, the largest of the series of mineral deposits associated with the Palæozoic rocks of the eastern Alps. The raw ore averages 38·73 per cent. of iron, and the calcined ore 50·68 per cent. The ore is obtained by quarrying, the entire face of the deposit being laid out in a series of steps or terraces, fifty-eight in all, varying in height from 33 feet to 43 feet, giving a total depth of working faces of about 2000 feet. The present annual output is about 1,600,000 tons. The mining of iron ore on the Erzberg has been carried on from very early times. Traditionally, the workings date back to the eighth century, but there are no authentic records older than A.D. 931.

A paper on steel and meteoric iron was read by Prof. F. Berwerth (Vienna). The paper was prepared by way of introduction to the meteorite collection of the Imperial Natural History Museum, where opportunities are afforded for the study of meteoritic iron masses under conditions unequalled elsewhere. Meteoritic falls from 615 different localities are represented in the collection by 2075 specimens, the total weight of which is 3½ tons. Of these, 232 falls are iron meteorites, weighing together more than 2½ tons. The author's descriptions show that meteoritic iron and steelworks' steels are results of essentially similar chemical and physical causes.

Prof. J. von Ehrenwerth (Leoben) read a useful paper on the determination of the total quantity of blast-furnace gas for a given make of pig iron. The method proposed should prove of great value in view of the increasing importance of the waste gases as an economic factor in iron smelting, more particularly since their successful application in driving gas-engines makes it necessary that closer control should be exercised in their disposal.

At the present time there is a constantly increasing number of cases in which industrial practice is profiting by the application of the laws of modern physical chemistry. Some examples of conclusions dealing with the metallurgy of iron which may be arrived at in this way were given in a lengthy paper contributed by Baron H. von Jüptner (Vienna). He dealt more particularly with the laws of chemical equilibrium as applied to metallurgical chemical processes.

In a paper read before the institute last May, Mr. C. E. Stromeyer (Manchester) mentioned several failures of steel plates and structures, which appeared to indicate that certain qualities of mild steel might have the property of changing their nature with age. In a supplementary paper he gave the results of further experiments. They have not revealed a test which will discriminate between trustworthy and treacherous qualities of steel, but they have nevertheless established the fact that mild steel does possess ageing properties, and that certain practices which are still fairly common amongst engineers are not free from dangerous possibilities.

Four papers were read on the subject of hardening steel. Mr. C. O. Bannister (London) and Mr. W. J. Lambert (Woolwich) dealt with the case-hardening of mild steel, giving the results of some observations on the microstructure of cemented bars, on the depth of hardness, and on the carbon contents. The results do not throw much light on the manner in which the carbon penetrates the metal, but the authors consider that the solid solution theory is capable of offering a satisfactory explanation. Mr. G. Shaw Scott (Birmingham) also contributed a paper on case-hardening. He considered that nitrogen in some form is necessary for the practical performance of case-hardening, and suggested that ammonia, whilst being the prime agent in any change, may lead to the formation of cyanogen, which acts as a carrier of carbon to the metal to be carburised. Nitrogen, he concluded, should be added to the list of elements which cause iron to take or retain the γ form; and since γ iron combines more readily with carbon than does α iron, the action of nitrogen on the iron would appear to be sufficient to explain its beneficial effect during the early stages of the process of case-hardening. Throughout the research burnt leather, which is in general use in trade circles in England, was employed as the standard case-hardening material.

The results obtained in practice during the hardening of steel depend upon the conditions under which the transformations of the metal take place, and particularly on the duration and the temperature of the heating, the energy of the quenching bath, and the size of the pieces quenched. The part played by each of these factors was discussed in a lengthy paper contributed by Mr. L. Demozay (Paris). The last paper on hardened steels, contributed by Mr. Percy Longmuir (Sheffield), was somewhat controversial in character. He stated that no metallographical investigation yet published has been of the least service as a guide to the thermal treatment of high-speed steels, and that comparatively little information has been given on the hardening or tempering of carbon steels. The diversity of structure in normal and abnormal products quenched under unsuitable conditions explains to some extent the attitude of practical men towards the microscope, but instead of leading to condemnation it should rather lead to recognition of the value of microscopical examination. Diversity indicates wasters, whilst uniformity denotes correct hardening conditions. The ideal structure, or lack of structure, of commercially hardened carbon steels is produced only in a certain range of quenching temperature, which varies according to the composition of the steel and the contour of the piece to be hardened. Temperatures outside this range result in more or less crystalline patterns, which in the smallest of sections vary from field to field. Although certain of these patterns may give the appearance of special constituents, they are in reality the product of an abnormal quenching temperature, and steels containing them, although hard, are useless for cutting or resisting abrasion.

A paper was then submitted by Mr. B. H. Thwaite (London) on the economic distribution of electric power from blast furnaces. The scheme he proposed is to pool the waste gases from all the furnaces of an iron-making district and to transmit the electrically transformed energy to a central distributing station.

The last paper submitted was by Mr. F. J. R. Carulla (Derby), who described a new blue-black paint as a protective covering for iron. In the preparation of iron and steel rods for wire drawing and galvanising, as also in the preparation of plates for tinning, the iron is kept for a time in a bath of acid to remove the scale. When hydrochloric acid is used, a solution of chloride of iron is obtained, and many methods have been devised to utilise these solutions. It is now suggested that ammonia might be employed for the precipitation of the oxide of iron, seeing that the value of the ammonium chloride is greater than that of the ammonia employed. The blue-black precipitate is a valuable addition to the list of pigments that can be employed with advantage for the protection of structural ironwork.

During and after the meeting the institute was received with lavish hospitality. The members and the ladies accompanying them were entertained at banquets by the Austrian iron trade and by the Municipality of Vienna; they were taken to luncheon on the top of the Schneeberg, to afternoon tea at the Imperial Palace of Schönbrunn, and to a special performance at the Imperial Opera House. They were honoured with a reception at Court, and the council lunched with the Archduke in his palace. On September 26 and 27 the members were divided into three groups, to visit the iron mines and works in Bohemia, Styria and Moravia, and Silesia respectively. Altogether the meeting was without doubt the most enjoyable and the most instructive recorded in the institute's annals.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. ANDREW CARNEGIE has given a donation of 10,000*l*. towards the establishment of a technical college at Aberdeen.

MR. ARTHUR ACLAND is to distribute the medals and prizes of the Royal College of Science in the lecture theatre of the Victoria and Albert Museum this afternoon (October 3) at four o'clock.

AT Oxford on Monday the honorary degree of Doctor of Science was conferred upon Dr. Ludwig Mond, F.R.S., who was nominated for the degree at the last Encænia, but was prevented by ill-health from attending then to receive it.

A COURSE of free lectures to teachers, entitled "The Native Races of the Empire," will be given by Dr. A. C. Haddon, F.R.S., at the Horniman Museum, on Saturday mornings from October, 1907, to May, 1908, beginning on October 12. Admission will be by ticket only, to be obtained from the Clerk of the London County Council, County Hall, Spring Gardens, S.W.

THE mayor of the borough of Bethnal Green appeals for assistance for the Bethnal Green Free Library, which is supported entirely by voluntary subscriptions. The great want of the present time is a new and enlarged building in a more prominent position, to accommodate the increasing number of readers and provide reading-rooms for boys and girls. Mr. G. F. Hilcken, the librarian, will be glad to receive donations or subscriptions.

ANNOUNCEMENTS of the following scholarship awards have reached us:—University of London: University College—Bucknill scholarship of 135 guineas, T. C. Graves; entrance exhibitions of 55 guineas each, P. V. Early and B. Woodhouse. Guy's Hospital Medical School—Senior science scholarships for university students, 50*l*., J. G. Saner; junior science scholarships, 150*l*., J. F. Mackenzie; 60*l*., R. D. Passey. Entrance scholarships, 100*l*., C. S. L. Roberts; 25*l*., G. D. Eccles; 25*l*., G. F. Romer.

THE programme of university extension lectures for the coming session has just been issued by the University Extension Board of the University of London. A three years' course on the evolution of mankind as seen in the development of industries and institutions will be carried on at University College, the first term's work being taken by Prof. Lyde on geographic control of human evolution, while Dr. Slaughter will lecture in the Lent term on forms of primitive society, and Dr. Haddon in the summer term on the distribution of races. The course of work on human evolution as seen in the child and the race, brought to a successful conclusion last session, will be repeated at the Goldsmiths' College, New Cross, Dr. Chalmers Mitchell giving the earlier lectures and Dr. Slaughter and Dr. McDougall taking the later lectures.

AMONG recent developments connected with the Northampton (Polytechnic) Institute, London, E.C., referred to in the calendar for the session 1907–8, particular mention should be made of those in the department of technical optics. The most noteworthy of these developments is a course on the production and measurement of light, which is being given to both day and evening students by the electrical engineering and applied physics department and by the department of technical chemistry jointly. The lectures and laboratory work in the electrical engineering department deal with all the various kinds of electric lamps, glow, arc, and luminescent; with the problems of the production of light, and photometry, and general questions of radiation. In the technical chemistry department the subject is taken up from the chemical side, and the whole subject of incandescent lighting dealt with. The properties of rare metals and rare earths, their production, extraction, and use for all kinds of incandescent lighting, both gas and electric, are fully dealt with, and the production of metallic filaments for electric glow lamps is thoroughly studied. In the technical optics department four new classes especially suitable for artisan students have been started. There are also special classes for the instruction of kinematograph operators, which it is hoped will place this kind of work upon a sound scientific basis.

THE calendar of University College, London, for the session 1907–8, which has just been issued, contains many new features. There is a sketch of the history of University College by Dr. Carey Foster, together with a full statement of the statutes and regulations under which the college is now governed in its new position as an integral portion of the University of London. It also contains a set of plans that show the uses to which the extension of buildings is being put. It appears that the space now available for university purposes is greater by one-third than it was last session. Among the most striking features of the new developments are the following:—the institution of a new department of geology with geological museum, rock museum, and research room; the enlargement of each of the engineering departments and of the drawing office; the enlargement of the department of applied mathematics, and the provision of special rooms to be known as the Galton research laboratories in connection with the Eugenics Institute founded by Mr. Francis Galton. The calendar also contains a section setting forth in full the arrangements for post-graduate courses of lectures and arrangements for research work. The opportunities for research work are full and ample, and the regulation with regard to admission is such that no one qualified to undertake research work ought to be debarred therefrom. It appears from the summary of students that there were no fewer than 171 post-graduate and research students in the college last session, consisting of 140 men and thirty-one women.

At the annual meeting of the governors of the Glasgow and West of Scotland Technical College on September 24 Mr. G. T. Beilby, F.R.S., was unanimously elected chairman of the governors in succession to the late Sir William Robertson Copland. As a chemical technologist, Mr. Beilby enjoys a world-wide reputation. In industrial circles his name is more particularly associated with the Young and Beilby retort, and with a process for the manufacture of potassium cyanide. The introduction of the former revolutionised the process of shale distillation, and enabled the industry to emerge successfully from the struggle for existence; by means of the latter invention he has been instrumental in retaining an important industry in this country. As an investigator in the regions of pure science, Mr. Beilby has also established his reputation, his valuable researches on the surface structure of metals having attracted widespread attention. The second section of the new buildings for the college is in course of erection, and is expected to be ready for occupation in the session 1908–9; operations on the third section, which will complete the buildings as originally planned, will be undertaken immediately. The accommodation provided in the new buildings has enabled the college to extend its work in various directions. Recognition has been given to the importance, in a large engineering centre, of the study of fuels and their applications, and a very complete equipment has been provided in the department of technical chemistry for valuing fuels and illustrating the methods of controlling their use. This consists of calorimeters of all the various types for use with solid, liquid, and gaseous fuels, all the commonly used forms of pyrometer, and an experimental gas producer. Another feature of this department is the plant which has been installed for giving instruction in the methods of conducting technical experiments. The equipment includes grinding mills, filter and hydraulic presses, a hydro-extractor, a small refrigerating plant, pumps, an air liquefier, a steam-jacketed pan, and a double-effect vacuum evaporator plant. The laboratory in the department of motive-power engineering has been fully equipped, and in designing the equipment the object has been, not merely to provide for the illustration of principles set forth in the lecture course, but also to promote the industries of the district by obtaining information ahead of current practice. In addition to the ordinary steam, gas, and oil engines, there are several pieces of plant of special interest; with one of these engines experiments are being made from which it is hoped that information will be obtained to settle the much disputed points in the initial condensation *versus* valve leakage controversy. In the equipment of the other laboratories equal care has been shown, and every effort has been made to render them suitable for the needs of a great centre of industry.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 20.—"The Fluted Spectrum of Titanium Oxide." By A. **Fowler.**

The author has previously shown that nearly all the dark flutings which are characteristic of the spectra of Antarian or third-type stars correspond with flutings obtained from compounds of titanium.

The first part of the present paper gives an account of experiments which indicate that the flutings in question are produced by a compound of titanium with oxygen, and not by the vapour of the metal itself. The most conclusive evidence on this point was afforded by titanium chloride, which, in the absence of oxygen, did not show the Antarian flutings, although the occurrence of another group of flutings, attributed to the chloride itself, indicated that the conditions were not unfavourable for their production if their existence depended only upon the presence of titanium. Experiments with metallic titanium also showed that the Antarian flutings were only produced in the presence of oxygen.

The result is of some importance as indicating that the source of the fluted absorption in the Antarian stars is at a temperature low enough to permit the formation of a chemical compound, and also as demonstrating the presence of oxygen, of the existence of which in these stars there is otherwise no direct evidence. The investigation has lately gained additional interest in consequence of Prof. Hale's discovery of some of the less refrangible flutings in the spectra of sun-spots.

The second part of the paper contains a revised and extended table of wave-lengths, based upon photographs taken with much greater dispersion than that previously employed. For the first heads of the more prominent groups of flutings the wave-lengths tabulated are 4584·62, 4761·08, 4954·78, 5167·00, 5448·48, 5597·92, 6158·86, and 7054·5. All of these are strongly marked in the stellar spectra, that in the extreme red having lately been photographed by Slipher and Newall. Two of the stellar bands, however, about wave-lengths 5862 and 6493, do not appear to be sufficiently accounted for by titanium oxide. Photographs of the spectrum are reproduced in the paper.

Received July 4.—"The Effect of Pressure upon Arc Spectra. No. 1. Iron." By W. Geoffrey **Duffield.**

The first part of the paper contains a description of the mounting and adjustment of the large Rowland concave grating in the physical laboratory of the Manchester University. The feature of this is the stability of the carriages carrying the grating and camera, and the novel construction and attachment of the cross-beam, which secure the absence of any disturbance which might be caused by bending or sagging.

The second part describes experiments made with a pressure cylinder designed by Mr. J. E. Petavel, F.R.S., in which an arc is formed between metal poles opposite a glass window, through which the light is examined by means of the grating spectroscope. A system of mirrors allows the image of the arc, however unsteady it may be, to be kept almost continuously in focus upon the slit.

Two sets of photographs of the iron arc in air have been taken for pressures ranging from 1 to 101 atmospheres (absolute), and the results are given below for wave-lengths $\lambda = 4000$ Å.U. to $\lambda = 4500$ Å.U.

I. *Broadening.*

(1) With increase of pressure all lines become broader.

(2) The amount of broadening is different for different lines, some almost becoming bands at high pressures, and others remaining comparatively sharp.

(3) The broadening may be symmetrical or unsymmetrical; in the latter case the broadening is greater on the red side.

II. *Displacement.*

(1) Under pressure the most intense portion of every line is displaced from the position it occupies at a pressure of 1 atmosphere.

(2) Reversed as well as bright lines are displaced.

(3) With increase of pressure the displacement is towards the red side of the spectrum.

(4) The displacement is real, and is not due to unsymmetrical broadening.

(5) The displacements are different for different lines.

(6) The lines of the iron arc can be grouped into series according to the amounts of their displacements.

(7) Three groups can in this way be distinguished from one another; the displacements of Groups I., II., III. bear to one another the approximate ratio 1 : 2 : 4. (The existence of a fourth group is suggested by the behaviour of two lines, but further evidence is needed upon this point; 1 : 2 : 4 : 8 would be the approximate relations existing between the four groups.)

(8) Though all the lines examined, with two possible exceptions, fall into one or other of these groups, the lines belonging to any one group differ to an appreciable extent among themselves in the amounts of their displacements.

(9) The relation between the pressure and the displacement is in general a linear one, but some photographs taken at 15, 20, and 25 atmospheres pressure give readings incompatible with this relation. Other photographs at 15 and 25 atmospheres present values which are compatible with it.

(10) The abnormal readings are approximately twice those required by the displacements at other pressures, if the displacement is to be a continuous and linear function of the pressure throughout.

(11) On the photographs showing abnormal displacements the reversals are more numerous and broader than they are on plates giving normal values, and there is some evidence in favour of a connection between the occurrence of abnormal displacements and the tendency of the lines to reverse.

III. *Reversal.*

(1) As the pressure is increased, reversals at first become more numerous and broader.

(2) The tendency of the lines to reverse reaches a maximum in the neighbourhood of 20 to 25 atmospheres, and a further increase in pressure reduces their number and width.

(3) Two types of reversal appear on the photographs, symmetrical and unsymmetrical.

(4) Within the range of pressure investigated, the reversals show no tendency to change their type.

(5) In the case of unsymmetrically reversed lines in the electric arc, the reversed portion does not in general correspond to the most intense part of the emission line, being usually on its more refrangible side.

(6) The displacements of the reversed parts of the unsymmetrically reversed lines of Group III. are about one-half the displacements of the corresponding emission lines. Indeed, the reversed parts of the lines of Group III. fall approximately in Group II.

(7) No relation between the order of reversal and the frequency of vibration, such as exists in the spark, has been observed in the iron arc for the ranges of wave-length and pressure examined.

IV. *Intensity.*

(1) The intensity of the light emitted by the iron arc is, under high pressure, much greater than at normal atmospheric pressure.

(2) Changes in relative intensity of the lines are produced by pressure. Lists of enhanced and weakened lines are given.

PARIS.

Academy of Sciences, September 23.—M. Henri Becquerel in the chair.—The red disease of the pines in the Upper Jura: E. L. **Bouvier.** This disease attacks *Abies pectinata* and leaves Picea untouched, and during the last year has assumed alarming proportions in the Jura. A fungus would appear to be the cause of the disease, and as this attacks pines only, it is proposed as a remedial measure to plant no more pines, but to replace them with Picea. Trees that are attacked should be cut down, since their vitality is already destroyed.—Parthenogenesis without oxygen. The elevation of the parthenogenetic larvæ of Asteria up to the perfect form: Yves **Delage.** The author has repeated the experiments of Loeb on the influence of the absence of oxygen, but cannot confirm them; oxygen does not appear to have the influence accorded to it by Loeb. The preparation of the solution for the development experiments has been simplified, and now consists of 300 c.c. of sea water, 700 c.c. of a solution containing 388 grams of saccharose per litre, 0·15 gram of tannin dissolved in a little water, and 3 c.c. of a normal solution of ammonia. The eggs, extracted from the ovary, are placed for one hour in 50 c.c. of this solution, then placed in sea water, two or three times renewed by decantation in order to remove all traces of the reagent. After eighteen hours the vessel swarms with living larvæ. Details are given of all the sea-urchins which have reached the fully developed stage, including one abnormal specimen possessing hexameral symmetry.—The series of methylation of ethyl alcohol from the point of view of the aptitude of isomerisation of the haloid esters: Louis **Henry.** The change of an alkyl halide into an isomer usually means the transference of the halogen atom to a carbon atom combined with a smaller number of hydrogen atoms than the original carbon atom.—The Daniel (1907) comet and its spectrum: Henri **Chrétien.**—Special iron castings, and more especially castings containing nickel: Léon **Guillet.** The net result of this, together with the previous work on the same subject, is that elements such as nickel, aluminium, and silicon, which dissolve in the iron, favour the formation of graphite. Elements which form a double carbide with cementite oppose the formation of graphite (manganese, chromium).—Experimental researches on the lesions following compression and crushing of the sensitive ganglia: G. **Marinesco** and J. **Minea.**—Memory in *Convoluta roscoffensis*: Louis **Martin.** Specimens of Convoluta removed from the seashore and placed in a jar in the laboratory oscillate for a certain time in synchronism with the time of the tides. Under certain conditions, which are described in detail, this memory disappears.—Contribution to the study of the lower valley of the river Ain: J. B. **Martin.**

CONTENTS.

THURSDAY, OCTOBER 10, 1907.

HIGHLAND SPORT.

The Wild Sports and Natural History of the Highlands. By Charles St. John. Pp. xx+314. (London: John Murray, 1907.) Price 2s. 6d. net.

THE appearance of a reprint of the ninth edition of "The Wild Sports of the Highlands," first published sixty-one years ago, is sufficient proof of the permanent merit of that delectable book, but hardly affords a pretext for a set review of one so well and widely known. More to the point, perhaps, to recall the personality of the author, with which his many readers are less familiar than they are with his writings. A great-grandson of Lord Bolingbroke, the Tory Minister of Queen Anne and Secretary of State to the Old Pretender, Charles St. John became a clerk in the Treasury in 1828, where he proved a distinct failure. His heart was in the open air; his uncle, the second Lord Bolingbroke, lent him a lodge in Sutherland, where he had the good fortune to win the affections of Miss Ann Gibson, a Newcastle banker, whom he married in 1834. His wife not only brought him some money, but hearty sympathy in his devotion to sport and natural history.

In these pursuits the St. Johns might have passed their placid lives known to few except shepherds, gillies, and such venturous sportsmen as had discovered the splendid resources of the moors of Moray and Sutherland, had not Cosmo Innes, Sheriff of Moray, made acquaintance with the recluse and become impressed with his knowledge of woodcraft and wild animals Why, he asked, did not St. John turn his abundant leisure to account by writing on his favourite subjects? St. John laughed at the notion, saying he was quite pleased if he could manage to reply intelligibly to his few correspondents; but in the end Innes persuaded him to try his hand, so that, during the winter of 1844-5, St. John composed a few little essays on sport and natural history. One of these, entitled "The Muckle Hart of Benmore," Innes shaped into an article for the *Quarterly Review*, which so much delighted the editor, Lockhart, that St. John, stimulated by an unexpected honorarium, set to work in earnest, and before his early death in 1853, at the age of forty-four, he had completed the work presently under notice, "A Tour in Sutherlandshire," two volumes, published in 1849, and "Natural History and Sport in Moray," published ten years after the author's death. Death is the crowning act of all field sports, and St. John was an adept in pursuit; but it was from the by-products, so to speak, of a day's fishing, shooting, or stalking that he drew keenest delight—the behaviour, the attitudes, the natural traits of beast and bird. He found out for himself many secrets which are now well known to every field-naturalist. Here is one, for instance, with which all gamekeepers are familiar, but the cause of which remains still to be elucidated.

"It is a curious fact, but one which I have often observed, that dogs frequently pass close to the nest of grouse, partridge, or other game, without scenting the hen bird as she sits upon her nest. I knew this year of a partridge's nest which was placed close to a narrow footpath near my house; and although not only my people, but all my dogs, were constantly passing within a foot and a half of the bird, they never found her out, and she hatched her brood in safety."

Here, again, is a note the truth whereof is slowly gaining ground, although it has had to fight its way to acceptance through half a century of incredulity.

"With regard to the mischief done by owls, all the harm they do is amply repaid by their utility in destroying a much more serious nuisance in the shape not only of the various kinds of mice, but of rats also; these animals being their principal food and the prey which they are most adapted for catching."

There has been a controversy in the *Scotsman* lately about the food of the water-ousel or dipper, opinion appearing to be equally divided upon the question whether that bird devours the spawn of fish. The late Prof. Newton, Frank Buckland, and other good observers stoutly defend the dipper against the accusation, but St. John entertained no doubt about its truth. It is certainly difficult to undersand how a carnivorous bird, searching for food at the bottom of the water, should be so discriminating as to reject the ova of trout and salmon and feed only on aquatic insects and their larvæ. Prof. Newton, however, wrote with much confidence on this subject.

"By the careless and ignorant it is accused of feeding on the spawn of fishes, and it has been on that account subjected to much persecution. Innumerable examinations of the contents of its stomach have not only proved that the charge is baseless, but that the bird clears off many of the worst enemies of the precious product."—("Dictionary of Birds," p. 668.)

On the other hand, St. John's adverse verdict does not seem to have been based on actual observation.

"The water-ousel is supposed to commit great havoc in the spawning beds of salmon and trout, uncovering the ova and leaving what it does not eat open to the attacks of eels and other fish, or liable to be washed away by the current; and, notwithstanding my regard for this little bird, I am afraid I must admit that he is guilty of no small destruction amongst the spawn. . . . Notwithstanding the bad name he has acquired with fishermen, I never could make up my mind to shoot him."

It is a pity that grave charges like this should be laid upon such slight evidence. It must be a very feeble or poor-spirited eel that cannot help itself to as much spawn as is good for it without employing the dipper as pioneer. The question ought to be settled once for all by examining the contents of the stomach of a water-ousel shot among spawning salmon.

St. John's pages well bear re-perusal. They are charged with the free air of the moor and the loch, and, greatly as nature students have multiplied since his day, none of them gives more direct insight than he does into the *vie intime* of wild animals.

B B

SOCIOLOGICAL SCIENCE.

(1) *Sociological Papers.* Vol. iii. (1906). Published for the Sociological Society. Pp. xi + 382. (London: Macmillan and Co., Ltd., 1907.) Price 10s. 6d. net.

(2) *Heredity and Selection in Sociology.* By G. Chatterton-Hill. Pp. xxxii + 571. (London: Adam and Charles Black, 1907.) Price 12s. 6d. net.

(1) THIS volume is quite equal in interest to either of its predecessors. Among the papers which it comprises, those contributed by Dr. Archdall Reid and Mr. A. E. Crawley are of preeminent interest, owing partly to the merit of the papers themselves, partly to the discussions which followed, and the written communications elicited from English and foreign authorities. Dr. Reid took as his subject "The Biological Foundations of Sociology." The present evolution of civilised man is, he maintained, mainly against disease. Intellectual power in a nation depends almost entirely upon the environment of the individuals that make up the nation—in fact, upon education. Education ought to make the pupil think instead of overtaxing his memory. In particular, medical students should study heredity. Until doctors as a body are masters of what is known on this subject, the medical profession will never occupy the place that properly belongs to it. Dr. Reid's statement of his case was at once trenchant and guarded, and the criticisms fell mostly wide of the mark. But is there not, in addition to the evolution against disease on which he lays so much strees, a moral evolution going on? There is everywhere a great demand for honest men. Steadiness and trustworthiness are the qualities which modern civilisation most requires. In the lowest stratum of society, from which the casual labourers mainly come, such things are perhaps not important enough to have survival value. But in all the strata above the very lowest the qualities of steadiness and trustworthiness are those which pay, are those which enable a man to bring up a family; and men and women who are deficient in them sink lower or are eliminated altogether. Dr. J. L. Tayler's paper on the study of individuals (individuology) and their natural groupings (sociology) is to some extent an answer to Dr. Reid's. Instead of finding in disease an influence which strengthens the race, he holds that slums favour barbaric types, whereas with higher social conditions, while diseases testing physical endurance are destroyed by hygienic developments, others arise that test mental tenacity and strength.

Mr. A. E. Crawley's paper on the origin and function of religion is one of great interest. He holds that the problem of religion is a psychological problem, and that the general culture of the savage is entirely religious. Religion is a "psychic tone or temper or diathesis." The religious emotion consecrates all such elemental concerns as birth, puberty, marriage, sickness, death, and burial. It is, in fact, the "affirmation and consecration of life." Religion, therefore, rests on a basis of individualism, though the heightening of the individual life leads to an expansion of individuality, and so to sympathy and altruism.

In a written communication Prof. Starbuck points out that not only religion, but art, morality, and philosophy, heighten and deepen life. The feeling of awe in the presence of a supersensuous reality is an essential part of religion.

We have space for little more than a bare enumeration of the other papers:—"A Practicable Eugenic Suggestion," by Mr. W. McDougall; "The Sociological Appeal to Biology," by Prof. J. A. Thomson; "A Suggested Plan for a Civic Museum and its Associated Studies," by Prof. Patrick Geddes; "Sociology as an Academic Subject," by Prof. R. M. Wenley—an interesting account of sociology in America; "The Russian Revolution," by G. de Wesselitsky; "The Problem of the Unemployed," by Mr. W. H. Beveridge—a short, sensible paper followed by a discussion in which Mr. J. A. Hobson and Mr. Rider Haggard took part; "Methods of Investigation," by Mrs. Sidney Webb; "The So-called Science of Sociology," by Mr. H. G. Wells.

(2) From beginning to end this is a very interesting book. It is the result of much thought on great subjects, and it is written in clear and forcible style. But many of the questions discussed are highly controversial, and it is only to be expected that among competent critics there will be not a few who will come to different conclusions or who will remain unconvinced.

Part i. is introductory, and consists of a general account of evolution. The author is a strong believer in Weismann, whose doctrines he vigorously champions. The criticism suggests itself, that since it is a cardinal doctrine of Weismann, accepted unconditionally by our author, that, as soon as natural selection ceases to work, degeneration sets in, it would have been better to give more evidence of this from the organic world. On the other hand, too much, in the opinion of the present writer, is made of germinal selection—a hypothesis which rests on a very unsure foundation.

In part ii. we get to the heart of the book. Its title is "Social Pathology," and in it our author deals very ably with some of the most difficult problems of modern civilisation. Among the most civilised nations suicide, insanity and syphilis are increasing. There is, besides, much inverse selection, elimination, that is, of many who under more natural conditions would be best fitted to survive, while, on the other hand, an artificial environment brings about the survival of the weak and sickly. No doubt there is much reason for our author's somewhat desponding tone. But is not suicide, however clumsy its operation, one of the means by which the unfit are eliminated? And does not drink remove thousands of the most weakly before they have propagated their kind? Though it degrades the individual, does it not keep up the physical strength of the race? The survival of the weakly has undoubtedly a deplorable effect. Altruism and science strive to keep every child that is born alive until it attains to manhood or womanhood. Here is the fountain-head of the physical degeneration of civilised races. Still, Mr. Chatterton-Hill is, perhaps, over-pessimistic. There is still an enormous amount of elimination; not far short of fifty per cent.

of our population die before the average age of marriage.

The possible remedies for the diseases of our social system are discussed. The increase of suicide, we are told in the very interesting discussion of the subject, is due to want of integration. We live in an age of rampant individualism, for which, however, socialism supplies no remedy. Religion has not the hold on man that it once had. Family life is less strong than it was, and tribes and village communities are things of the past. Men make away with themselves because they have no strong ties and no strong interests. In times of political commotion there are fewer suicides, apparently because there is plenty to think about. To a great extent the theory of want of integration explains the facts. But is our author right when he maintains that Roman Catholicism is a stronger integrating force than Protestantism? Is not the form of faith rather a symptom than a cause? The most go-ahead races have seceded from the church of Rome. The Roman Catholic peoples are more primitive and less industrial; and in this, as in most social questions, there are many factors to be taken into consideration. But however much we may disagree with some of Mr. Chatterton-Hill's conclusions, the book is a book to be read. **F. W. H.**

OUR BOOK SHELF.

British Rainfall, 1906. *On the Distribution of Rain in Space and Time over the British Isles during the year* 1906. By Dr. H. R. Mill. Pp. 100+280. (London: Edward Stanford, 1907.) Price 10*s*.

THE present volume is the forty-sixth of this valuable and unique publication; it gives, in various forms, the results of observations made at 4267 points in the British Isles. The plan of the work is the same as last year, being divided into two parts:—(1) original papers and organisation reports, (2) monthly and yearly rainfall tables, particulars of wet periods, and observers' notes on the principal meteorological occurrences of the year.

Dr. Mill gives an interesting discussion of the great snowstorm of December 25–26, 1906, illustrated by two maps; one of these shows the rate of movement across the country with greater detail than has probably been previously attempted. The area covered by the storm extended from the north-west of Scotland to the English Channel, the advance being least rapid in the north, where it was 12½ miles an hour, and most rapid in the south, where it was about 19 miles an hour; a motor-car could have kept out of the storm without exceeding the legal speed limit.

The frontispiece is a coloured map showing very clearly the relation of the rainfall of 1906 to the average of 1870–99. Generally speaking, the fall over the whole country in 1906 was near the average; Scotland had a pronounced excess, and Ireland a scarcely less pronounced deficiency. The timely revision and publication of such a mass of materials is only rendered possible by the interest taken by the staff in the work and by some valued voluntary assistance. The usefulness of the undertaking is recognised by such public bodies as the Meteorological Committee, the Metropolitan Water Board, and others, who pay for the information they receive, but the main burden of expense has been hitherto borne by the observers and those interested in rainfall investigations. We agree with Dr. Mill in thinking that no piece of work of equal magnitude is done so cheaply.

Le Feste Giubilari di Augusto Righi. Pp. vi+143. (Bologna: Nicola Zanichelli, 1907.)

THIS little work is a *Festschrift* in honour of Prof. Righi, giving an account of the ceremony recently held to celebrate the completion of his twenty-fifth year of university teaching. This period really expired in 1905, but it was decided by the committee organising the *fêtes* to postpone the celebration so as to make it coincide with the inauguration of the new Institute of Physics at Bologna, which is placed under Prof. Righi's charge. The ceremony actually took place on April 12. Prof. Righi delivered his first lecture in the new building, choosing for his subject the "Hypothesis of the Electrical Nature of Matter." Prof. Blaserna, on behalf of the subscribers, then presented the lecturer with a bust of himself in bronze. Congratulatory letters and telegrams received from all parts of the world were subsequently read. The *Festschrift* contains Prof. Righi's lecture printed in full, together with all speeches, letters, &c., received; it is illustrated with many photographs of Prof. Righi and of the new institute. A complete list of Prof. Righi's scientific publications, numbering two hundred and seventeen in all, and a chronological review of his career are appended.

The Half-tone Process. By Julius Verfasser. Fourth edition. Pp. 348. (London: Iliffe and Sons, Ltd., 1907.) Price 5*s*. net.

THE author describes his work in a sub-title as being "a practical manual of photo-engraving in half-tone on zinc, copper, and brass, with a chapter on three-colour work." In preparing the new edition he has thoroughly revised the work, and added to it so that it describes as far as possible the making and proofing of half-tone blocks as at present practised. The subject is treated in a strictly practical way, obsolete methods and historical details find no place in it, nor does the author venture into the future. Apparatus that every worker must buy is not described with excessive minuteness, but such information as is necessary for using it to the best advantage is clearly set forth. No theoretical considerations are introduced, except in connection with such matters as the cross-lined screen and the management of electric arc lights, and then only in the simplest manner as being the best guide to the intelligent use of the apparatus. After ten chapters on appliances, the author describes with all necessary formulæ the operations of making the negative, printing, etching, finishing, mounting, and proofing the plates. The chapter on the three-colour half-tone process assumes a general knowledge of the principles involved, and refers only to the additional manipulation necessary. The two examples of three-colour work are not much credit to the process, but the other illustrations, which are numerous, are useful and good.

The Alphabet of the Universe: Notes for a Universal Philosophy. By Gurney Horner. Pp. 44. (London: Hayman, Christy and Lilly, Ltd., 1907.) Price 1*s*. net.

THE aim of the author of these "skeletonic and informal notes" is "to find the one objective 'Something'—a quest in which humanity has hitherto been baffled and defeated." He is so obviously convinced that notwithstanding "the failure of Plato, Aristotle, and all later philosophers," he has really solved "the problem of the *Method* of the Universe" that he may perhaps be forgiven for allowing his "epoch-making discovery" to be announced in language which inevitably prompts the cautious reader to assure himself that he has not been entrapped by the advertisement of a new patent remedy. Mr. Horner appears to be entitled to the credit of having arrived twenty-five years ago at the now fashionable doctrine that man is essentially a behaving animal—or, as he expresses it, that "man's life is made up simply of a series of acts"—and of having anticipated the Pragmatists in the deduction "that acts form the only proper basis of philosophy." Unfortunately, he has shown in these pages no competence to construct upon this basis anything with which, even in these hard times, philosophy should be asked to allow her name to be connected.

The More Important Insects Injurious to Indian Agriculture. Memoirs of the Department of Agriculture in India, vol. i., No. 2, Ento. Se. Pp. 139+v; 80 figures. By H. Maxwell-Lefroy. (Pusa: Agricultural Research Institute, 1907.) Price Rs. 3.

THE above-named paper is a very excellent foundation for the young economic entomologist in India to work upon. The chief insects known to be injurious to crops in India are briefly described in systematic order.

The method of treatment of this subject is novel, and might well be copied by others compiling similar lists.

The technical name of each pest is given, and then one or two references of interest and a short, concise description of the insect follows. Short notes of the distribution, biology and food plants are appended, and finally the writer's opinion as to the status of the insect as a pest. A large number of the adults are figured, and in a few instances the larvæ also.

Showing the backward state of economic entomology in India is the fact that only four aphides are placed in this list. A sound foundation is, however, being laid, and we are glad to learn that a supplementary list is to follow when the material is available. In all 131 pests are dealt with, some of which are well known in Europe, such as the diamond-back moth, the turnip moth (*Agrotis segetis*), the large cabbage white, convolvulus hawk moth, the corn aphis, cabbage aphis, and thistle aphis.

F. V. 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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The "Friar's Heel" or "Sun Stone."

IN an old number of *Notes and Queries* (4, v. 598) E. Dunkin asks "why the 'Friar's Heel' at Stonehenge is so named," and the only answer I can find in the bibliography of Stonehenge (*Wilts Archaeological Magazine*, vol. xxxii.) is as follows:—"It may have been called the Heel stone," observes Prof. Flinders Petrie, "from A.S. *helan*, to hide or conceal, just as a cromlech at Portisham, Dorset, is called the 'Hel-stone.'"

The word *Heal* or *Hele* is used in N. Wiltshire in this sense. "When the ground is dry and hard and the wheat when sown does not sink in and get covered up at once, it is said not to *heal well*" (Dartnell and Goddard, "Glossary of Wiltshire Words," 1893), but this meaning is more applicable to the cromlech than to the upright stone at Stonehenge.

Modern researches as to the date of the erection at Stonehenge point to a time when a Celtic word rather than an A.S. word would have been in use, and it has occurred to me that the word *Heol*, which is the Breton word for *the Sun*, may be an explanation of the name of the stone in question, as it is the stone used for the observation of the rising sun at Midsummer. It would be interesting to learn from Celtic scholars what equivalent Celtic word was in use in Britain when *Heol* was the word used in Brittany, and whether *Heol* or *Hel* would be the Cornish form of the Welsh word for the sun. The Rev. J. Griffith tells me "that *houl* is the oldest Welsh form of the word—then *heil*, and now in literary Welsh *haul*."

The foolish mediæval legend of the devil flinging the stone at a mocking friar and hitting him on the heel is evidently of very late date, but it is singular that a similar legend is attached to the "Hel Stone" in Dorsetshire, where the story is that the devil, playing at quoits in the island of Portland, flung the Hel Stone across to Portisham (see Hutchings' "Dorset," i., 554).

There is another Hel Stone near, so called in common with the cromlech at Portisham, and it stands in a small combe to the north of Long Bredy hut; it is a rude mass about 7 feet high and 7 feet wide, whilst the capstone of the cromlech at Portisham is 10 feet by 7 feet by $2\frac{1}{2}$ feet (Warne's "Ancient Dorset," pp. 111–135).

By the time the legends of the "Friar's Heel" and Hel Stone were invented, the old language would have been a thing of the past, but possibly the old name lingered in the memory of men wholly ignorant of its significance, giving rise to the traditions.

October 4. T. STORY MASKELYNE.

The Double Drift Theory of Star Motions.

PROF. J. C. CHAMBERLIN'S planetismal hypothesis has given geologists a great deal of matter for thought, and on the whole the phenomena with which they are acquainted appear to fall into line when the earth is considered as a body that has always been solid. The cosmical aspect of the question, which Prof. Chamberlin introduced in advancing his hypothesis, geologists are unable to judge, and they are waiting until astronomers give them an opinion before adopting the hypothesis on the larger scale. On the planetismal hypothesis our stellar system is a disc the edge of which is the Milky Way; beyond lies another stellar system, the so-called nebula in Andromeda, for all the most distant stars in the neighbourhood of the nebula appear to be this side of the luminous disc. If our stellar system is of the same nature as that of the nebula in Andromeda, then it must be a spiral nebula with two equivalent arms originating from a central core and winding spirally round the centre in approximately the same plane. Suppose our sun had experienced a gravitational drag and was moving at a less rate than the general average of the other stars, or suppose its spiral course was steeper than the general average, and hence its angular velocity less, then an observer regarding the rest of our stellar system from our planet would see the stars near the centre of the spiral travelling in two directions, those on this side of the centre travelling from right to left, and those on the other side in the reverse direction. Is this not a possible explanation of Prof. J. C. Kapteyn's double-drift theory of star motions? It explains why the two systems travelling in opposite directions should be of equal composition and proportions, but it necessitates that in the region of the sky opposite to that in which the double drift has been observed the drift should be simple.

The explanation also presupposes that our stellar system was once more closely aggregated, and because there is no central core to our system it must be of less bulk than that of the nebula of Andromeda. The two stellar systems, once consisting of closely packed stars and more or less spherical, travelling in opposite directions and approaching each other within reach of the action of gravitation, would have experienced disruption, each throwing out equal equatorial prominences on the same principle as that which produces the tidal bulges. On the nearer approach of the two systems to each other, the smaller of the two, our stellar system, would have experienced the entire disruption which has reduced it to the tenuity which it exhibits, whereas the larger stellar system, the nebula in Andromeda, would have been enabled to keep its central core.

ERNEST H. L. SCHWARZ.

Rhodes University College, Grahamstown, Cape of Good Hope, September 12.

The Origin of Radium.

IN an earlier communication to NATURE (September 26, p. 544) I mentioned some experimental proof which had been obtained of the existence in uranium minerals of a new radio-active element differing from those which have previously been identified. More conclusive evidence of the individuality of this new substance has now been obtained through the examination of the properties of its α radiation. The α rays which it emits are much more readily absorbed by aluminium than the α rays from polonium, with which it has been directly compared. Their apparent range in air determined by the scintillation method is less than 3 centimetres, and a more accurate determination is somewhat difficult, since it has not yet been found possible to obtain the new substance entirely free from thorium. Certain operations are now being carried out with considerable quantities of a uranium mineral containing no thorium which it is hoped will result in the separation of a highly active preparation of the new body free from other radio-active substances. The short range of the α particles is, however, sufficiently characteristic to serve as a definite means of identification.

The new substance also gives out a β radiation which is much less penetrating and more easily absorbed than that from uranium, the value found for the coefficient of absorption being about 1·8 for aluminium.

Experiments which have been carried out with the view of obtaining a quantitative separation of this new element from small quantities of very pure uraninite have given results which are in good agreement with one another, and which indicate that the activity of the new element in equilibrium with radium is about 0·8 of the activity of the radium itself with which it is associated. This is about the value to be expected if the new substance is intermediate between uranium and radium when the ranges of the α particles are taken into consideration.

The name "ionium" is proposed for this new substance, a name derived from the word "ion." This name is thought to be appropriate because of the ionising action possessed by this element in common with the other elements which emit α radiations.

BERTRAM B. BOLTWOOD.

Sloane Laboratory, Yale University, New Haven, Conn., September 21.

Excretion from Plant Roots.

THIS subject, discussed at intervals over the greater part of a century, has been recently revived. Mr. Pickering has suggested that the effect produced by one plant on another is probably due to the indirect action of bacteria. Dr. Russell attributes it to chemical changes in the soil, whilst Schreiner and Reed in America (Bulletin of the Torrey Botanical Club, June) and Mr. Fletcher in India have described experiments tending to show that some deleterious substance is excreted from the root. The questions incidentally raised by these several experimenters are not all identical, because, as Mr. Pickering points out, his work has to do with initial stages of growth, while that of others relates to subsequent development.

So far as *excretion* is concerned, it seems to be almost excluded as a possible explanation, because it would demand open orifices in the root which do not exist. There is nevertheless another line of thought which may have a more likely bearing on the subject. I refer to ionised changes such as occur when hydrogen chloride forms inside the red-blood corpuscle and sodium carbonate on the outside, or when sodium hydrate forms in the blood and hydrogen chloride in the stomach. Both these changes are due to the selective power of the living cell wall; and similarly it is probable that the cell wall of the root exercises a like property, and that the substances called plant foods do not pass into the root cell as such, but suffer change. Thus it is explained why the liquid outside the root becomes more basic, that on the inside more acidic (Hall and Miller, Proc. Roy. Soc., 1905).

May it not be equally possible that, owing to such changes, harmful substances may be formed in the soil solution?

J. WALTER LEATHER.

Agricultural Research Institute, Pusa, Bengal.

Pleochroic Halus.

IN the March number of the *Philosophical Magazine* I gave reasons for believing that the pleochroic halos of certain micas are referable to the radio-activity of the enclosures which are invariably associated with the halos. I cited in favour of this view the facts that all minerals definitely recognisable as forming the centres of halos are radio-active; that the perfect sphericity of the halo in a medium such as mica precluded any explanation involving diffusion or segregation of colouring matter, and that there was a very exact agreement between the known effective penetrability of α rays in media of this density and the maximum radius attained by the halo. I subsequently found, by examination of specimens kindly lent to me by Dr. Teall, that the same reasoning was applicable to halos formed in cordierite.

When first conceiving this idea, I started experiments on cleavage flakes of biotite to ascertain if halos could be induced by enclosing between the flakes specks of radium bromide. For some two months I kept these preparations under observation, but no change was apparent. They were then put aside in view of experiments which necessitated my abstention from any contact with radio-active preparations.

Within the last few days Dr. Teall has directed my attention to the (independent) work of O. Mügge, of Königsberg i. Pr., which appears in the July number of *Centralbl. für Min.*, in which a coloration was successfully induced in cordierite by application of radium, a coloration agreeing in properties with the halos in cordierite. This sent me back to my slides, and I find that a brown coloration has now developed around the larger radium specks. These stains have all the appearance of halos save that the radius is greater and the boundary less defined, differences at once explicable on the fact that the rays here travel in air before entering the mineral, and hence possess a greater, and at the same time a less sharply defined, range of effectiveness. The coloration is faintly pleochroic, the direction of greatest absorption agreeing with that of some naturally occurring halos present in the flakes.

There is, of course, nothing in these observations to prove that the effects observed are obtained in the precise manner in which radio-active enclosures appear to affect mica. It may be that sufficiently intense β radiation may produce effects which in the mineral are almost certainly referable to α rays. Still more protracted observations will be required to differentiate between the rays. However this may be, the cumulative evidence seems to leave no room for doubt that these extraordinary halos are indeed due to radio-activity. In these halos we have, I believe, the only instance so far observed in nature in which the presence of radium can be determined by direct eye observation of a radio-active effect.

J. JOLY.

Geological Laboratory, Trinity College, Dublin, September 30.

Apus cancriformis in Great Britain.

SINCE the publication of Baird's "Natural History of the British Entomostraca" (1850), no record of the occurrence of *Apus cancriformis* in the British Isles has, so far as I am aware, been published. Mr. Scourfield, in his "Synopsis of the British Fresh-water Entomostraca" (Journ. Quekett Micr. Club, [2], ix., 1904), remarks of this species:—"it is doubtful whether this ought to be included in any modern list of British Entomostraca."

It is therefore of great interest to know that *Apus cancriformis*, so long lost to observation, has actually reappeared in this country. It was found, during last month, by my friend Mr. Frank Balfour Browne, in some numbers in two small shallow pools on Preston Merse, near Southwick, in Kircudbrightshire. These pools, he believes, may be somewhat brackish, as they are probably occasionally covered by the sea. The specimens which he was good enough to send me were all females, mostly of a good size, and bearing eggs.

ROBERT GURNEY.

Sutton Broad Laboratory, Catfield, Great Yarmouth, October 6.

WHEN THE REINDEER LIVED AT MENTONE.[1]

OF all Quaternary sites associated with the remains of man none is more important than that constituted by the grottoes of Grimaldi. The deposits are of great depth, and rich in archæological and anthropological remains. They exhibit, moreover, a perfect continuity, and enable us to review in definite order the events of a remote and extended period. It is fortunate that the explorations were undertaken by such savants as Villeneuve, Boule, and Verneau, and that the results of their labour have been enshrined in so noble a work as that under notice. The book is in three folios; the first furnishes us with a full topographical description and historical account of the locality, which takes its name from Charles Grimaldi, Prince of Monaco, in the fourteenth century. The rocks which contain the caves are of superior Jurassic formation, and from their rose-red colour have been denominated the Baoussé Roussé, or Balzi Rossi. They originally projected as a V-shaped mass into the Mediterranean, the apex of the V being the Baoussé de Torre, at the foot of which are two caves, the Barma Grande and the Barma della Cippia di Ponte. On the western side of the projection, passing from the Baoussé de Torre, we meet in order La Grotte du Cavillon, La Grotte de Florestan, L'Abri Lorenzi, and La Grotte des Enfants. On the eastern side are La Grotte du Prince and two other caves of minor importance. The caves all open by high, narrow ogee mouths towards the Mediterranean (Fig. 1). They are filled with deposit to the height, in some cases, of 40 metres. In this deposit foyers can be recognised; a foyer is defined as a surface which, from the presence of cinders or products of industry, may be regarded as affording evidence of man's presence.

So far back as the middle of last century the caves were known to contain deposits of scientific value. "Some time before 1848" Prince Florestan I. of Monaco had dispatched a box of earth from one of the caves to Paris for examination. From that time onward numerous workers directed their attention to the caves, particularly Prof. Forel in 1858, and M. Rivière from 1871–1895. In 1882 Prince Albert of Monaco carried on investigations, and issued explicit instructions as to the methods to be employed, instructions which left nothing to be desired on the score of precision. During these excavations human skeletons were found, the first on March 26, 1872, by M. Rivière, in La Grotte du Cavillon, at a depth of 6·55 metres below a layer of stalagmite. The year following three skeletons were found in the Barma della Cippia di Ponte; in 1874 and 1875 two young skeletons were found in La Grotte des Enfants, and no less than seven were obtained from La Barma Grande.

Meanwhile, much discussion had arisen as to the age of the deposits. M. Rivière attributed them to the Quaternary period. M. Mortillet, on the other hand, regarded them as Neolithic, largely, however,

FIG. 1.—General view of the grottoes of Grimaldi. Seen from the sea.

[1] "Les Grottes de Grimaldi (Baoussé-Roussé). Tome i. Fasc. 1, Historique et Description. By M. L. de Villeneuve. Pp. 70. Tome i. Fasc. 2, Géologie et Paléontologie. By Prof. Marcellin Boule. Pp. 71–156+plates. Tome ii. Fasc. 1, Anthropologie. By Dr. René Verneau. Pp. 212+plates. (Imprimerie de Monaco, 1906.)

on the unsubstantial ground that the dead had been designedly interred. Three polished stone axes in the Genoa Museum from the collection of Prof. Pérès were believed to be derived from these caves. Rivière himself had obtained from this site a polished axe-head and a ring or disc *en jayet*. During the discussion it was shown that the axes in the Genoa Museum came from Nice, and there was strong probability that the axe and ring found by Rivière lay on the deposit rather than in it. All went to prove that further and more precise excavations were necessary before the age of the deposit could be definitely fixed. It is with these later investigations that the second and third folios are concerned.

The second folio is divided into three sections. In the first the various cave-beds are described with their petrographical characters; a list of the fossils found in each bed is given. The second section is concerned with the marine formations observed at the entrance and in the interior of the caves, and with the geographical changes which have taken place in the bed of the Mediterranean during Quaternary time. An interesting attempt is made to correlate the movements of the level of the Mediterranean with the movements of the ice, and to show that great glacial invasions are coincident with great positive movements of the sea, while interglacial periods correspond to negative movements. It is suggested that the negative movement of the Inferior Pleistocene was possibly able to re-establish relations between the large Mediterranean islands and the neighbouring continents, and that in this way may be explained the similarity in the contemporary fauna and palæolithic tools of south Europe and Africa. The third section of the folio is devoted to the study of the fossil animals which have been discovered during the excavations. It throws light on the fauna during successive periods, and discloses the danger of dating deposits from implements alone, for in these caves Moustiérien implements are found in association with a Chelléen fauna.

The illustrations, which form a very marked feature of the work, show sections of the caves, and clearly demonstrate the positions of the foyers and skeletons. The bathymetric charts of the Mediterranean are deserving of special mention.

The third folio is largely devoted to anthropology, but to some extent partakes of a *résumé*. The human skeletons are described in great detail, and are compared with each other, with Cro-Magnon Man, with the Negro, and with the European of to-day.

All the skeletons save two conform, with but slight variation, to the Cro-Magnon type. They resemble that type in stature, which is high, and in the shape of the skulls, which latter are dysharmonic, the crania being long while the faces are low and wide. The nose is leptorhine, depressed at the root, yet projecting sharply from the face. The orbits are rectangular and microseme; the supraciliary eminences are faintly developed; the mandible is robust, possessing a prominent chin. Certain negroid traits are noticeable in the skeletons; the proportions of forearm to arm, of leg to thigh, of lower limb to upper limb, resemble those found in the Negro and differ from those in the European. The two skeletons above referred to as not conforming to this type were discovered on June 3, 1901, in La Grotte des Enfants (Fig. 2). They were found at a depth of 8·5 metres, and are the most ancient human remains from these caves, although it should be remarked that a skeleton of the Cro-Magnon type was found in the same cave at a depth of 7·8 metres. The two skeletons were those of an old woman and a boy. The skulls are of the usual type in being dysharmonic, the cranium long, the face low and wide. The orbits are microseme, the forearm and leg relatively long. They differ from the type in

FIG. 2.—Skeletons of an old woman and a boy, from La Grotte des Enfants.

stature, which is not high, in the nose being platyrhine, in the face being prognathous, with the chin *fuyant*. On these grounds the two skeletons are separated from the rest and regarded as constituting a special type—the Grimaldi type. Before accepting such a separation, it should be remarked that little importance can be attached to stature when one of the examples is a boy, the other an old woman. Again, the skulls were obtained in a more or less fragmentary state, and the platyrhinity and prognathism might quite easily be in part due to the reconstruction. Sex, age, and individual variation might also account for some of the difference. It is unfortunate that more examples—and those examples of adults—are not forthcoming.

One of the most remarkable features of the boy's jaws are the teeth, which form the subject of a special report by Prof. Gaudry.

It will be seen that the work is to an unusual degree exhaustive, and has been performed with an attention to scientific accuracy for which palæontologists cannot be too grateful. The observations are beyond dispute, and the theories advanced are suggestive and worthy of careful consideration. The work furnishes us with the most important collection of data as to the nature and habits of Quaternary Man, since the discoveries in the caverns at Spy. We know that Man, even in the Pleistocene, buried his dead, sometimes on intact foyers, sometimes in holes dug in the floor of the cave, sometimes in rude cists consisting of upright stones supporting horizontal flagstones. Frequently he buried them in beds of ologist iron. In the Barma Grande there is evidence of disposal of the dead by incineration. With the dead were buried such trinkets as necklaces, bracelets and anklets made of perforated teeth, shells, and vertebræ of fish.

As to the people who lived in these caves, we can with considerable confidence correlate them with the Quaternary hunters in the valley of La Vézère, with those whose remains have been found at Laugerie-Basse, Gourdan, Chancelade, and Cro-Magnon. It is probable, however, that the hunters of the Grimaldi Mountains were the earlier.

In conclusion, we can unhesitatingly state that the Grimaldi caves have furnished us with the most complete picture we yet possess of Man's life in Europe during Mid-Quaternary time. William Wright.

MEDICAL EDUCATION AND SOME OF ITS PROBLEMS.

By a time-honoured ordinance, the opening of the medical session at the beginning of October is made the occasion for the delivery of inaugural addresses at the various schools of medicine. In London, medical education is in a somewhat transitional stage, and it may be interesting to inquire whether the addresses delivered shed any light on the problems that have to be solved. At the present time in London there is a need for concentration of the preliminary and intermediate studies, chemistry, biology, anatomy, and physiology, taken during the first two years of the curriculum, and until recently taught in every medical school. Now these are scientific subjects, and could more efficiently and less expensively be conducted in fewer centres with better equipped laboratories than has hitherto been the case. In this way it would be possible for some, at least, of the medical schools to devote all their energies and funds to the professional training of the last three years of the curriculum. Various plans have been suggested for effecting this. Some years ago, a scheme for a central institute at South Kensington for teaching the preliminary and intermediate subjects was inaugurated. It was an ambitious scheme requiring some 200,000*l.* for its realisation, and though in theory a good one, is probably not the best practical one for London. London is too large to have a single centre; and University and King's Colleges, and one or two of the medical schools, have definitely decided to continue teaching the preliminary subjects. Moreover, by a recent vote of the Faculty of Medicine of the University of London, the scheme of a Central Institute at South Kensington has been negatived, and the former policy reversed.

Another scheme is actually in being and seems to be working well, and might be extended; this is the drafting of the Westminster Hospital students to King's College, and of the St. George's Hospital students to University and King's Colleges, for the preliminary and intermediate studies. Speaking of this departure, Dr. Allchin, of Westminster Hospital, in his opening address at King's College, said:—

"When in 1899, after the report of Lord Selborne's Commission on a University for London, the medical demand for a re-constitution of the University took organised and coherent shape, the urgent need that there was for some concentration in medical teaching was always placed among the foremost arguments. The feeling generally among the medical schools at that time—or certainly of the great majority of them—was in favour of some scheme by which certainly the elementary subjects of the curriculum, and to some extent also the intermediate, should be taught at fewer centres, thus leaving the smaller schools at least, on whom the pressure of expenditure was relatively the greatest, free to devote their energies entirely to teaching the later subjects. But so far the University of London has utterly failed to bring about any concentration whatever during the seven years of its re-constituted existence, and, what is almost as serious, it has by the course it has followed converted what was seven years ago a widespread feeling among the metropolitan medical teachers of welcome towards the principle of concentration into one of very considerable hostility towards the principle, and has led to many of the schools resolutely opposing any coalescence. In 1905 a coalescence with regard to preliminary studies was arranged between the Westminster Hospital School and King's College, and has worked satisfactorily. I believe that if the University six or seven years ago, when the medical schools would, for the most part, have welcomed the principle of concentration, had exercised upon the different schools a wise and judicious pressure towards giving effect to this principle, much might have been done in this direction."

Certainly this scheme has much to commend it, and with some financial aid from the University it is difficult to see that an arrangement of this kind would be less efficient than a central institute; it would be far less costly than the latter, and, therefore, more likely to be in working within a reasonable time. The last is an element of some moment, for there can be no doubt that London has suffered by contrast with the splendid laboratories and facilities of the new provincial schools, and students in the London schools have diminished in numbers. Long as the five years' curriculum is for the pockets of those who have to pay the fees, it is none too long for the acquirement of the knowledge required for the pass examinations; in fact, it is the exception for a student to obtain a qualification under about six years. It has therefore been suggested that the curriculum might be lightened by relegating to the school science studies the physics, chemistry, and biology required. This plan commended itself to Sir Douglas Powell in his address at University College. He said:—

"I am myself decidedly of opinion that most, if not all, of the chemistry, biology, and physics required for the ordinary pass examination might, and should be, and in time will be, included in the public-school science studies, and be cleared off before the student enters upon the medical curriculum at all; so that the first two years of the student's time may be given up almost entirely to anatomy and physiology, including some comparative anatomy, so far as it may be illustrative of human anatomy, and some physiological chemistry."

Intimately associated with the question of medical education is that of qualifying examinations. In England, Scotland, and Ireland, there are no fewer than twenty-one bodies which have the power of granting degrees or diplomas qualifying to practise medicine and surgery, and there must of necessity be considerable variations in the standard of, and in the conditions of admission to, these examinations. To bring order out of chaos, the only practicable plan would be the institution of a State examination, which everyone should be required to pass, irrespective of any degree or diploma he should otherwise obtain, as advocated by Dr. Ewart in his address at St. George's Hospital. The London students have a grievance in that the diploma of the Royal Colleges does not entitle the holder to an M.D. degree, and the University of London degree is comparatively inaccessible to the average student. To meet this difficulty, Dr. Allchin frankly contended that the University should grant a degree in medicine accessible under reasonable conditions to the average man, reserving for those who desired them honours examinations more stringent than the pass ones. Sir Douglas Powell also expressed his regret that the diploma of the Royal Colleges could not be signalised by some more definite designation than it now carries. He would make any further work beyond the requirements for the qualifying examinations more strictly post-graduate work. He says:—

"When a man has qualified in his first two years' subjects by passing the required examination, he would do well to proceed to a six months' or a longer course in those subjects for the higher university degrees, and when he has qualified in the second grade and obtained his licence to practise he may proceed to post-graduate clinical, pathological, or other research for his final examinations in those degrees or for the membership of the Royal College of Physicians or fellowship of the Royal College of Surgeons. A university degree and the higher grades of medicine and surgery should be regarded as something beyond and in a sense outside a qualification to practise—as an academic or other distinction for the attainment of which a man may take as long as he pleases, but for which certainly some additional work in each grade or period of his studies should be required."

There is a parallel to this in the case of veterinary medicine, in which the University degree does not take the place of the diploma of the Royal College of Veterinary Surgeons, as it is not a licence to practise, as was pointed out by Prof. Lander in his address at the Veterinary College.

Post-graduation study and research in medical subjects are essential if the practitioner is to keep abreast of recent advances, if the science of medicine is to advance, and the public health to improve. In London, with its seven millions of inhabitants, the supply of clinical material for teaching and research is unique, but there can be no question that it is not utilised nearly to the full extent. The West London Hospital, the London School of Clinical Medicine, the Polyclinic, and a few hospitals are doing excellent work in post-graduate teaching, but if London is to be, as it ought, a great centre for post-graduation work, there must be more coordination and concentration among the numerous special hospitals. The system which makes our hospitals and medical schools dependent on voluntary support has led to the founding of a number of hospitals for special diseases, widely scattered, and therefore largely unavailable for teaching purposes, draining the general hospitals of the particular cases they admit, and using up public subscriptions which might be better utilised. There can be no doubt, on the score of economy alone, that a combination between many of the special hospitals would be of advantage, a view which has been taken by the King's Fund. The poor-law infirmaries also are almost entirely unutilised, yet contain material of the utmost value for teaching and research. Sir Douglas Powell says:—

"I cannot but think further that some affiliative grouping of the great clinical hospitals about the three university centres would be of great value in point of view of financial economy and strength of teaching. It is very possible, too, that special hospitals and infirmaries might be more utilised than they now are for clinical teaching material, and especially for post-graduate teaching."

As regards research, the special hospitals, the poor-law infirmaries, and the hospitals of the Metropolitan Asylums Board offer unique opportunities for clinical and pathological investigation, but are almost unutilised in this respect, and the general hospitals are unable to do what could and should be done in this direction owing to lack of funds. Contrast this state of affairs with what obtains, say, in Berlin—the newest hospital, the Virchow Krankenhaus, has 2000 beds for all kinds of cases, its department for infectious diseases, its pathological institute, with scientific staff, and the research Institute for Infectious Diseases is close by and affiliated to it—and it must be admitted that London makes but a poor show.

In the teaching of hygiene and the necessary curriculum for the diploma in public health, concentration again is eminently desirable. At present nearly every medical school retains teachers, and the requisite expensive equipment, in each case for the instruction of but a few students.

SCIENCE IN THE EAST.[1]

AMIDST the crowded town life of England, physical science outside the laboratory seems to be becoming a thing of the past. The ordinary British physicist concerns himself with the eccentricities of radium, the cosmogony of the ion, and other matters which are at present but names of mystery to most people. The work of the Indian Survey carries with it the sense of open air and large areas. It deals with subjects which appeal, in part at least, to the intelligence of the average educated man.

A great magnetic survey has been in progress for some years. Up to the date of the report by Captain R. H. Thomas, observations had been made at 808 stations, and three more seasons, it was hoped, would complete the field work, except in so far as repetitions of observations might prove necessary or extensions into the hills might be found practicable. The main part of the magnetic report deals with the intercomparison of instruments, but there are also some data as to the diurnal inequalities of declination and horizontal force at several of the fixed observatories erected to assist in the survey work. These inequalities are based on five "quiet" days a month, but the non-cyclic change is not explicitly shown, and there seems no statement as to whether it has been allowed for. The difference between the values for 0 a.m. and 11 p.m. in horizontal force is suspiciously large.

Until the question has been actually investigated, it is unsafe to assume that diurnal inequalities from quiet days are really representative of the ordinary day; the part played by disturbance also varies largely from day to day. Thus, though the inequality data are of much intrinsic interest, it is impossible to say in advance what degree of utility they may possess for survey purposes. From the large differences between the inequalities at the different Indian stations, it is clear that problems of some difficulty will have to be faced when it comes to correcting the field observations for diurnal changes, regular and irregular.

Part ii. gives an account of pendulum observations made by Major G. P. Lenox Conyngham and his

[1] Extracts from narrative reports of officers of the Survey of India for the season 1904–5; prepared under the direction of Colonel F. B. Longe, R.E., Surveyor-General of India. Pp. 127. (Calcutta: Government Printing Office, 1907.) Price 2s. 3d.

party at ten stations, including nine nearly on a meridian passing through Darjeeling. The northmost station, Sandakphú, was at a height of 11,766 feet. The results of this and similar future work promise to be of much interest in connection with the theories proposed to account for the observed large deflections of the plumb line in India, and the deductions made as to the density of the material underlying the Himalayas. The observations at some stations had to be taken in a tent exposed to temperature changes, and one of the chief uncertainties was the determination of the proper temperature correction. Considering that the value of gravity at the base station at Dehra Dun—on which all the other Indian values depend—is arrived at by assuming for Kew the value 981·200 C.G.S., it does seem desirable that some British authority should exist possessing both the apparatus and the scientific knowledge necessary to determine the accuracy of such assumptions. In the meantime, practical geodetic science in the British Empire has to turn for guidance and inspiration to Potsdam, Vienna, or Washington.

Part iii. deals with the report by Mr. J. P. Barker on tidal observations and levelling operations. A good many data are given as to tidal constants at various stations, and there is interesting information as to the degree of accuracy of the predicted times and heights of low and high water. At the open coast stations in 1904 the mean error in the predicted times was only nine minutes, and the mean error in the predicted heights was less than 3 per cent. of the range; but in the riverain stations the errors were nearly twice as large, and there seems room for improvement.

Part iv. describes triangulation in Baluchistan, while part v. deals with survey operations of a rapid kind made with the Somaliland Field Force. The officer in charge of the latter, Captain G. A. Beazeley, and his assistant, Captain C. G. Hunter, evidently had a very stirring time.

One of the duties of the tidal officers seems to be the inspection of anemometers at tidal stations. At first sight the following information respecting the anemometer at Port Blair is rather startling (p. 91):—"On November 19, 1904, the velocity of wind registered . . . was 1112 miles, the greatest on record since December 1, 1897, on which day 918 miles was registered." The *day* is rather an unusual unit of time for velocities, and why the limitation? There are other instances where the method of presenting the facts might be improved upon, but fortunately the absence of a good English style does not necessarily imply a corresponding laxity in scientific accuracy. Another criticism that is likely to present itself to many readers is that the season 1904–5 is becoming now a little remote.

C. CHREE.

PROF. CHARLES STEWART, F.R.S.

ON Friday, September 27, Prof. Charles Stewart, conservator of the museum of the Royal College of Surgeons, died at the age of sixty-seven after a few weeks' illness, following some years of failing health.

Prof. Stewart was a native of Plymouth, where both his father and grandfather had been in practice. Following their example, he too entered the medical profession, being educated at St. Bartholomew's Hospital, and taking his M.R.C.S. in 1862. After some few years spent at Plymouth he returned to London, upon obtaining (in 1866) the post of curator of the museum at St. Thomas's Hospital. Later, in 1871, he became lecturer on comparative anatomy at the same school, and in 1881 joint lecturer with Prof. John Harley on physiology. He also for some years held the professorship of biology and physiology at Bedford College.

During this St. Thomas's period, Prof. Stewart accumulated, by incessant work as a teacher and museum curator, and mainly by direct observation, that vast fund of biological knowledge for which he was so well known, and of which he was so lavish to all who came to him for help in their difficulties. In the comparatively small museum at St. Thomas's, he perfected his natural talent for practical museum work, performing with his own hands all the processes necessary in the preparation and display of anatomical specimens, and gaining a thorough insight into all the minutiæ of museum management. At the same time, the variety of his teaching appointments, embracing anatomy, physiology, botany, and pathology, effectually prevented him from becoming narrow or specialised. Thus, when in 1884 the conservatorship of the Royal College of Surgeons' museum fell vacant, through the appointment of Sir William Flower to the control of the British Museum (Natural History), Prof. Stewart was singled out by his practical experience and wide attainments as Flower's natural successor.

Although during his twenty-three years of office at the College of Surgeons Prof. Stewart supervised and stimulated the growth of all parts of the museum, he made the object of his special care the improvement and completion of that section of the museum—"the physiological series of comparative anatomy"—in which are embodied John Hunter's philosophical researches into the normal processes of life. For the advancement of this great collection of adaptive modifications, Prof. Stewart laboured consistently almost to the day of his death, adding or planning new specimens, lecturing so long as health allowed, and finally editing, and in part writing, the first few volumes of a full descriptive catalogue.

The year after his appointment as conservator he was elected Hunterian professor of human and comparative anatomy at the college, and annually until 1902 gave series of lectures that reflected the work he was doing in the museum, and served as introductions to the several sections of the "physiological series." At this time he also delivered some "Friday evening" lectures at the Royal Institution, and was Fullerian professor of physiology there from 1894 to 1897. In his own way, Prof. Stewart was inimitable as a lecturer. He had an easy flow of language, delivered with a persuasive eagerness that compelled attention, and illustrated by wonderful free-hand drawings on the blackboard. The combined result was a picture, not easily forgotten, of interwoven word and line animated by a charming personality. Unfortunately, his lectures were delivered from the scantiest notes, so that little remains of his original researches except some few papers in the publications of the Linnean Society and in some microscopical journals which give but a feeble idea of his real powers.

Since 1866 Prof. Stewart had been a Fellow of the Linnean Society, and from 1890–4 held the office of president. He was also deeply interested in the Royal Microscopical Society, being one of its secretaries from 1878–82; and he was an original member, and for some years treasurer, of the Anatomical Society. He also was an ardent supporter of the Marine Biological Association. In 1896 he was elected to the fellowship of the Royal Society, and three years later was honoured by the conferment upon him of the degree of LL.D. *hon. caus.* by the University of Aberdeen.

In brief, Prof. Stewart was professionally a successful teacher, a great lecturer, and a master of all museum arts; personally he was the simplest and kindest of men, unassuming to a fault, with a cordial detestation of everything false, presumptuous or sordid. His cheery, youthful manner and lively conversation endeared him to many, even of those who had not the privilege of seeing the deep sympathetic nature beneath.

NOTES.

An extra meeting of the Chemical Society will be held in the theatre of the Royal Institution on Friday, October 18, at 9 p.m., when Prof. Emil Fischer, F.R.S., will deliver the Faraday lecture, entitled "Organic Synthesis and its Relation to Biology."

The honorary secretary of the Hampstead Scientific Society informs us that, by permission of the London County Council, a meteorological station (in connection with the Meteorological Office and the British Rainfall Organisation, Camden Square) is to be established by the society at the flagstaff on the summit of Hampstead Hill. This being the highest point in the neighbourhood of London, some interesting records should be obtained. A small astronomical observatory is also to be placed at the same spot, which it is hoped may be of educational value to students and senior pupils of London County Council schools.

The British military airship travelled on Saturday last from Aldershot to London at the rate of about twenty-four miles an hour, and after circling round St. Paul's Cathedral, headed against the wind on the return journey. Owing to the strong wind prevailing, the descent was made in the grounds of the Crystal Palace at Sydenham. The total distance covered was fifty miles, and the mean altitude was 750 feet.

An exhibition is to be held at the Royal Horticultural Hall, Vincent Square, Westminster, on October 22–26, in connection with the *Model Engineer*, and will include a collection of engineering models of all kinds; electrical, optical, and scientific instruments; technical education apparatus; and lathes, tools, and workshop appliances. Popular scientific lectures and demonstrations will be given each day, and many of the models will be shown at work.

Mr. F. Wood-Jones, Harley Lodge, Enfield, informs us that on November 15, 1905, he set adrift several bottles from the Cocos-Keeling atoll, Indian Ocean (12° 04′ 24″ S., 95° 55′ 19″ E.), containing messages requesting that the finder would let him know the place and time of finding. On May 27, 1906, one was picked up on the coast of Brara, Italian Somaliland (1° 06′ 08″ N., 44° 01′ 52″ E.), and on July 11, 1907, another turned up at exactly the same spot. These facts point to a constant westward current in this part of the Indian Ocean. For both communications Mr. Wood-Jones is indebted to Captain Resident G. Piazza, of Italian Somaliland.

The death is reported on September 22 of Prof. W. O. Atwater, of the Wesleyan University, Middletown, Connecticut. He directed from 1875 to 1877 the Connecticut Agricultural Experiment Station, the first institution of the kind in the United States. In 1888 he founded the experiment station of the Federal Department of Agriculture. Of late years he had directed the special investigations of that department into questions of nutrition. He was joint inventor of the Atwater-Rosa calorimeter for experiments on the metabolic changes going on in the human body; and was the author of a large number of articles and reports on physiological and agricultural chemistry. Prof. Atwater, who was sixty-three years of age, had been practically helpless since he suffered from a stroke of apoplexy two years ago.

News has been received from Dr. Sven Hedin by the Simla correspondent of the *Pioneer Mail*, the communication being dated July 25, from the Mansarowar Lake. Dr. Hedin reports that this last journey from Shigatse to Tok-chen, on the lake, has been richer in results than his previous one from the Aksai Chin to Shigatse, as he has been almost the whole time in inhabited country. His message, of which the following is an extract, appears in the *Pioneer Mail* of September 20:—"The results are 1300 big pages in annotations, 203 sheets of maps, 410 specimens of rock in connection with geological profiles, 700 panoramas, twenty-six astronomical points, the meteorological journal continued three times a day, and passes and camps fixed by boiling-point thermometer; at every river crossing a detailed measurement of the volume of water—the Brahmaputra—has been measured at seven points, and most of the northern tributaries, as well as some of the southern; a collection of plants; a great number of sketches, especially types, the interior of temples, and landscape sceneries. One lake, Amtchok-Tso, has been carefully measured, and an isobathic map made. The height of many peaks has been measured with the theodolite at a couple of places; the height of old beach lines of lakes has been measured."

An appeal for funds to secure the preservation of the "Sarsen Stones" on the Marlborough Downs known as the "Grey Wethers" has been issued jointly by the National Trust for Places of Historic Interest or Natural Beauty, the Wiltshire Archæological and Natural History Society, and the Marlborough College Natural History Society. These sarsen stones are, geologically, the hardened and solidified boulders of a stratum of Eocene sand formerly covering the chalk, which in the course of ages has been denuded of the softer portions. The stones vary in size from small boulders to masses of sixty or seventy tons. For many generations these stones, scattered widely over the downs, have been broken up and used for building and other purposes, mainly of a local character. As there is every probability that the work of breaking up the sarsens will be undertaken soon on a greatly extended scale, an attempt is being made to secure the preservation of some characteristic examples of the stones in their natural condition. The sum of about 500*l.* is asked for in order to purchase about twenty acres of land where there are many of the stones. If the money is forthcoming, characteristic examples of a unique geological phenomenon will be secured for the nation. The donations already received or promised amount to 164*l.* Subscriptions to the fund may be sent to Mr. E. Meyrick, F.R.S., Thornhanger, Marlborough, or to Mr. Nigel Bond, secretary, the National Trust, 25 Victoria Street, Westminster, S.W.

To *Spolia Zeylanica* for August Mr. J. Llewellen Thomas contributes further particulars on hybridising the Ceylon jungle-fowl (*Gallus stanleyi*), a subject on which a note appeared in our columns last year. The new experiments demonstrate that in certain circumstances the hybrids with domesticated fowls are fertile, both *inter se* and with their parents, and under really favourable conditions it is surmised that complete fertility could be established. This being so, Darwin's argument from the infertility of the hybrids that *Gallus stanleyi* cannot be the parent stock of domesticated poultry no longer holds good. The difficulty, however, is to convert this negative evidence into positive proof that the Ceylon jungle-fowl is entitled to occupy that position. An important point in the case is the fact that when domesticated fowls tend to revert to the wild type, the cocks develop red or brown (never black) breasts. As the Indian *Gallus bankiva* is black-breasted, the reversion is thus in the direction of the Ceylonese species, which has a reddish-brown breast in the males.

It is a well-known fact that many lizards inflate the body, the region of the mouth, or special laryngeal sacs, for the apparent purpose either of frightening enemies or as a means of sexual attraction, or perhaps for both together. Examples of this are displayed by the inflation of the body in Lacerta and Phrynosoma, in the expansion of the frills of Chlamydosaurus, and the dilatation of the gular sacs of Metopoceros and other iguanas. Such effects might be enhanced, it is reasonable to suppose, by a swelling-out of the head and protrusion of the eyes. Such a function, according to Dr. H. L. Bruner in the *American Journal of Anatomy*, vol. vii., pp. 1–117, is, however, insufficient to explain the existence in the heads of both sexes of many lizards and snakes of an apparatus of muscles and vascular sinuses for producing excessive blood-pressure, and consequent swelling in this region. In lizards, at any rate, this mechanism is developed for the purpose of aiding in the shedding of the scales, and acts physiologically by accelerating lymph movements, and thus promoting metabolism, and mechanically by stretching the skin over the soft parts. This being so, the probability is that the same factor holds good in the case of snakes and tortoises. In some instances, however, the function may be modified for terrifying or sexual purposes, and it is probable that the ejection of blood from the eyes of the "horned toads" (Phrynosoma) is a special development of the same mechanism.

A Greek pamphlet lately published at Athens (P. D. Sacellarius) under the title of "Αἱ τῶν Lamarck καὶ Darwin Θεωρίαι παρὰ τῷ Ἀριστοτέλει," gives an interesting account of various passages in the works of Aristotle which contain anticipations of modern observations and discoveries. The existence of a placenta in selachians and the sexual dimorphism of certain cephalopods were among the facts well known to the Greek philosopher, who also shows a considerable grasp of the phenomena of correlation, of the influence of external conditions on individual development, and of the rivalry between organisms in which the weakest goes to the wall. It is, however, rightly pointed out that Aristotle, though he had distinctly before his mind the principle of natural selection as propounded by Empedocles, deliberately rejected that principle as a factor in organic evolution. A passage from the "Physics," frequently quoted and almost as frequently misinterpreted, shows conclusively that Aristotle, though no theist, held firmly to the view that the scheme of nature is purposeful and rational; but adaptations, in his opinion, came into existence ready-made, and not by degrees. The difference between this latter position and that of Darwin is clearly emphasised in the present pamphlet, but even here the force of the argument in the passage we allude to does not seem to have been fully realised.

We have received a reprint of the memoir (*Biometrika*, vol. v., part iii.) by Mr. J. F. Tocher on the anthropometric characteristics of the inmates of asylums in Scotland, based on data collected by a survey organised by Mr. Tocher under the Henderson Trust of Edinburgh. The characters observed and recorded were stature, head length, head breadth, and head height, hair colour, eye colour, and nose contour. The data are discussed very fully by Mr. Tocher, with especial reference to the methods of Prof. Karl Pearson; to those not familiar with his methods the memoir will prove somewhat difficult reading, the more so as Prof. Pearson's symbols are frequently used without definition. It is impossible to compare the measured characteristics with those of the sane, since no such survey of the sane population has yet been carried out; as regards hair and eye colour, however, comparisons can be made with the results of a survey of school children, and it appears that the sane and insane differ significantly, the latter being lighter eyed and darker haired than the sane population. The majority of the frequency distributions for measured characters are skew, but not more so than similar distributions, drawn from other sources, for the same characters of sane populations. The whole of the original individual data and measurements, concerning 4381 males and 3925 females, together with correlation tables, are given in an appendix.

The publications of the Natural History Section of the Indian Museum, Calcutta, will in future consist of Memoirs, to be issued periodically, and of Records, which will contain shorter papers on zoology and the allied branches of anthropology, and will be issued, so far as possible, quarterly. The first two numbers of the Records contain many contributions of interest. Captain Lloyd describes a collection of the fauna of the Arabian Sea, which was made in the course of a voyage by the Indian survey ship *Investigator* between Aden and Muscat. Considering that this is new ground, the results are disappointing, only a small number of new specimens having been obtained; but the repeated recurrence of many of the species at different stations is remarkable, and the appearance of the giant isopod, *Bathynomus giganteus*, and the large bilaterally symmetrical hydroid, *Branchiocerianthus imperator* (here recorded for the first time in the Indian seas), is noteworthy. Mr. C. A. Paiva discusses the Hemiptera and Hymenoptera of the Himalayas, and Dr. Annandale, with the assistance of the Rev. T. R. R. Stebbing, continues his reports on the fauna of the brackish pools at Port Canning, to which Mr. R. Gurney adds some further notes on Indian fresh-water Entomostraca. In part ii. the most elaborate papers are that of Mr. E. Brunetti on the revision of the Oriental Stratiomyidæ, and a report on a new large collection of batrachia, reptiles, and fish from Nepal and the Western Himalayas, by Mr. Boulenger, Dr. Annandale, and Mr. Regan. It is not difficult to explain the prevalence of malarial fever in Bengal when we learn that Mr. Chatterjee found within three hours no fewer than 250 specimens of the Anopheles mosquito in the rest-house at Port Canning. It has been suggested that this pest might be destroyed by admitting sea-water into the pools occupied by them; but while there are recorded instances of mosquito larvæ being found in salt water, it has now been ascertained that the brackish pools at Port Canning contain an abundant supply. Here at least petroleum is likely to hold its ground as a remedy.

A practical article on pruning cocoa is contributed by Mr. W. Cradwick to the Bulletin of the Department of Agriculture, Jamaica (June and July), and the diagnoses of two new species of Comocladia are furnished by Dr. N. L. Britton. The report prepared by Mr. F. Stockdale on cocoa-nut diseases in Trinidad, describing a root disease referred to a fungus Botryodiplodia, a leaf disease caused by a Pestalozzia, and a bud-rot disease, is also published.

THE third part of the first volume of the Proceedings of the Association of Economic Biologists is devoted to the papers presented at the meeting of the society held in Cambridge in January. The majority of the papers are represented by abstract or title, but the paper by Mr. E. S. Salmon on the American gooseberry-mildew is printed at length. The author refers to the spread of the disease, and its prevalence in parts of Worcestershire, where the County Council has been taking measures to stamp it out; also he points out the necessity for establishing a sub-department of the Board of Agriculture to look after the fruit industry.

THE latest number of the entomological series of Memoirs of the Department of Agriculture in India (vol. i., No. 5), for which Mr. E. E. Green and Dr. H. H. Mann are conjointly responsible, is devoted to the Coccidæ attacking the tea plant in India and Ceylon. Although thirty species are enumerated, only two or three have so far proved serious pests, but it is stated that with Coccidæ, even more than other phytophagous insects, every species must be regarded as a potential enemy, since, owing to some unforeseen change, dangerous multiplication may ensue. Two new species, *Chionaspis manni*, *Dactylopius theaecola*, and a new variety of *Tachardia decorella* are described.

COMMISSIONED by the New Zealand Government to undertake a botanical survey of the small island of Kapiti, situated in Cook Straits, Dr. L. Cockayne has compiled a highly interesting report describing the various plant formations, and enumerating the indigenous ferns and flowering plants. It is proposed to conserve the island as a sanctuary for native birds and plants, especially for species that are becoming rare. As a shelter for birds, and from an ecological standpoint, the forests are alike important. *Corynocarpus laevigata*, *Dysoxylum spectabile*, *Macropiper excelsum*, *Myoporum laetum*, and *Melicytus ramiflorus* are conspicuous trees. The northern rata, *Metrosideros robusta*, varies greatly, sometimes throwing out arches composed of aërial roots. Other species of Metrosideres generally form lianes, and among them *Metrosideros scandens*, but when growing in the open it assumes a shrubby habit. Allusion is also made to the marked heterophylly of *Lomaria filiformis*, to the cauliflory or production of flowers on the naked stems of several trees, and to many other interesting ecological features.

UNDER the title "Ombre sismiche e rimbalzi sismici," Prof. V. Monti has issued a pamphlet dealing with the phenomenon known as earthquake shadow. He finds that Mount Etna appears to have a protective effect in the case of earthquakes in Sicily, and that, wherever the focus may be situated, places lying on the further side of the mountain do not feel the shock, though others at a greater distance are shaken. Monte Cimone, in northern Italy, seems to exercise a similar protective effect, but the much higher range of the Gran Sasso d'Italia and Maiella has no influence of this nature. He rejects the explanation suggested by Prof. Rizzo in his study of the Calabrian earthquake of September 8, 1905, but offers none in its stead. We may remark that the term shadow is based on the supposition that earthquakes originate in areas of small dimensions compared to that over which they are felt; the term loses its significance if Major Harboe's suggestion of extended origins, noticed in NATURE of April 26, 1906, is accepted.

THE U.S. *Monthly Weather Review* for May contains a full translation, by Dr. O. L. Fassig, research director of Mount Weather Observatory, of M. G. Guilbert's principles of forecasting the weather, submitted to the international competition at Liége, organised in 1905 by the Belgian Astronomical Society, with the view of showing the state of our knowledge of that subject. The jury, which was composed of six well-known meteorologists, unanimously awarded the first prize to M. Guilbert, of Caen, whose forecasts were based upon conclusions drawn from the study of the relation of the theoretical to the actual wind. He claims to be able to predict with precision the displacements and variations of centres of high and low pressure for twenty-four hours in advance, and to foretell the inception and dissolution of storms. Dr. Fassig points out that the rules can readily be put to test, and that the paper should receive the careful consideration of all who make weather forecasts. The subject is referred to in the last Parliamentary Report of the Meteorological Committee, and a valuable discussion of the principles will be found in the *Archives des Sciences* for July, 1906, by M. Brunhes, chairman of the jury of award.

Science for August 30 contains the presidential address of Mr. F. T. Shutt to the section of agricultural chemistry at the meeting of the American Chemical Society held this summer in Toronto. Mr. Shutt's address deals mainly with the virgin soils of the new north-west, showing by analysis their richness in nitrogen, but pointing out how rapidly they become exhausted under the common system of growing successive wheat crops with an occasional bare fallow. He gives figures to show that twenty years of such cultivation has reduced the nitrogen content of the soil down to the depth of 8 inches by no less than 2206 lb. per acre, of which not more than 700 lb. has been obtained in the crop. Although no marked falling off in the yield of this soil is as yet apparent under proper cultivation, chemistry warns the cultivator that a great drop in fertility must inevitably take place unless something is done to replenish the nitrogen. This, Mr. Shutt points out, can be done by the growth of clover, and gives examples of the enrichment of the soil consequent upon the introduction of this crop.

MR. CHARLES A. CULVER, of the University of Pennsylvania, has undertaken a study of the relative efficiencies of the various types of receiving systems in use in wireless telegraphy, and the *Physical Review* for September contains an account of the first part of his investigations. Of the types tested, those consisting of one or more vertical wires are the most efficient, and it seems immaterial whether the component parts are connected together at the lower, upper, or both ends. Partial screening of the aërial produces little effect, while the resistance of the earth between the sending and receiving stations is of prime importance. From a consideration of his own results and those of others, Mr. Culver concludes that the theory of propagation of the waves through the surface of the earth accounts for more of the observed facts than the free ether-wave theory, although it does not at present account for several phenomena encountered in practical work.

REPRINT No. 40 from the Bulletin of the Bureau of Standards at Washington consists of an account of some preliminary measurements of the temperature and selective radiation of the filaments of various kinds of incandescent electric lamps made by Messrs. C. W. Waidner and G. K.

Burgess. They find that at temperatures about 1500° C. platinum departs farthest of all the substances tried from radiating as a perfectly black body, while carbon most nearly approximates to a black body. All the filaments used are thus selective radiators, and are more efficient luminous radiators than a black body, the order being for the same temperature—platinum, tantalum, tungsten, carbon. The superiority of tantalum and tungsten over carbon filament lamps is to some extent due to this fact, which is further emphasised by the higher temperature at which they can be worked, the light emitted varying nearly as the twelfth, while the energy supplied varies only as the fifth, power of the temperature.

THE Health Education League of Boston, Massachusetts, has sent us two copies of new booklets published in continuation of the series noticed in a recent number of NATURE (September 12, p. 508). In one of the booklets (No. 12) Dr. M. H. Bailey deals with "Emergencies," and in the other Miss A. F. Rogers and Dr. J. H. McCollom describe "Microbes: Good and Bad."

A SECOND edition of Prof. J. Reynolds Green's "Introduction to Vegetable Physiology" has just been published by Messrs. J. and A. Churchill. The price of the work is 10s. 6d. net.

A SECOND edition (third impression) of Mr. W. P. Workman's "School Arithmetic," which is a school course adapted from "The Tutorial Arithmetic," has been published by Mr. W. B. Clive.

WE have received from Mr. C. Baker, of High Holborn, London, the October issue of his classified list of second-hand instruments and of new pieces of apparatus recently introduced. The catalogue contains a description of more than a thousand pieces of apparatus, together valued at more than 6000*l*. Those who are contemplating the purchase of microscopes, telescopes, spectroscopes, and other physical apparatus would do well to examine this catalogue.

THE general committee of the Dr. Fream memorial fund has confirmed the following resolution, which was passed at a recent meeting and accepted by the Board of Agriculture and Fisheries:—"That the Fream Memorial Fund shall be invested in the name of the Board of Agriculture and Fisheries or of an official trustee selected by the Board, and shall be administered by the Board of Agriculture and Fisheries, and that the income shall be applied by way of a Fream memorial prize of books to be competed for in each year by students in the science of agriculture, and so that as long as an examination is held by the National Agricultural Examination Board for the national diploma in agriculture the prize shall be awarded to the person who obtains the highest marks in such examination." A sum of about 200*l*. is available for the purpose of the memorial.

PHOTOGRAPHERS will study with interest the new edition of the catalogue of photographic apparatus and materials recently issued by Messrs. Marion and Co., Ltd., of Soho Square, London. The full descriptions and carefully tabulated particulars as to sizes and prices contained in this well-illustrated list should render the choice of material easy and expeditious.

OUR ASTRONOMICAL COLUMN.

THE PHYSICAL NATURE OF METEOR TRAINS.—An interesting discussion of the nature of meteor trains is published in No. 2, vol. xxvi. (p. 95, September), of the *Astrophysical Journal* by Prof. C. C. Trowbridge. Prof. Trowbridge, believing that valuable information concerning the upper layers of the earth's atmosphere may be thereby deduced, has compiled a catalogue of observed meteor trains, and for several years has made a comparative study of the data, at the same time making a study of the phenomena of gas phosphorescence. The discussion of altitudes leads to the conclusion that there is a definite layer of the earth's atmosphere, probably some fifty to sixty miles high, where the conditions are favourable to the production of the peculiar glow constituting a meteor train. Prof. Trowbridge believes that the secondary appearance of duality, so frequently observed in meteor trains, is due to the probable tubular form of the trains. The train itself is probably a tube of gas and particles of meteor dust, rendered phosphorescent by some temperature or electrical effect produced by the meteor's passage. The rate of diffusion and the colour of meteor trains agree with similar phenomena observed in phosphorescent air in the laboratory.

THE PULKOWA ECLIPSE EXPEDITION TO TURKESTAN, JANUARY, 1907.—An interesting account of the expedition dispatched from the Nicholas Central Observatory, Pulkowa, to observe the eclipse of January 13, 1907, is given in No. 18, vol. ii., of the *Mitteilungen der Nikolai-Haupsternwarte zu Pulkowo*. The site chosen for the observation of the eclipse was near the small town of Ura-tyube, in the Samarkand district of Turkestan, and there the various instruments were erected on December 31, 1906. The accompanying illustration, reproduced from the *Mitteilungen*, gives some idea of the conditions under which the observers worked, and shows the instruments in position. The long tube on the left is the coronagraph of 5 inches aperture and 43·5 feet focal length, with which M. Hansky hoped to obtain photographs showing details of the inner corona and prominences; as may be seen, this instrument was pointed directly to the sun's place at the moment of mid-totality. With the photographic refractor of short focus, it was planned to obtain five photographs of the corona with various coloured screens and on different plates. In addition to these, an attempt was to be made to photograph the spectrum of the corona from C to the ultra-violet, and M. Hansky also proposed to carry out photographic photometric researches.

Observing Station of the Eclipse Expedition at Ura-tyube, Russian Turkestan.

Heavy snowfall prevented this programme from being carried out on the day of the eclipse, but some interesting observations of the terrestrial colour effects and the shadow-bands were made. M. Hansky also discusses some observations of the zodiacal light made by him whilst at Ura-tyube.

Daniel's Comet.—The spectrum of Daniel's comet (1907*d*) was photographed, with an objective-prism camera, at the Nice Observatory on several nights during July and August by MM. H. and L. Chrétien, and is discussed by the former in No. 13 of the *Comptes rendus* (p. 549, September 23). A prism of 62° was employed, mounted in front of an objective of 10 cm. aperture and 47 cm. focal length, the spectrum of Capella being photographed on each plate for the purpose of comparison.

The following sets of bands were found, quite sharp and easily measurable, on plates secured on August 16 and 18:—387·0, 388·2; 398·9; 401·2, 402·0; 411·1, 413·8, 419·0; 420·0, 421·3; 425·8, 427·5; 430·1, 431·0, 433·5; and 450·3, 454·2; those at 401, 426, and 450 are very similar in character. The spectrum of the tail comprises three groups of radiations, the mean wave-lengths of which are 401·6, 426·7, and 452·2 respectively. An examination of the plates shows that each of these is composed of two condensations, the separation of each couple being 1·9, 1·7, and 3·9 $\mu\mu$ respectively.

Mr. Gillman, of Aguilas (Spain), has forwarded to us another chart depicting the results of his eye-observations made on September 4, 5, and 11. On the last-named date he was able to trace the tail of the comet to a distance of about 17½° from the head in a direction a little north of west.

The Spectroscopic Binary α Draconis.—Since July, 1906, α Draconis has been under observation at the Dominion Observatory, Ottawa, for radial-velocity determinations, and in No. 4, vol. i. (p. 237, July-August), of the Journal of the R.A.S. (Canada), Mr. Harper discusses the observations, with those of other observers, and derives a set of elements for the orbit of this binary. The observed velocities range from −54 km. to +56 km., and Mr. Harper's elements are as follows:—period = 51·38 days, velocity of the system = −16·7 km., eccentricity = 0·42, longitude of periastron (ω), from descending node = 198°, T = 1906 July 11d. 0h., and semi-major axis = 30,057,900 km.

ENGINEERING AT THE FINSBURY TECHNICAL COLLEGE.

The completion of a new wing of the City and Guilds Technical College at Finsbury was the occasion, on Wednesday, October 2, of a large gathering of distinguished members of the city companies to witness the opening ceremony. Mr. Baker, chairman of the Colleges Extension Committee, in inviting the Lord Mayor to declare the new wing open, gave an interesting account of the history of the City and Guilds of London Institute, which, founded in 1878 and incorporated by Royal Charter in 1900, has raised and expended nearly three-quarters of a million pounds for the promotion of technical education.

The growth of the Finsbury Technical College has for some years necessitated the work being carried on in three unconnected buildings, and in order to bring all departments under one roof, with greatly improved facilities for their work, the institute set aside 10,000*l.* from its reserve fund, and the Corporation and Guilds of London contributed an equal amount, while a generous friend of the college contributed 10,000*l.* for equipment. With this sum the committee was able to carry out a long cherished scheme of centralisation and extension, and it was particularly fortunate in having Sir William White as one of its number to advise on all matters relating to the engineering equipment. Mr. Baker also referred to the long and distinguished connection of Prof. Silvanus Thompson and Prof. Meldola with the college, and in conclusion expressed the pleasure of the company at the presence of the Lord Mayor and Sheriffs to open the new wing.

The Lord Mayor, who was received with great enthusiasm, then declared the building open, and delivered an address to the students on the development of character.

Mr. Yarrow, in proposing a vote of thanks, briefly referred to the advantages which the two-year course at Finsbury offered to students, especially those who had served an apprenticeship in an engineering works, and said that in his opinion the Finsbury Technical College fills a special need, which is not supplied by other existing institutions, excellent though many of these are.

Sir John Wolfe-Barry, chairman of the executive committee, seconded the vote of thanks, and after acknowledgment by Sir William Treloar the company proceeded to view the building. On arriving at the engineering laboratory, the Lord Mayor pressed a button, setting the machinery in motion, and afterwards made a tour of inspection with the company, which included Sir Edward Clarke, Sir William White, Sir John Watney (secretary of the institute), Sir A. B. W. Kennedy (president of the Institute of Civil Engineers), Sir Philip Magnus, M.P., Mr. A. C. Morton, M.P., Prof. Unwin, Prof. Dalby, Mr. T. H. Blakesley, Mr. Ralph Palmer, Mr. S. S. Gladstone, and Mr. Soper (assistant secretary of the institute).

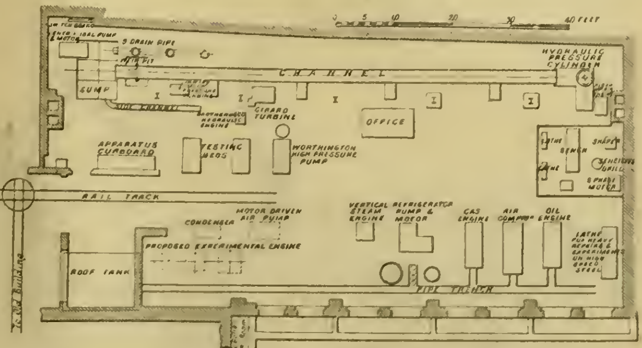


Fig. 1.—Plan of the Engineering Laboratory of the City and Guilds Technical College, Finsbury.

The engineering laboratory, shown on the accompanying plan, is about 100 feet long and 45 feet wide, and is a well-lighted room having walls faced with white tiles from the window levels, those below being brown glazed. Along one side a cast-iron channel of square section, 2 feet wide and 80 feet long, is sunk into the floor. This channel is free from end to end, so that, when occasion requires, the whole length can be utilised for experiments on towing, wave motion, and the like. There are also two smaller channels, parallel to the main one, for draining water into the measuring tanks without disturbing the main channel.

The measuring tanks are six in number, having a combined capacity of about 4000 gallons, and all the water collecting therein can be raised to a tank on the roof by a centrifugal pump delivering 200 gallons a minute against a head of 90 feet; the water is distributed anew by a 5-inch falling main and branches. The usual arrangements of weirs, float gauges, and the like are provided for measuring the water in the channel, and a Venturi meter can also be inserted in the pipe line.

At the other end of the channel is a hydraulic cylinder of special design, capable of giving horizontal and vertical jets up to 2 inches in diameter under any head not exceeding 300 feet. This cylinder is suspended by cross girders over a pit for receiving the vertical jet, and the horizontal jet is directed along the main channel.

The equipment of hydraulic machinery also includes turbines of the Girard and Francis types, and a high-pressure pump for operating an experimental engine of the Brotherhood type.

The heat-engine equipment consists of a representative set of machines arranged along one side of the laboratory, and spanned by an overhead crane capable of delivering a load of 30 cwt. to a lathe at one end. The engines already installed comprise a 12 horse-power "National" gas engine, with special thermometer pockets in the cylinder walls, and arrangements for releasing and shutting down the valves at any moment. This engine can be run on town gas or on suction gas from a producer. A 6 horse-power oil engine has similar thermometer pockets and valve-releasing gear.

An experimental "Linde" refrigerating plant is arranged to work with carbonic acid or ammonia by using interchangeable cylinders. The compressing pump is driven by a motor operating through a worm-wheel gear, so arranged that by disconnecting the pump coupling experiments can be made on the efficiency of worm gearing.

A small vertical steam engine, a petrol motor, a "Rider" hot-air engine, and a pulsometer pump are also included, while spaces are reserved for an experimental reciprocating steam engine of compound or triple expansion type, and an independent condensing plant to be installed at an early date. The steam-raising plant will consist of a Yarrow water-tube boiler, and a separately fired superheater.

An experimental compound air compressor, coupled directly to a motor, has been installed, and is fitted with special arrangements for experimental work. The equipment for testing the strength of materials includes a ten-ton "Buckton" testing machine, a combined bending and twisting machine, and a number of other machines for small-scale experiments. A specially designed machine for compression up to fifty tons will also be installed.

The drawing office, over the engineering laboratory, is a well-lighted room 80 feet long and 34 feet wide, with accommodation for one hundred students.

The college workshops have been recently equipped with the most modern tools, and in addition a special shop for the construction and repair of apparatus is provided in the engineering laboratory. The new wing also contains a lecture theatre and rooms for the staff.

As will be apparent from this brief description, the equipment has been designed with the purpose of giving students a practical acquaintance with as wide a field of engineering as possible. All the machinery and apparatus are of moderate dimensions, easily handled by students without excessive supervision, and at a small cost for running expenses.

While instruction, not research, has been the primary object, there is little doubt that in the future original work can be accomplished which will be of interest and value to the engineering profession.

E. G. COKER.

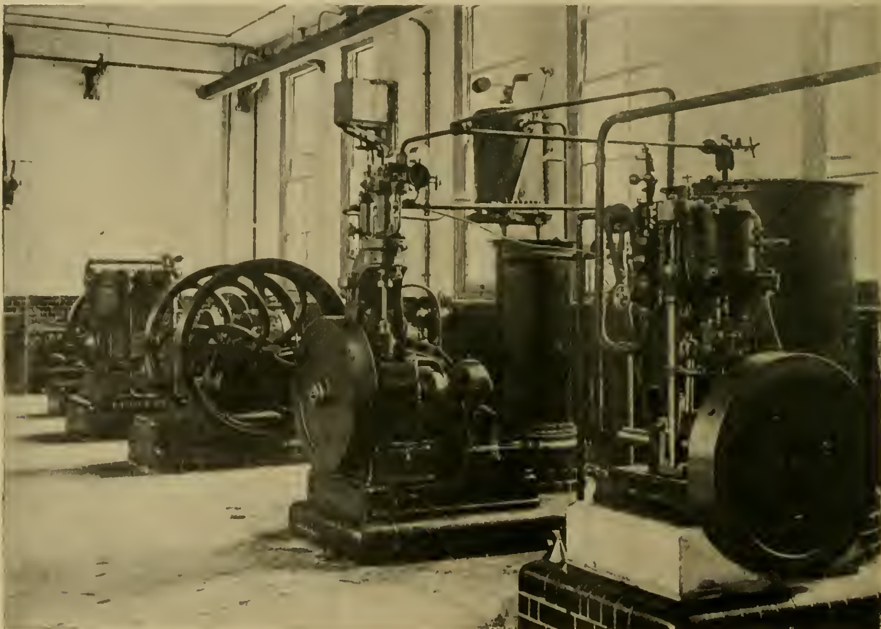


FIG. 2.—View of the Engineering Laboratory showing part of the Heat Engine Equipment.

FORTHCOMING BOOKS OF SCIENCE.

MR. SIDNEY APPLETON promises:—"A Book of Birds," by W. P. Pycraft, illustrated; "Minerals," by L. J. Spencer, illustrated; "Earthquakes," by Prof W. H. Hobbs, illustrated; "The Moon," by G. P. Serviss, illustrated; "The Warblers of North America," by F. M. Chapman and others, illustrated; "The Life and Habits of the Ants," by Dr. L. I. Dublin, illustrated; "Iron and Steel," by Dr. J. R. Smith, illustrated; "Gold," by Dr. J. R. Smith, illustrated; "The Horse: Ailments and

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Mr. E. Stanford gives notice of:—"The Elements of Geography," by J. H. N. Stephenson, part i.

The list of the University Tutorial Press contains:—"The Science of Speech: a Full Account of the Structure and Use of the Vocal Organs and the Means of Securing Distinct Articulation," by H. H. Hulbert, illustrated; "The Theory and Practice of Perspective Drawing," by S. Polak; "Certificate Hygiene: a Course of School Hygiene for Teachers, dealing with Sanitation, Physical Training, Food, Drink, Clothing, Fresh Air, Work, Rest, &c.," by R. A. Lyster; and "Junior Chemistry: a Text-book of Experimental Chemistry on Modern Lines," by R. H. Adie.

Mr. T. Fisher Unwin announces:—"Last Hours with Nature," by Mrs. Brightwen, edited by W. H. Chesson, illustrated; "Eliza Brightwen: the Life and Thoughts of a Naturalist," edited by W. H. Chesson, illustrated; "The Matterhorn," by G. Rey, illustrated by E. Rubino, translated from the Italian by J. E. C. Eaton, illustrated; "The Andes and the Amazon: Life and Travel in Peru," by C. R. Enock, illustrated.

The list of Messrs. Vinton and Co., Ltd., contains:—"The Mare and Foal and their Treatment"; "Milch Goats: Breeds and Management"; "Dogs: Breeds and Management"; "Poultry: Breeds and Management"; "Fifty Years among Shorthorns," by R. Bruce; and "The History of Shorthorn Cattle," edited by J. Sinclair.

Messrs. Watts and Co. will issue:—"The Picture Book of Evolution," by D. Hird, part ii.

Messrs. Whittaker and Co.'s announcements comprise:—"The Metric and British Systems of Weights, Measures, and Coinage," by Dr. F. M. Perkin; "Moving Loads on Railway Under Bridges," by H. Bamford; "Principles of Electrical Engineering (Direct Current)," by J. R. Barr; "Steel Works Analysis," by Prof. J. O. Arnold and F. Ibbotson; Whittaker's "Arithmetic of Electrical Engineering"; "Modern Practice of Coal Mining," by D. Burns and G. L. Kerr, parts ii. and iii.; "Electricity in Mining," by P. R. Allen; and "Advanced Text-book on Steam, Gas, and Oil Engines," by J. W. Hayward.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Public Orator, Dr. Sandys, spoke as follows on October 1 in presenting to the Vice-Chancellor the several recipients of honorary degrees on the occasion of the visit of the guests of the Geological Society of London:—

Dignissime Domine, Domine Procancellarie, et tota Academia.

Societatis Geologicae Londiniensis hospites, hesterno die ad nos paulisper advectos, omnes etiam nostrorum hospitum in numero libenter computamus; omnes, scientiarum in hac sede venerabili e tot orbis terrarum partibus praesentes, non sine fraterno quodam animi motu contemplamur. "Saxa et solitudines voci respondent": quanto magis nos, litterarum humaniorum et scientiarum amore imbuti, eorum adventu vehementer commovemur, qui scientia quadam admirabili praediti, etiam ex ipsis saxis rerum naturae veritatem extorquent! Hospitibus nostris omnibus patent hodie Musea nostra, patent Collegia nostra omnia, patent omnium corda. In hoc templo denique honoris, dum hospites nostros omnes, e tot terris advectos, ea qua par est observantia excipimus, nonnullos, gentis uniuscuiusque quasi legatos praecipuos, titulo nostro velut exempli causa decoramus, qui honos aliorum hospitum insignium praesentia illustratus, vestrum omnium plausu sine dubio comprobabitur.

(1) Christiania ad nos misit Universitatis suae Rectorem, geologiae professorem insignem, qui patriae in rupibus et metallis explorandis non sine laude iamdudum exercitatus, Norwegiae australis praesertim de saxis igneis praeclare disputavit. Iuvat videre virum patriae devotissimum, virum Regni novi senatoribus adscriptum, virum denique gentis totius Universitatis legatum auspiciis optimis nominatum.

Doctorum nostrorum in serie primus hodie incedit WALDEMAR CHRISTOPHER BRÖGGER.

(2) Assurgit deinceps Saxoniae explorator indefessus, Universitatis Lipsiensis professor eximius, qui Germania e septentrionali oriundus, palaeontologiae imprimis usus auxilio, Saxoniae in saxis serie perpetua ordinandis diu feliciter occupatus est. Idem geologiae in elementis enarrandis quantum excellit! Rerum naturae in penetralibus suo Marte explorandis quam fortis est! Rerum naturae in miraculis et observandis et explicandis quam subtilis!

Praesentatur vobis Regni Saxonici unus e Consiliariis, geologiae professor Lipsiensis, HERMANN CREDNER.

(3) Progreditur proximus Musei Bruxellensis curator sollertissimus, vir in palaeontologia vertebrata (ut aiunt) investiganda diligentissimus. Meministis arte quali, ossibus immensis ordine apto collocatis, bestiam illam immanem, Iguanodon Bernissartensem, in speciem suam pristinam restituerit, cuius effigiem accuratissime expressam, et zoölogiae in Museo nostro positam, Belgarum Regis liberalitati acceptam rettulimus.

Nostri in Regem illum animi grati testimonium hodie sine dubio libenter audiet unus e ministris eius fidelissimis, LUDOVICUS DOLLO.

(4) Francogallorum respublica maxima, vicinitatis vinculis nobiscum consociata, trans fretum angustum, nonnullis tam formidolosum, ad litora nostra legatum transmisit acceptissimum. Hospes autem noster, qui Normannorum in provincia superiore vallem quandam viridem olim ab oceano denudatam penitus perscrutatus est, in Instituto Catholico Parisiensi geologiam praeclare profitetur. Scientiae vero illius in Actis edendis diu occupatus, Scientiarum ab Academia, viri magni in locum, epistolarum minister perpetuus nuper est electus. Idem stili lucidi perspicuitate et verborum aptorum venustate insignis, opus ingens, summi laboris, summi acuminis monumentum, scientiae suae studiosis dedicavit, cuius in ipso limine professorem quendam Germanum, operis tanti aemulum generosissimum, aperte atque ingenue collaudat, qui, tempore eodem, laudis titulo eodem a nobis iure optima exornatur.

Laudis eiusdem socius merito declaratur ALBERTUS AUGUSTUS DE LAPPARENT.

(5) Germaniae quidem e legatis alterum hodie non sine dolore desideramus, Scandinaviae vero legatum alterum non sine gaudio salutamus. Salutamus professorem, cuius Regem illustrem inter doctores nostros iamdudum libenter numeravimus, cuius popularem insignem, Linnaeum, cum orbe terrarum toto nuper celebravimus. Hodie vero Florae antiquae potius quam hodiernae antistitem decoramus, qui scientiarum ardens amore, saepenumero etiam caeli arctoi frigora fortiter toleravit. Talium virorum auxilio vetera illa poetae Romani verba denuo vera redduntur:—

"Venient annis saecula seris,
Quibus Oceanus vincula rerum
Laxet, et ingens pateat tellus,
Tethysque novos detegat orbes,
Nec sit terris ultima Thule."

Interim velut ultimam Thulen hodie nobis repraesentat doctorum nostrorum illustrium in serie supremus, poli arctoi indagator audax, ALFREDUS GABRIEL NATHORST.

Mr. Augustine Henry, reader in forestry, will deliver his inaugural lecture in the Botany School lecture theatre on Tuesday, October 15, at 5 p.m.

On the nomination of the special board for mathematics, Dr. Glaisher has been appointed an elector to the Isaac Newton studentships until September 30, 1911.

OXFORD.—In the Convocation held on September 30 the degree of D.Sc., *honoris causa*, was conferred upon a number of distinguished foreign geologists who had attended the centenary celebration of the Geological Society, and also upon Dr. Ludwig Mond, who was nominated by the Chancellor for the degree at the last commemoration, but was at that time unable to attend. The following is the text of the speeches delivered by Prof. Love in presenting them for the degree:—

PROF. C. BARROIS.

Aristoteles auctor est ubi hodie terra sit fuisse pontum, ubi pontus terram. Has vicissitudines testantur ipsa e quibus terra constat elementa, φωνήεντα ξυνετοῖσι, sed multorum operam rei ubique incumbentium requirentia ut recte intelligantur. Cum harum rerum investigatores unum in locum aliquando congregari soleant, quo melius quid profectum sit recognoscant, quid egendum sit deliberent, paucos ex eiusmodi conventu laudem singularem adeptos hodie ornat Academia nostra.

Inter Gallos qui geologiæ student fere illustrissimus est Carolus Barrois. Qui vir cum longos saxorum tractus scrutaretur, aliam superficiei structuram esse vidit, aliam medullarum: unde duo saxorum genera distinguere potuit, hæc ignea vi conflata, illa sub vadis, quibus Galliæ pars magna olim opplebatur, sensim concreta. Idem cretæ naturam rimatus, quæ apud nos et apud Gallos perexiguo freto divisos invenitur, nova indicia nactus est unde maris lati et profundi, quo utraque terra olim tegebatur, et incessum et regressum lentum ostenderet.

PROF. A. HEIM.

Qui hodie de vi occulta qua montium iuga super planitiem elata fuerint optime disserunt auctorem sequuntur Albertum Heim. Hic ille est Alpium suarum investigator qui, cum singulorum iugorum, e quibus hæc vasta compages constat, anfractus ramosque perlustrasset, terræ defectus quibus hæ regiones aliquando vexantur, concretas glaciei moles quibus superiora vallium obsidentur, prona montium obteguntur, diligentissime observasset, descriptionem Alpium tabulis pulcherrimis expressam confecit, laboris et fructum et testimonium non pœnitendum.

PROF. A. LACROIX.

Saxorum ignea vi conflatorum varia genera distinguere et quasi in classes distribuere potuit Alfredus Lacroix. Hic ille est qui quattuor abhinc annos monte Peleo vi immani convulso a Galliæ gubernatoribus eo missus est ut nubium ardentium naturam cognosceret: qua in legatione valde periculosa cum appropinquanti exitium flammæ minarentur, mariti virtutem æquavit coniux, quam honoris causa nomino, periculorum olim, nunc laudis socia. Ne multa. Felicissime rem egit vir fortis et sagax, qui harum nebularum natura bene explorata reversus est.

PROF. A. PENCK.

Intercessisse tempora quædam cum terra summo frigore oppressa fuerit nemo nescit. Ultimam quidem ex his quasi periodis, quæ una erat e pluribus quas hic orbis terræ passus est, ex quo animantium sæcula exorta sunt, plurimi pertractaverunt, nemo ex his qui hodie Europam incolunt melius quam Albertus Penck. Cum enim hac periodo exeunte hominem super agros caput extulisse constet, hic noster exstitit qui humani generis vetustatem ultimam illustraret, cum inter variarum gentium instrumentis lapideis utentium tempora et eventus quibus vasti Europæ tractus glacie purgarentur rationem intercedere doceret.

PROF. H. REUSCH.

De Scandinaviæ geologia optime egit Hans Reusch. Qui vir, cum in Norvegia saxa quædam invenirentur innumerabilibus ante sæculis mari terram operiente sensim concreta, deinde vi ignea adeo liquefacta et mutata ut nulla omnino animalium vestigia exhiberent, ipse rationes novas commentatus eiusmodi indicia deprehendit, unde saxorum ætatem colligere potuit. Ostendit etiam Norvegiam vastissimis glaciei molibus antiquitus fere obtectam esse, ex quo patet etiam in vetustate ultima magnis caloris et frigoris vicibus obnoxiam fuisse terram.

PROF. F. ZIRKEL.

Qui illud Scientiæ Naturalis genus pertractant quod ad metallorum saxorumque structuram pertinet Ferdinando Zirkel fere omnia accepta referenda censent, cum microscopo, ut cum physicis loquar, hac in re primus usus sit. Neque satis erat ei nova huic rei studentibus subsidia parare, ipse enim in hoc genere plurimum profecit, cuius doctrinam et peritiam testatur maximus ille de Petrologia liber luculentissime conscriptus.

DR. L. MOND.

"Magnum vectigal est parsimonia" dixit Tullius, quod etiam in Chemia valere sensit Ludovicus Mond. Cum enim id agunt chemici ut certum aliquod elementum a ceteris secernant, restant tanquam rediviva quædam, quæ saepe magni pretii sunt. Multos iam annos hic vir varios modos commentatus est, quibus corpuscula ab aliis spreta, tanquam inutilia, in usum converteret. Ita parcendo dives factus Scientiam Naturalem omni liberalitatis genere coluit. Maximum Londinii laboratorium Humphredo Davy et Michaeli Faraday, Chemiæ et Physicæ auctoribus clarissimis dedicatum, ædificavit et muneribus locupletavit: idem Societati Regali catalogum maximum, in quo omnia ab omnibus in quovis scientiæ genere his centum annis reperta continerentur, conficiendum et typis imprimendum curanti pecunia subvenit.

THE Association of Technical Institutions offers two prizes, each of 25*l.*, for the two best essays, one on "The Bearing of Technical Education on Industrial Progress," and the other on "The Bearing of Technical Education on Agriculture and on Industries of a Rural Character." Particulars of the conditions may be obtained from Dr. Clay, Northern Polytechnic, Holloway, London, N.

A COURSE of eight lectures on "Certain Fundamental Problems in Physiology common to Animals and Plants" will be given by Dr. W. M. Bayliss, F.R.S., at University College (University of London) on Wednesdays, at 5 p.m., beginning October 23. The lectures are open to all students of the University of London; also to qualified medical men and to such other persons as are specially admitted.

PROF. W. C. McINTOSH, F.R.S., professor of natural history in the University of St. Andrews, in July last presented the University museum with 3150 spirit preparations, large and small. The preparations consist of (1) a named series (about 1150 in number) illustrating the marine zoology of St. Andrews—the types of the "Invertebrate Marine Fauna and Fishes" of St. Andrews, 1875; (2) a glazed cabinet illustrating the development and life-history of the salmon of the Tay in ninety-five preparations; (3) a reference series (265 in number) from the trawling expeditions of 1884, each station showing both fishes and invertebrates; (4) a general zoological collection in spirit (consisting of about 1595 specimens), chiefly marine, from Shetland to the Channel Islands, but also including a considerable number of amphibians, reptiles, birds, and mammals; (5) forty-five typical botanical preparations, including a fine series of pitcher plants with their insects.

THE programme of day and evening classes at the Woolwich Polytechnic during the session 1907–8 has been received. The volume contains the usual syllabuses of subjects studied at the polytechnic, and particulars of the examination requirements of London University, Board of Education, and other examining bodies. We are glad to see here and there short notes as to the value of preliminary scientific education to the student of technology. Thus, it is pointed out that a sound knowledge of mathematics is the surest basis for satisfactory progress in mechanical and physical science. In the physical department, all students are required to attend both the lecture and the laboratory course in each class; and students of electrical engineering must attend classes in electricity and magnetism concurrently if they have no knowledge of the principles of electrical science. Systematic courses of study extending over three or more years are arranged in various branches of technology; and the time-tables of these courses should be useful as a guide to serious students. We notice the announcement that the governors are desirous that no young man or woman shall be deprived of the advantages of the instruction given in the polytechnic, on the ground of inability to pay the fees. The principal is authorised to admit students free who desire to attend any of the classes and to work steadily, but are unable to pay the necessary fees.

THE distribution of medals, prizes, and certificates to students of the Royal College of Science on Thursday last was made the occasion of several references to the charter of incorporation of the Imperial College of Science and Technology. The Dean, Prof. W. A. Tilden, trusts that by the end of the year everything will be ready for the transfer of authority which is to take place from the Board of Education to the governing body of the Imperial College on January 1 next. In his address to the students, Mr. A. H. D. Acland said that in the forwarding of technology this country has been lamentably backward. Scientific knowledge is at the very root of the prosperity of the Empire. If determined efforts are made a great national institution will be established of which the country will really be proud. Mr. Acland advised the students to do something to study the great masterpieces of the English language. He remarked that in later life, when they have to make reports, as all men in scientific life must do, they will often find that the study of the English language will not have been altogether useless, even at the present stage of their education. Mr. Acland also advised the students to travel when it is possible for them to do so. Scientific men do a great deal by their interchange of ideas between this and foreign countries to forward that which we all desire—international friendliness. Prof. Dalby, Dean of the Central Technical College of the City and Guilds of London Institute, referred to the union which is to take place between the three colleges; and Sir William White said that to put the charter in practical form it is necessary to recognise all that has been done in the past, to utilise fully all that exists, and to bring the whole of the higher technical instruction into one harmonious and sympathetic working whole.

A STRONG plea for the establishment of a university for Bristol and the West of England was made by Prof. F. Gotch, F.R.S., at the annual distribution of prizes to the students of the faculty of medicine of the University College of that city on October 1. Prof. Gotch pointed out that the geographical position of Bristol, her civic prosperity, and her educational institutions are such that there is no excuse for further delay. It is time for the city to realise that in higher education the organisation of her teaching resources is a matter of momentous importance, and that the way to attain this is to segregate all her scattered educational efforts in a university. Surely the citizens of Bristol are as enlightened and generous as those of Liverpool, Manchester, Birmingham, Leeds, and Sheffield; and the fact that the city has not also a university of its own must be because the difference between a college and a university is not understood. A university possesses greater educational stability, and, in consequence, greater educational efficiency. It segregates all the higher educational enterprises of the district, rivalry gives place to cooperation, general interest is thus awakened, and it is sustained by the knowledge that, having become a working partner in a great enterprise, it must at all hazards be made a success. The credit of the community is then at stake, thus ensuring its proper support; and since the enterprise has, from the educational point of view, attained a new level, it is viewed from a different and a higher standpoint. Another conspicuous feature of a university is the freedom which it enjoys. The possession of the power to give a degree carries with it a matter of enormous freedom. Collegiate teaching has to follow along lines prescribed by those bodies which give degrees, and such prescription stifles educational development, because the teacher has no voice in the matter. A further feature of a local university is the enlargement of the area of educational responsibility. The pride which the citizens of Liverpool and Birmingham have in their universities is due to their proprietary interest in them. A university would thus become the dominant educational force and pride of Bristol and all the surrounding district. The last feature of a university, as distinct from a college, is one which will in the end carry on its broad back all the others: it is prestige. So long as Bristol only possesses a college, she will from the standpoint of higher education have but little general prestige. The fault does not lie with the character of the collegiate teaching, the size of the buildings, or the equipment of the scientific laboratories. So long as the college continues to remain in its present condition, so long will it not only gain no prestige, but may begin to lose what prestige it now possesses. Those who take over wider university responsibilities are felt to be possessed by the spirit of the age, and are duly honoured, whilst those who hesitate to do so are felt to be without this spirit, and lose their position.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, received June 8.—"On Luminous Efficiency and the Mechanical Equivalent of Light." By Dr. Charles V. **Drysdale**. Communicated by Prof. Silvanus P. Thompson, F.R.S.

The paper first directs attention to the fact that the term luminous efficiency requires more rigorous definition. If Q is the total power consumption of the source, R the total radiation $= \int_0^\infty I_\lambda d\lambda$, and L the luminous radiation $= \int_{\lambda_1}^{\lambda_2} I_\lambda d\lambda$, the luminous efficiency is generally taken to mean the ratio L/Q. In many cases, however, the ratio L/R, which has been termed by Nichols the radiant efficiency, is determined. Neither of these definitions is entirely satisfactory from the practical point of view, as a source might apparently be of high efficiency if its radiation were confined within the visible spectrum, but near to either end of the spectrum, where the luminosity is low. A better definition is that of Dr. Guilleaume, which may be termed the reduced luminous efficiency L_λ/Q, where L_λ is the equivalent radiation of the most effective form required to give the same light emission. In order to obtain the latter quantity it is necessary to determine the mechanical equivalent of the most effective luminous radiation which is in the neighbourhood of $\lambda = 0{\cdot}54\ \mu$.

For the measurement of the mechanical equivalent a spectrum was formed by a carbon bisulphide prism, and a combined photometric and bolometric arrangement was made to enable the luminosity of any part of the spectrum to be measured, and the radiation to be compared with that from a glow lamp radiating a known amount of power. By means of a movable screen the radiation from the spectrum or from the source of radiation could be intercepted alternately, and the radiation from the comparison source altered until no effect was observed on changing from the spectrum to the comparison lamp. This eliminated trouble due to drift. Measurements were made both with approximately monochromatic light in the neighbourhood of $0 \cdot 54\ \mu$, and in white light obtained by widening the slit until the whole of the light within the visible limits was collected at the bolometer. The result obtained for the mechanical equivalent was 0·06 watt per candle for the yellow-green light; for white light obtained from an arc the mechanical equivalent was 0·08 watt per candle, and from a Nernst filament as source 0·12 watt per candle, the latter result agreeing almost exactly with that obtained by Ångström for the light of the Hefner lamp. The ideal source of white light should therefore give somewhere about ten candles per watt, and a monochromatic yellow-green source nearly seventeen candles per watt.

June 13.—"On the Identification of Chitin by its Physical Constants." By Miss I. B. J. **Sollas.** Communicated by Prof. W. J. Sollas, F.R.S.

The determination of the physical constants of chitin forms a useful method of identifying it. The specific gravity of chitin from various sources approximates to the value 1·398, a number which represents the specific gravity of chitin precipitated from its solution in strong acid. The refractive index lies between the limits 1·550 and 1·557.

The bristles of Lumbricus, the pupal skin of Pieris and other Lepidoptera, the radula of Mollusca and the shell of Sepia, when freed from mineral matter and easily soluble organic substances, have specific gravities and refractive indices which lie between the same limits as those of chitin from various sources.

June 27.—"The Pressure of Bile Secretion and the Mechanism of Bile Absorption in Obstruction of the Bile Duct." By Dr. Percy T. **Herring** and Dr. Sutherland **Simpson.**

The authors find that the maximum pressure attained by the bile in obstruction of the common bile duct considerably exceeds the figures given by Heidenhain. In the dog, cat, and monkey the average maximum pressure reached in a number of experiments was 300 mm., measured in terms of the height of a vertical column of bile. The highest pressure recorded was 373 mm. bile in a cat.

When the common bile duct is obstructed the bile escapes from the liver by the lymphatics, and in the cat may be seen in the thoracic duct one hour after obstruction.

Evidence is adduced to show that the obstructed bile enters the intracellular plasmatic channels of the liver cells, and passes from them by the natural lymph flow into the lymph channels of the portal spaces. The mechanism of absorption lies in the liver cells, and is not an escape from interlobular bile ducts.

The intracellular plasmatic channels are held to constitute an intermediate system between the blood-vessels and lymphatics of the liver. The "vital" theory of lymph formation is supported.

"On the Relation between the Output of Uric Acid and the Rate of Heat Production in the Body." By E. P. **Cathcart** and J. B. **Leathes.** Communicated by Dr. C. J. Martin, F.R.S.

A diet containing no purine bases, free or combined, was taken by one of the experimenters in equal amounts every three hours during the day, and the output of uric acid during each of the periods of three hours was determined. In this way the average rate of excretion for each period of the day could be ascertained, as well as the daily total. Exposure to cold for about three hours with no voluntary muscular exertions increased the rate of excretion at the time and for some time after (in the first twenty-four hours nearly 50 per cent. above the mean calculated from sixteen successive days), whereas a similar exposure to cold counteracted by muscular activity increased it much less (in the first twenty-four hours about 15 per cent.), and muscular activity without the stimulus of cold (in heavy clothing) for the same length of time diminished it (in the first twenty-four hours about 30 per cent.). The conclusion pointed to is that the endogenous uric acid is in part, and it may be to a considerable extent, a product of the reaction of the body to loss of heat, and that this reaction consists in some form of activity distinct from voluntary movements of the muscles.

"Further Studies of Gastrotoxic Serum." By Dr. Charles **Bolton.** Communicated by Prof. S. Martin, F.R.S.

The serum referred to in this communication was prepared by injecting the stomach cells of the guinea-pig into the rabbit, the blood serum of the rabbit developing toxic properties for the guinea-pig's tissues.

It has been shown that the serum contains, not only a precipitin for stomach-cell proteid, but also separate precipitins for other body proteids. The actions of these precipitins overlap to some extent. There is no agglutinin for the stomach-cell granules, the agglutination which was found to occur being brought about by the precipitins.

The repeated injection of gastrotoxic serum does not produce chronic gastric ulceration, but immunity to the serum is established. The immunity is not only active, but the serum is able to confer passive immunity upon another animal. The tissues of the immune animal are still acted upon by the gastrotoxic serum in the test-tube, the immune substances being present in the blood serum of the animal.

It has been demonstrated that the necrosis of the mucous membrane of the stomach resulting from the injection of gastrotoxic serum is not directly caused by the serum, but is brought about directly by the action of the gastric juice. The cells are functionally damaged by the serum, which renders them susceptible to the gastric juice. The process is thus one of self-digestion. Hyperacidity of the gastric juice increases the tendency to this self-digestion.

Received July 20.—"A Preliminary Summary of the Results of the Experimental Treatment of Trypanosomiasis in Rats." By H. G. **Plimmer** and J. D. **Thomson.** Communicated by Sir Ray Lankester, K.C.B., F.R.S.

The experiments described were undertaken under the direction of the Tropical Diseases Committee of the Royal Society.

The strains of trypanosomes used were a nagana from the original strain brought to England, and a surra from Prof. Lingard in India. The nagana strain kills rats in an average time of 5·5 days, and the surra strain in 6·9 days.

Of drugs experimented with, fifteen chinolin compounds, dichlorobenzidine + acidH, trypanroth, arsenious acid, atoxyl, monophenylarsenic acid, nitrophenylarsenic acid, paratolylarsenic acid, and other arsenic compounds are commented upon, and their effects on the development and course of the diseases stated. Of all the arsenic compounds, and, indeed, of all substances tried singly, atoxyl had by far the most favourable action.

This is the most important substance, so far discovered, in relation to the treatment of trypanosomiasis. In nagana and surra atoxyl causes the entire disappearance of the trypanosomes from the blood, so that rats inoculated with the blood when it was microscopically free from parasites failed to take the disease; but the trypanosomes have invariably recurred, and death was only delayed for a period varying with the dose, and with the time of commencement of the treatment.

When atoxyl is given more continuously or more freely than is required, in cases in which there have been many recurrences, and probably under some other conditions of which we are ignorant, in a certain small proportion of rats so treated a race of trypanosomes is produced which entirely resists atoxyl, and continues to develop and multiply in spite of continued exhibition of the drug. This strain, when inoculated into fresh rats, retains its resistance to atoxyl. Ehrlich, who has produced such a strain in mice, calls them "atoxyl-fest," and we have obtained this atoxyl-proof variety of trypanosome in rats, both in nagana and surra.

In human trypanosomiasis the danger of the production of an atoxyl-proof strain will be at once apparent. For an account of the production and behaviour of these atoxyl-proof strains, and for the results obtained with them, reference must be made to the original paper. Their importance and their bearing on the treatment of human trypanosomiasis by atoxyl is obvious.

Under the heading "Treatment with two or more Drugs," a number of tables are given showing the results of treatment with atoxyl and various mercury compounds, and atoxyl and iodipin. Of the mercury compounds used, the succinimide appears to be the best; it has the great advantage of being unirritating to the tissues, and it will mix with atoxyl without precipitation, and without interfering with the action of the latter.

The results with atoxyl and iodipin are sufficiently encouraging to suggest a further trial of this combination. Several of the animals treated are alive, and apparently well, some as long as five months after inoculation; the duration of the disease has been very greatly prolonged in the great majority of cases, and in some the authors have confidence that a cure has been effected.

PARIS.

Academy of Sciences, September 30.—M. Henri Becquerel in the chair.—Is the use of arsenious acid a preventative against trypanosomiasis? A. **Laveran** and A. **Thiroux.** The authors have repeated the experimental work of Loeffler and Rühs, and come to the conclusion that the use of arsenious acid for trypanosomiasis is not advisable, although in certain cases it may have a useful effect. It cannot be used like quinine against malaria, as the necessary doses of quinine in the latter case are small, not toxic, and can be administered without inconvenience during several months, whilst the doses of arsenious acid which must be administered, either in man or in animals, judging from the doses necessary with the guinea-pig, would be quickly followed by poisonous symptoms. In animals used for food, in particular, the prolonged use of arsenic would have the result of rendering the flesh poisonous.—Researches on the laws of action of light on glucosides, enzymes, toxins, and anti-bodies: Georges **Dreyer** and Olav **Hanssen.** The authors have examined the action of light on two glucosides, saponine and cyclamine; three enzymes, yeast, trypsine, and papayotine; two toxins, ricine and abrine; and one immuno-serum, coli-agglutinine. All these are weakened by the action of light, the ultra-violet rays retained by glass being the chief cause. The action progresses regularly under the action of continuous lighting, the change following very exactly the law of monomolecular reaction.—Transformers with magnetic leakage and secondary resonance for wireless telegraphy: MM. **Gaiffe** and **Gunther.**—Observations on the affinities and evolution of the Chicoraceæ: Léon **Dufour.**—The pluricarpellary origin of the pistil in the Lauraceæ: Marcel **Mirande.**—The function of the spleen in trypanosomiasis: A. **Massaglia.** Trypanosomes collected from the spleen present the same characters as those collected from other parts of the body. This virulence of the trypanosome does not disappear more rapidly in the spleen of animals killed by the trypanosome than in the blood of these animals, and the extract of the spleen does not destroy, *in vitro*, the trypanosomes. The course of the disease surra is the same in a dog from which the spleen has been removed as in the normal animal.—Researches on the chemical nature of the fundamental colouring material of the urine: S. **Dombrowski.** The urochrome is isolated from the urine by precipitation with copper acetate, and from its analysis is shown to contain carbon, hydrogen, nitrogen, sulphur, and oxygen. The sulphur is easily removed by alkalis; the presence of sulphur shows that this body is not derived from the coloured part of hæmoglobin or urobilin, as has been asserted up to the present.—Sodium chloride as a sensitising substance for vegetable ferments: C. **Gerber** and Mlle. S. **Ledebt.** Sodium chloride, in small proportions, accelerates the coagulation of milk by vegetable ferments. It determines the phenomenon when the ferment is present in too small quantities to act alone.

NEW SOUTH WALES.

Linnean Society, August 28.—Mr. A. H. Lucas, president, in the chair.—A preliminary record of the occurrence of Chlamydoselachus in the waters of New South Wales: D. G. **Stead.** The record was based upon portions of a specimen cast ashore some time since in Rose Bay, Port Jackson, comprising the skull and about 150 vertebræ. The specimen measured more than 10 feet in length. Only one species of the genus is known, *C. anguineus*, Garman, from the Sea of Sagami, Japan, as well as from deep waters in the vicinity of Madeira, the Azores, and the coast of Norway, while the length of the largest specimens hitherto known appeared to be about 5 feet.—The resistance of the vegetation of Australia to bush-fires, and the antiquity of the Australian aboriginal: Dr. J. B. **Cleland.** The object of the paper is to suggest that, if it can be proved that the vegetation of Australia has been modified in the course of ages so as to have become more tolerant of bush-fires, and as a result of the frequency of such fires, and if the frequency of such fires can be regarded as due mainly to the agency of man, then there would seem to be some grounds for attributing considerable antiquity to the presence of fire-producing man in that region, and therefore, presumably, to the ancestors of the vanishing aboriginal Australian.—The geology of the Warrumbungle Mountains, N.S.W.: H. I. **Jensen.** In this paper the physiography of the Warrumbungle Mountains district is described, and it is shown that many of its peculiarities are due to *arid erosion*. The mountains may be looked upon as forming a dissected lava conoplain surrounded by an arid erosion peneplain.

CONTENTS.

SUPPLEMENT.

THURSDAY, OCTOBER 17, 1907.

STEREOCHEMISTRY.

Stereochemistry. By Dr. A. W. Stewart. Pp. xx + 583. (Text-Books of Physical Chemistry. Edited by Sir William Ramsay, K.C.B., F.R.S.) (London: Longmans, Green, and Co., 1907.) Price 10s. 6*d*.

THIS book is practically a complete and in many cases a detailed account of the subject of stereo or space chemistry since the foundations of this exceedingly fruitful branch of chemical science were laid by Pasteur and Wislicenus. It is not an historical summary, but a carefully thought out treatise, and one which chemists who have to lecture or teach the subject will find of the greatest use.

The book commences with a short historical introduction. Part i. deals with optical activity, the first section describing the asymmetry of the carbon atom. The author's idea of explaining the effect of polarisation on light by means of a paper-knife and two books is distinctly good. The next chapter deals with inactive compounds, and from this we are led up to the active compounds and the determination of configuration.

Chapter viii., on "other active elements," is a review of the work done upon nitrogen compounds, and also deals with the isolation of active compounds of sulphur, selenium, and tin by Pope and his coadjutors. The first part of the chapter is a survey of cases in which nitrogen is known to show isomerism; the second part is a consideration of the various theoretical explanations put forward upon the configuration of nitrogen compounds. This complex part of the subject would perhaps have been more easy to follow if the author had been able to devote a little more space to the consideration of these theories, but as the references are ample and the book is by no means short, even as it is, Dr. Stewart must be left as the best judge of how much space to devote to each portion of the work. As the author himself says in his preface, stereochemistry is much easier to follow if one has a set of models to work with. It is, in fact, very difficult to study the subject from a book alone, and in Appendix B directions for the construction of stereochemical models are given, one of the simplest methods for making tetrahedra being to cut them out of hard yellow soap, needles being used for bonds.

Steric hindrance is a subject which is very much to the fore at the present time, and one rarely visits a meeting of the Chemical Society without hearing it mentioned. For this reason the chapter on steric hindrance in this book is of particular interest. To a certain extent also interest is added because the author, in connection with his work with Baly upon absorption spectra, has come across facts which in the opinion of the authors are a contradiction to the theory of steric hindrance, Stewart and Baly holding that in the case of the carbonyl group the reactivity is not inherent in the group itself, but depends upon the "nascency" of the radical, this "nascency" being governed by the action of the adjacent groups upon the carbonyl radical. Could not some rather more euphonious name be chosen for the activity of the group than "nascency"? One can perhaps hardly talk about the atomic character of a group; would not activity itself do? It is not unusual to speak of hydrogen, at the moment of its liberation, being in the active form, but one never talks of the "nascency" of hydrogen. Or one might borrow an electrochemical term, and speak of the potential of the group. Thus the potential of hydrogen is high or low, depending upon the surface and character of the electrode from which it is liberated, and the tension or potential of the carbonyl group might be high or low, depending upon the character of the adjacent groups.

Appendix A deals with the relations of stereochemistry to physiology. That the configuration of the groups should affect the physiological action is certainly interesting. Thus when given to rabbits in various ways it was found that in the case of the three arabonic acids more of the lævo- than of the dextro-variety was acted upon, and in the case of the mannoses the dextro-variety appears to be best suited for nourishment. The taste, at any rate to some extent, depends upon the stereoisomeric form; thus in the case of glutaminic acid the dextro-form is sweet, but the lævo-form is tasteless. Furthermore, the toxic action in some cases varies considerably with the different isomeric modifications. For example, *l*-hyoscyamine is almost twice as active in its effects upon the pupil nerve-endings as *dl*-hyoscyamine. This branch of the subject is of great interest, and doubtless the gathering together of these facts will serve to stimulate investigation in this valuable practical part of the subject.

The illustrations are good, some of the half-tone reproductions of models being excellent, and the book itself is well got up. It is decidedly one of the most useful of the series, and Dr. Stewart is to be congratulated upon the completion of a very painstaking work.

F. M. P.

ORIENTAL PLAGUE.

Studies in the Bacteriology and Etiology of Oriental Plague. By Dr. E. Klein, F.R.S. Pp. xv + 301. (London: Macmillan and Co., Ltd., 1906.) Price 12s. net.

THE appearance of this book at the present time is opportune, for plague is ravaging our Indian Empire, some 900,000 deaths having been recorded there from January 1 to May 31 this year. The work is based on Dr. Klein's large experience of the bacteriological examination of cases which clinically and epidemiologically were under suspicion of being plague. Many epizootics among rats on shipboard were also investigated by Dr. Klein, and the results of his examinations are included. The data so obtained, and published in many scattered papers, are thus brought into a convenient form for reference.

In chapter i. a good account is given of the histology of plague lesions and of the distribution of the plague bacillus in the tissues; in chapter ii. the characters of the plague bacillus are described with great fulness, and many valuable hints on staining, &c., will be found here. Dr. Klein believes to be erroneous the view of Calmette that passage of the plague bacillus through a series of animals of a species, while increasing its virulence for that species, diminishes the virulence for other species. The statement is made at p. 29 and again at p. 47 that Hankin described long filamentous modifications of the plague bacillus when the organism is grown on salted media, an observation for which Dr. Klein claims priority. But surely what Hankin did describe was the occurrence of large spherical, spindle- and pear-shaped involution forms on salted media (see *Centr. für Bakt.* xxii., p. 438). Here and in some other places references are omitted, and authors' names are sometimes wrongly spelt, *e.g.* Tideswell for Tidswell, and Simmonds for Simond (p. 154). Chapter iii. deals with the bacteriological analysis of plague material, many valuable practical hints being incorporated, and chapter v. with microbes simulating the plague bacillus. Notable among these are the *Bacterium bristolense* and the *B. myxoides.* The former was isolated from dead rats found on a ship unloading at Bristol, which had come from a plague-infected port. It caused the death of guinea-pigs with a hæmorrhagic septicæmia and enlarged glands, and the bacilli that were present in the lesions were much like the plague bacillus. As a matter of fact, however, cultures showed that the organism was allied to the *B. coli.* The *B. myxoides* was isolated from a case of acute hæmorrhagic febrile disease, which had been notified as possibly one of septicæmic plague. The organism morphologically and in staining properties presented a certain resemblance to *Bacillus pestis*, but it was not pathogenic by subcutaneous inoculation to guinea-pigs and rats, and culturally differed from the plague bacillus. The case was actually one of hæmorrhagic small-pox with a secondary or a terminal infection with this microbe. These examples illustrate the care necessary to diagnose plague bacteriologically. Plague in the rat and in other rodents is discussed in chapters v. and vi. Dr. Klein considers that there may be a type of *B. pestis* occurring in the rat which is less virulent than the ordinary human type. The transmission of plague from one animal to another (chapter vii.) Dr. Klein would ascribe principally to infection by the digestive tract and not to fleas, lice, and other insects, though it must be pointed out that the careful work of Tidswell (Report on the second outbreak of plague at Sydney) and of the Indian Plague Commission (*Journal of Hygiene*, vi., 1906, No. 4) support strongly the latter theory.

Chapter viii. discusses the agglutination reaction and its application to plague; on the whole the test is difficult to apply in this disease, but under certain conditions may be of value. The important subject of preventive inoculation is dealt with in the last chapter but one. The subject of the supposed danger of inoculation during the incubation period is first alluded to, and Dr. Klein remarks that with a prophylactic he has devised there is no risk of this sort. No reference, however, is made to Bannerman's statistics (*Centr. f. Bakt.*, Abt. i., Bd. xxix., p. 873), which seem completely to remove this objection to the use of the Haffkine prophylactic. As the result of his experiments, Dr. Klein says, "I am prepared emphatically to maintain that 10 c.c. of the Haffkine prophylactic is capable of fully protecting a rat against a subsequent lethal dose of living plague culture." Important testimony this to the protective power of the vaccine when India is decimated with plague and the author of the prophylactic treatment is under a cloud in consequence of an unfortunate accident for which we believe he was in no way responsible! Dr. Klein incidentally confirms much of Haffkine's work on the plague prophylactic.

The most interesting portion of this section is that which deals with the preparation of a new form of vaccine material devised by Dr. Klein which consists of an emulsion of the *dried* organs of a guinea-pig dead of plague. The drying deprives the plague bacilli of their vitality, and it was found that 10–15 milligrams of the dried organ powder sufficed completely to protect a rat against a lethal dose of plague bacilli. The final chapter is devoted to a consideration of the modes for the destruction of the plague bacillus, and much useful information on the action of disinfection and disinfectants on this organism is included.

The book, which lacks an index, is profusely illustrated with a number of excellent plates, and we congratulate Dr. Klein on the amount and importance of the work he has done with reference to plague and the plague bacillus. R. T. HEWLETT.

MEMOIRS ON MARINE ANIMALS.

(1) *Anurida.* By A. D. Imms. Pp. viii+99; 7 plates. 1906. Price 4*s.*

(2) *Ligia.* By C. Gordon Hewitt. Pp. viii+37; 4 plates. 1907. Price 2*s.*

(3) *Antedon.* By Herbert C. Chadwick. Pp. viii+47; 7 plates. 1907. Price 2*s.* 6*d.* (London: Williams and Norgate.)

THESE volumes, which form the thirteenth, fourteenth, and fifteenth of the Liverpool Marine Biological Committee's memoirs, are comprehensive studies, admirably illustrated by lithographic plates, of animals common on our shores and readily accessible to the student. The authors and the editor, Prof. Herdman, are to be congratulated on the production of such excellent aids to the study of types of our British marine animals.

(1) Mr. Imms's memoir is a well-arranged and detailed account of the interesting Collembolan *Anurida maritima*, which is common on the surface of the quiet shore-pools and in the crevices of the rocks near Port Erin and at other localities on the British coast. In the description of the habits of the animal attention is directed to the covering of hairs, which, when the animal is submerged, retains a supply of air which serves for respiration (there being sufficient to last the insect five days), and also renders the body incapable of being wetted. Chapters follow on the external characters, integument and coloration, mouth parts, digestive, circulatory, nervous, excretory and repro-

ductive systems and embryology. The author has wisely chosen to describe only the general features of the muscular system; a more detailed account would have been beyond the scope of the present memoir. The ventral tube, characteristic of Collembola, present as a papilliform organ on the mid-ventral aspect of the first abdominal segment, is formed, as is shown by development, by the fusion of a pair of appendages. The various functions which have been ascribed to this organ are set forth. The author records his observations in support of the view that its primary function is that of an organ of adhesion, but he also believes that it plays an important part as a respiratory organ, in virtue of the ease with which blood flows into it and distends its two terminal thin-walled vesicles. He confirms on Anurida the observations of Willem and Hoffmann on other Collembola, that the secretions of two pairs of cephalic glands flow into a ventral groove leading from the head to the ventral tube, which they serve to moisten. In the chapters on the general structure, classification and affinities of the Collembola, the author concludes that there are no grounds for regarding these animals as degenerate; they show affinities with the Thysanura (especially in having a pair of mouth appendages—the maxillulæ—intercalated between the mandibles and first maxillæ), and, by reason of certain generalised features, to the lower Arthropoda. The memoir also contains additional remarks on other marine insects, and an extensive bibliography relating to papers on the Collembola published since Lord Avebury's monograph.

(2) In selecting *Ligia oceanica* for description as a type of the Isopoda, Mr. Hewitt has made an excellent choice, for not only is this the largest British Isopod, but it is intermediate between the aquatic and terrestrial forms. Although specimens are usually found just above high-water mark, in deep cervices of rocks or quay-walls, the author found them at St. Kilda on the top of a hill 450 feet above sea-level, to which altitude the sea-spray often reaches. It was remarkable that most of the examples found at this height were females, which do not descend to sea-level to feed, but probably do so when liberating the young from their brood-pouches, for large numbers of young individuals were found under the rocks between tide-marks, but none at the high level. Following the description of the habits are clear and concise accounts of the external characters, the various systems of organs, and the development. The eyes are described in some detail. In each ommatidium there are two cone-cells, each of which secretes a hemispherical, transparent mass. These two masses, with their flat sides apposed, form the cone on the proximal side of which the cone-cells further produce two subcylindrical accessory cones, an interesting and exceptional feature of the eye of Ligia.

(3) The present volume on *Antedon bifida* is Mr. Chadwick's second contribution to this series of memoirs, his previous one, on Echinus, having been published in 1900. Detailed and useful descriptions, with excellent figures, are given of the various parts of the skeleton and of the three nervous systems and their functions. The other systems of organs and the development are well treated. The author is inclined, but without giving reasons, to regard the sacculi as excretory structures; he holds that the view that they consist of reserve material for use in the regeneration of lost or injured parts is discounted by the fact that sacculi are not present in the allied genus Actinometra, in which, nevertheless, regeneration proceeds quite as actively as in Antedon. The account of the axial organ contains no discussion of the many functions which have been ascribed to it, but the author has observed that, at the breeding season, the epithelial cells lining the tubules of the organ break away and become amœboid, suggesting that at this period, at any rate, the axial organ is a site of formation of amœbocytes.

J. H. A.

A LIFE OF SIR WILLIAM FLOWER.

Sir William Flower. By R. Lydekker, F.R.S. Pp. vii+191. (English Men of Science Series.) (London: J. M. Dent and Co., 1906.) Price 2*s*. 6*d*. net.

IT will be long ere the name of William Henry Flower is forgotten by those in this country who are interested in scientific zoology and in the progress and development of zoological museums; and the sketch of his life and work which Mr. Lydekker has put together in the present volume, a small one indeed, though rich in interesting material, will be much valued by those especially who had the advantage of personal acquaintance with the great museum conservator.

As Mr. Lydekker has indicated in his preface, the present work is more devoted to the scientific than to the personal and social side of Sir William Flower's career. Nevertheless, the opening chapter deals with his birth, parentage, education, marriage, general career, and with his lamented death at the age of sixty-seven, in a manner which is both sympathetic and interesting. The remaining seven chapters are devoted to his work as a scientific worker and as a museum conservator or director, and the value of the work which he performed in both capacities is well brought out by the writer of the memoir.

As all zootomists know, Sir William Flower's original work lay almost entirely in the domain of mammalian anatomy and general classification of mammals, and his name will go down to posterity as the discoverer of many new and important facts, and as the propounder of more satisfactory views on many matters of zoological interest. We need only mention his demolition of Owen's classification of mammalia by their brains; his discovery of the fact that in the marsupial dentition only a single pair of teeth on each side is replaced by vertical succession; or his classification of the carnivorous mammalia according to the characters of the base of the cranium. Everyone knows also that Sir William Flower was a first-class authority on the Cetacea, and that in his later years he devoted much attention to anthropological studies.

In the chapters on Sir William's work as conservator of the museum of the Royal College of Surgeons, as director of the Natural History Museum, and on his museum and miscellaneous work, Mr. Lydekker gives a very clear account of the principles on which that work was guided and of the results achieved. The main lines along which Sir William's ideas of the purpose of museums and of their arrangement ran must be approved by all interested in the subject, although as to some matters of detail there may be room for individual differences of opinion. There can be no doubt of the soundness of the principle that the specimens exhibited in the galleries should, so far as possible, form a distinct collection adapted specially to its purpose of instructing the general public, that old and bad taxidermy should disappear from the cases, that specimens should not be crowded together, but that each should be exhibited with a purpose, instructively or "descriptively" labelled, and placed so that it can be properly seen. How far, however, the principle of making such a popular series rather a collection of "labels illustrated by specimens" than a collection of specimens explained by labels should be carried out is a question which it would be out of place to discuss in a notice like the present, as is also the question as to how far "pictorial mounting" ought to be adopted in natural history museums.

Sir William Flower was a strenuous opponent of the unnatural divorce between recent biology and palæontology. Everyone agrees with him now—theoretically—but how many zoologists will take the trouble to look up and read an original palæontological memoir? If they want information on a fossil subject, do they not usually take it and quote it from some text-book at second hand?

In compiling this memoir Mr. Lydekker has done his work sympathetically and well, and has produced a little volume which is worthy of a place on the book-shelves of all British naturalists. R. H. T.

OUR BOOK SHELF.

Sfere cosmografiche e loro applicazione alla risoluzione di Problemi di Geographia Matematica. By Prof. Angelo L. Andreini. Pp. xxix+326. (Milano: Ulrico Hoepli, 1907.) Price 3 lire.

This little book, as its title implies, shows how a class of simple problems in spherical trigonometry can be solved with approximation by mechanical methods. It is a form of exercise which has fallen into disrepute in this country, but practical computers will admit that there are times when an appeal to the globe is not without its uses. Such cases can occur in the transformation of coordinates, when the conditions of the problem make the choice of a quadrant uncertain. The author, however, is not so much concerned in providing assistance for the expert as in instructing the novice.

After tracing the history of globe construction and showing some forms of orrery which explain the motion of superior and inferior planets, the phases of the moon, &c., the author indicates the principal problems for which mechanical solution is possible. Very considerable ingenuity is exhibited in the choice and variety of problems submitted, and by some simple additional apparatus for measuring angles an approach to accuracy is made. In those problems connected with the diurnal rotation of the earth, the latitude of a place is determined by measurements made on the prime vertical, while in those depending upon the annual revolution about the sun the equation of time and the obliquity of the ecliptic find a place. This will give some idea of the range of subjects for which the author finds application. Indeed, not a little of the interest of the book centres in its completeness. We should imagine that no class of problems to which a globe has ever been applied is entirely unrepresented here. As a matter of fact, there is reference to the tides and the establishment of a port, though it is difficult to see how a globe can give any assistance in such matters. A large number of examples are given to be worked by the student, and in another section the manner of solution is indicated.

Electric Light and Power. By E. E. Brooks and W. H. N. James. Pp. viii+372. (London: Methuen and Co., n.d.) Price 4s. 6d.

The best that can be said of this text-book is that it is neither better nor worse than others of its class. The book is apparently intended as a first-year course for students of not very high scholastic attainments; if this is so, we think it covers too much ground. Starting from the very beginning, with experiments with knitting needles, the student is led to the consideration of dynamos, alternators, and motors. Then follow a couple of chapters on lighting circuits and lamps, a chapter on measuring instruments, and finally one on primary cells and accumulators. We doubt if any student can properly master all this material in a preliminary course. In any case, we are strongly of opinion that it is inadvisable that he should try to do so.

Much has been spoken and written on the question of the interconnection between teaching and manufacturing. We cannot forbear quoting one instance from this book, which shows how desirable closer sympathy is. After a very inadequate description of primary batteries, the authors write in reference to the dry cell:—"Economy in first cost is attained in various ways. For instance, a cell recently examined was found to have a solid block of wood nearly three inches thick between the bottom of the cardboard case and the bottom of the zinc cell." It is nothing short of a travesty of teaching to devote even four lines in a text-book, where space is only too valuable, to conveying this sort of information. The authors must have forgotten the excellent definition of an engineer as one who can do for a dollar what any fool can do for five. We pity the young engineer, nourished on this food, who, when asked by his employer to endeavour to reduce first cost, comes forward with a suggestion of this kind. M. S.

L'Hygiène moderne. By Dr. J. Héricourt. Pp. 311. (Paris: Ernest Flammarion, 1907.) Price 3.50 francs.

This book surveys, in an interesting, readable, and non-technical manner, modern views on hygiene. It is divided into four sections—hygiene of the individual, which includes predisposition, tuberculosis, diet, clothing, exercise, and infantile mortality; hygiene of the home, which includes the house and domestic life; hygiene of communities, schools, &c.; and public hygiene, including that of public vehicles, streets, domestic animals, &c. One of the earlier chapters on the arthritic diathesis would be better suited, perhaps, to a medical text-book, and the author seems to be one of those who hold extreme views on the evils of uric acid. On the question of alcohol, the author believes that good wine or spirit in moderation does no harm, and in many cases is beneficial. The kissing of children is rightly condemned, and the condition of the public streets, with their dust, dirt, and spitting, is characterised as a "hygienic scandal." R. T. H.

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 intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Advancement of Science.

Some weeks ago Sir Oliver Lodge directed attention to the congestion of work in Section A of the British Association at Leicester. Last week Dr. Chree remarked upon the comparative neglect on our part of such scientific subjects as terrestrial magnetism and the local variations of gravity, which cannot be pursued adequately within the walls of a laboratory, but depend upon observations "in the field." In the meantime, Nature has noted Dr. Mill's protest against the scanty opportunity for the discussion of meteorological subjects at Leicester.

My own experience at Leicester supports Dr. Mill's protest. I do not refer to what happened to my own paper. I have no complaint to make against the officers of the section, who, with the rest of us, were victims of an unworkable system. I refer to the proceedings with regard to the papers by Mr. Petavel and his fellow-workers at Manchester on the investigation of the upper air.

Since the meeting, I have learned that the results of the work of the international week at Manchester (the last week in July) were of remarkable interest as showing in an exceptional manner all the characteristic features of the variation of temperature in the atmosphere up to a height of 20 kilometres. The papers were among a large number on the programme for Tuesday, August 6. When I left the section at three o'clock to attend a conference as the delegate of Section A, they had not been reached. When I returned at half-past four I was told that the proceedings of the section for the year had already been concluded, with the usual votes of thanks. Whether the papers had been read in the interval or withdrawn I do not know, nor is it of much consequence. If the only time to be found for a subject of such general interest is after three o'clock on Tuesday afternoon, it is clear that some change is required.

The sectional proceedings on Tuesday opened with a discussion upon new methods of treating observations, an important practical matter for the observational sciences. In the circumstances, it was evidently desirable that the opening paper should be printed *in extenso*; but the recorder pointed out to me, and quite rightly, that such a proposition could not be entertained by the British Association, because the committee of Section A had adjourned for the year on the previous day.

These things do not make for the advancement of science.

I wish, however, to take up the point raised by Dr. Chree, and to emphasise the fact, already too obvious to those who have to do with such things, that subjects like terrestrial magnetism, seismology, atmospheric electricity, and the physics of the globe generally, without any reference to meteorology in particular, suffer very seriously in this country from the congestion of work in Section A.

On the one side, work is done of which the scientific public know little or nothing. Atmospheric electricity is a flourishing study on the Continent; seismology is now the subject of an international organisation with Government support; terrestrial magnetism has called for expenditure on a large scale for an establishment to replace Kew as the normal observatory. It is desirable that the association should know what is going on in such matters.

There are, moreover, a number of departments of Government the work of which has at least its scientific side. Papers of scientific interest could probably be obtained for the asking, from a number of competent workers, by an energetic president or secretary, animated by the meritorious wish to use the meeting of the association to bring the scientific staff of the various departments into touch with the scientific public; but the officials in charge of such work have not the advantage of academic long vacations. The time spent at the British Association must be taken either from short leave or from duty. The matter must, therefore, be treated in a business-like way, which in present circumstances is impossible.

It would be absurd, for example, for a secretary or an organising committee to ask, let us say, the hydrographer of the Navy for a paper on submarine centres of magnetic disturbance, or the Astronomer Royal for a paper on magnetic storms and sun-spots, or any other aspect of the magnetic or meteorological work of the Royal Observatory. There is the paralysing consciousness that the time for reading the papers would have to be looked for in a general scramble between three and half-past four on Tuesday afternoon. What is true with regard to these distinguished public servants is equally true with regard to distinguished foreign workers in science.

There is provision in the constitution of the association for asking competent persons to prepare reports upon recent progress in particular branches of science. The provision is, unfortunately, a dead letter in the subjects mentioned. One reason at least is obvious—there is no time to listen to such reports, however valuable they might be.

It is time that we recognised that the attempt to include in one section with mathematics subjects like laboratory physics, in which workers are many and in constant intercommunication, and subjects like terrestrial magnetism, atmospheric electricity, and other branches of geophysics, in which workers are few and widely scattered, is disastrous for the one class of subjects; and, judging by the way in which a discussion upon so important a subject as the measurement of temperature by radiation was received at Leicester, it is not too successful for the other class.

Some years ago there used to be a subsection for the outdoor subjects, with the not very euphonious title of "Astronomy and Cosmical Physics"—perhaps astronomy and geophysics might be better. It has disappeared—not on account of any want of success while it lasted. It was simply omitted from the South African arrangements. The circumstances which called it into existence have now become more pressing. Laboratory physics has become more radio-active, and the other subjects have extended their operations. The temporary expedient of a special subsection is not now adequate. One special secretary at least is required in the interest of those branches of geophysics which are not covered by astronomy. The occasional treatment of such subjects in a presidential address would be of real advantage to science in this country.

I ask, therefore, the hospitality of the columns of Nature in order to appeal, in the name of the advancement of science, for the establishment of an independent section of the British Association which shall have sufficient time at its disposal to promote the advancement, not only of meteorology, but also of such subjects as terrestrial magnetism, atmospheric electricity, seismology, and geophysics generally. The briefest consideration of the changes which have taken place since Section A was initiated will show that such an appeal is not unreasonable.

W. N. Shaw.

October 12.

On Correlation and the Methods of Modern Statistics.

I regret that the pressure of work associated with the opening of a new session did not permit of my replying to Mr. Hinks last week. His letter (October 3) is so far satisfactory that it gives evidence that one professional astronomer realises the existence of stellar correlation; but Mr. Hinks will have to advance much beyond "scatter diagrams" before he can hope to get much profit out of modern methods. Further, may I suggest that he would be more just to both Miss Gibson and myself if (1) he read her paper carefully, and (2) he did not suppose that, because we approach the subject from a different standpoint from himself, we are of necessity both very ignorant and very foolish?

At the expense of reiteration, I must again refer to one or two facts. There are, in my opinion, three points of much interest in Miss Gibson's memoir:—

(*a*) The correlation of magnitude and parallax is shown to be low; what correlation exists is shown to depend largely on the sinuosities of the regression curve, and not on a uniform decrease of parallax with magnitude. Miss Gibson's values for the seventy-two Newcomb stars are:—Correlation coefficient, $+0{\cdot}1 \pm 0{\cdot}1$; Correlation ratio, $0{\cdot}5 \pm 0{\cdot}1$. For the 173 stars given in the Yale memoir, Dr. Lee has shown that Correlation ratio $= 0{\cdot}28 \pm 0{\cdot}06$.

Now let us see how Mr. Hinks faces such results. In the report of the British Association discussion, published with his approval in the Royal Statistical Society's Journal, he refers, in the *first place*, to the theoretical question, namely, he speaks of the theoretical possibility that the relation between luminosity and distance is controlled by a logarithmic curve, and makes the suggestion that this curve (although referred to several times in Miss Gibson's memoir) had been overlooked by us, and that accordingly she ought not to have used the correlation coefficient, which might screen under such a value as 0·3 the really perfect correlation which would flow from the logarithmic relation. What was the meaning of Mr. Hinks's appeal to the logarithmic curve if he did not at the British Association suppose Miss Gibson's value of the relationship of magnitude and parallax to be an underestimation? If that appeal was made to show that she ought to have used the correlation ratio, then he had clearly not studied her paper before criticising it. The charge made at the British Association is indirectly repeated in the last words of his letter in NATURE, where he talks about the propriety of calculating the correlation ratio, as if it had not actually been given on p. 452 of the memoir. The divergence between the correlation coefficient and the correlation ratio shows the trained statistician that the sinuosities of the parallax-magnitude curve are not solely humps due to random sampling.

Well, let us come to our one point of agreement at present: "Astronomers do not believe that magnitude is closely related to parallax." I am glad Mr. Hinks accepts this view, and I will refrain from quoting the work of some great astronomers to show that it has not always been their opinion. Mr. Hinks states in his letter that I asked for details of the reason for the switchback character of Miss Gibson's diagram of parallax and magnitude. If he will read my letter carefully, he will find I asked for no such thing. I asked for details of *his* reasoning at the British Association that the dips and humps were produced by selection of proper motions, which is an entirely different point.

He said at Leicester:—"The second peak belongs to stars of the fourth and fifth magnitude; they were not representative of the average star of that magnitude, but had been chosen *because of their exceptionally large proper motion*." I very pertinently asked him why this selection had not also been applied to stars of the second to third and to stars of the sixth magnitudes, and further to demonstrate that if it had been thus applied it could possibly have produced the desired effect. To produce an effect on the correlation of A and B by selecting C, a third character, A and B must both be fairly highly correlated with C, and, further, to produce humps we must show that the selection was concentrated at certain points of the range. Mr. Hinks, to give a logical reply, must therefore show:—(1) that parallax and proper motion are highly correlated; (2) that proper motion and magnitude are highly correlated; (3) that the selection of astronomers has been discontinuous along the magnitude range. Instead of proving (3), Mr. Hinks has pointed out that the "humps" in the curve are due to the presence of individual stars of low or high parallax in the special groups, or rather that *some* of them are. Quite so; any statistician knows that with a population of seventy-two the averages of eleven subclasses will be largely influenced by individuals; but the statistician calls this a result of *random sampling*, and does not suggest discontinuous selection by a third variable with a relatively low correlation to at least one of the two characters. Did Miss Gibson, however, lay any special stress on these humps? On the contrary, she says:—"It is possible that a curve of a somewhat complex character—a quartic curve, for instance—might fit the observations." But she concludes:—"Examining Fig. 1, we see that on the present data nothing better than a horizontal straight line at the mean parallax, or a zero correlation coefficient is likely to be found to fit the observations." I think this will show that we laid no special weight on the humps. On the other hand, the high value of the correlation ratio compared with the value of the correlation coefficient does suffice to suggest that astronomers should be cautious about assuming even a moderately low, but continuously descending relationship between luminosity and distance. The rise in parallax of the faintest stars in Miss Gibson's diagram is again manifest in the Yale results, and is probably not due to mere random sampling. The thirty-six stars of magnitude eight to nine in the Yale data have a parallax nearly three times as great as those of magnitude six to seven, which number thirty-one. Will Mr. Hinks assert here again that the former group have been selected by proper motion and the latter have not?

Let me further remind him that the correlation between magnitude and proper motion has not even been mentioned by him in his argument, and yet this vital relationship, for which I have further determinations, is lower than 0·2. Accordingly, it would need a very high relationship between parallax and proper motion to reduce by a proper motion selection the magnitude-parallax relationship to a small value.

(*b*) The second point in Miss Gibson's memoir was involved in the statement that the correlation between parallax and proper motion was "quite significant and important, but not half-way up the scale of correlation" (p. 449). Mr. Hinks says that I am misled by Miss Gibson's results, and asserts that his scatter diagram shows "considerable correlation." Mr. Hinks is an astronomer, and therefore knows the value of exact numerical work. Miss Gibson obtained in her memoir the value 0·4 for the proper motion components. Does he really suppose that his scatter diagram can demonstrate that the value of the whole proper motion correlation is greater or less than this?[1] My estimate, however, was based, unfortunately for Mr. Hinks, not on Miss Gibson's results, but on determinations of the correlations of proper motion and parallax, which involve not only component, but total proper motion. Actually the Newcomb stars exaggerate the result, and the relation between the two characters is sensibly under Miss Gibson's value. Thus for the Yale stars, when we deal with the *whole* proper motion, it is only 0·36. Mr. Hinks says that Miss Gibson "has naturally obtained a smaller result than if she had used the whole proper motion in seconds of the arc on a great circle as is usually done." If Mr. Hinks had studied the subject of correlation a little more fully, he would have known that one correlation is related to the others, and if he had actually worked out the theoretical relationship between them he would not have attributed the lowness of our estimate of the parallax and proper motion correlation to dealing with component instead of total proper motions. The multiplying factor is, I think, $\sqrt{2/(1+r)}$, where r is the mutual correlation of the components $= 0{\cdot}3$.

Mr. Hinks would support his view of high relationship between parallax and proper motion by *selecting* seventeen stars by magnitude, and leaving the reader to form a mental impression of their correlation. He asserted that our results on seventy-two stars were vitiated by selecting by proper motion, yet he does not hesitate himself to select, not seventy-two, but seventeen stars by magnitude. And what is the result even of this selection? Why, that 40 per cent. of the value he reaches for correlation depends upon the fact that he has not sufficiently counteracted the overwhelming influence due to his inclusion of α Centauri in the seventeen! If he leaves this star out (or reduces its influence by introducing another seventeen stars) the value of the correlation differs from Miss Gibson's value by less than the probable error of the difference.

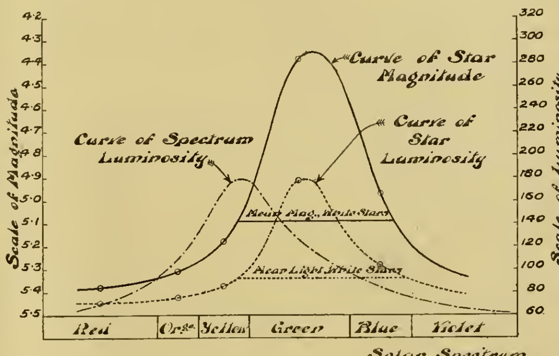
I must now state the conclusion to which I feel myself driven, namely, that astronomers in the near future will not suppose a *very* close, but a "quite significant and important" relationship between proper motion and parallax. The relationship is more intense than that of parallax and magnitude, but, as shown by the Yale data, it is probably less than the value originally fixed by Miss Gibson, and I

[1] For the total proper motion the Newcomb stars give $0{\cdot}58 \pm 0{\cdot}05$.

hold that this relatively low value is the second point her paper has indicated for the first time. Meanwhile, I leave Mr. Hinks to consider whether the proven correlations of both proper motion and magnitude with parallax (under 0·4) have or have not any significant bearing upon the differential method of determining parallax, and upon the fact that more than 20 per cent. of negative parallaxes can be found.

(c) The third point in Miss Gibson's paper was the statement that colours (and probably spectral classes) were more highly correlated with magnitude than distance. Mr. Hinks takes this point as one which will fully justify his criticisms at Leicester. I am of opinion that it is peculiarly a case in which he would have done well to have tempered his judgment by previously asking whether there was no method in our madness. He charges us with three grievous offences:—(1) using a highly selected material; (2) omitting to take into consideration the "white stars"; and (3) deducing from such material sweeping conclusions about the stars in general. He further charges me, *on the basis of this investigation*, with asserting "that colour and magnitude are related at least as closely as parallax or proper motion and magnitude."

In my letter, when making my statement, I made no reference to Miss Gibson's published work, but the fact that I cited the value of the correlation of magnitude and spectral class which is *not* given in the published paper might have warned Mr. Hinks that we held other reductions in our hands. Mr. Hinks asserts that our results would have been modified had we included the "white" stars. Using the 2834 stars of the Harvard Catalogue, of which roughly one-quarter are white ("Annals," vol. xiv.), Miss Gibson worked out more than a year ago the contingency of colour and magnitude; the value was 0·27 (±0·01), as compared with the 0·30 (±0·05) of the list in the Cape Observatory "Annals" previously given by her. Omitting the white stars from the Harvard data, the value is 0·297, agreeing absolutely with the result obtained from the Cape data. Thus we see that Mr. Hinks's suggestion that the Cape Catalogue is worthless, owing to selection of special stars, has no validity at all when we turn to the relationship of colour and magnitude, and, further, the inclusion of white stars produces, as we had logically anticipated, no sensible effect.



But I will go a step further, and reveal another conclusion, which I should naturally have preserved for the present, as the research is as yet incomplete. The mean magnitude of the white stars is almost identical with the mean magnitude of all the remaining truly "coloured" stars; the white star has not a preponderance of any special part of the colour spectrum, and if we wish to investigate the relationship between luminosity and colour we must logically leave out the white stars. The accompanying diagram gives the Harvard stars classed according to colour, with (a) the mean magnitudes of each colour group, and (b) the corresponding luminosity on the assumption that the light of a tenth-magnitude star is unity. It will be seen that the stellar luminosities form a curve very similar to the light-intensity curve of the solar spectrum, but shifted towards the violet end of that spectrum, possibly owing to the fact that the average star is hotter than our sun. On this scale there is clearly no place for the white stars, and the essential feature is that stellar magnitude takes its place in a continuous and definite relation to stellar colour.

I had no intention of anticipating work not yet completed, but Mr. Hinks's contemptuous reference to our omission of the white stars needed to be dealt with. Their inclusion or exclusion makes no difference from the standpoint of the statistical constant; their exclusion is, however, justified by the physical considerations which I have here suggested.

I should wish to say one word, albeit I am afraid it must be a strong one, about Mr. Hinks's further treatment of Miss Gibson and myself. In the paper, to use its own words, a suggestion, "even if it be only of the *vaguest* kind," is made that the bulk of the lucid stars *may* belong to a differentiated system. Mr. Hinks asserts that the basis for "this far-reaching suggestion" is one in which the white stars had no frequency in the record. Will the reader believe that this suggestion, which the writer herself describes as of the "vaguest kind," is not based on the colour correlation at all? Can Mr. Hinks really have criticised the memoir and supposed that even this vague suggestion was based on the 159 Cape stars? The suggestion, such as it is, is based on counts of *all* stars, and results from showing that a continuous curve can be found which describes with remarkable closeness the counts up to the sixth and seventh magnitude, but that beyond this magnitude any formula hitherto proposed fails even approximately to describe the frequency. This result, reached by other investigators, is confirmed by Miss Gibson, and in association with changes in other stellar characters, which occur about the same magnitude, does suggest, I venture to think, that in the vaguest kind of way some differentiation of the stellar system may possibly exist beyond the bulk of the lucid stars. I think Mr. Hinks owes us an explanation of what his statement, that a far-reaching suggestion has been based on stellar statistics from which all white stars have been excluded, really is intended to convey.

In conclusion, may I say that I have learnt from my experience with biologists, craniologists, meteorologists, and medical men (who now occasionally visit the biometricians by night!) that the first introduction of modern statistical methods into an old science by the layman is met with characteristic scorn; but I have lived to see many of them tacitly adopting the very processes they began by contemning. Mr. Hinks is at present in the first stage; but may I remind him that even astronomy owes something to the layman, and express my hope that he may quickly reach a more understanding and sympathetic frame of mind?

Karl Pearson.

Biometric Laboratory, University College, London.

The Body of Queen Tii.

Judging from the letter addressed to Nature of September 26 (p. 545), Mr. Hall (like Prof. Sayce in the *Times* of September 17) has been thrown into a state of doubt in regard to the real sex (? and age) of the mummy supposed to be "Queen Tii" by a letter from Mr. Theodore Davis, calling in question the accuracy of my statement that the mummy supposed to be an old lady of at least fifty years is the skeleton of a young man of about half that age.

Let me give a concise account of what I know in regard to this matter. At the end of June of this year Mr. Weigall, the Government inspector in the Service des Antiquités at Luxor, acting on the instructions of M. Maspero, the director-general of that department, sent me a skeleton to be examined and reported on. The skeleton was practically complete, for, although the face, certain ribs, and part of the pelvis were broken, most of the fragments were sent. Mr. Weigall told me that the bones were found in their coffin in a tomb opened by Mr. Theodore Davis in January last, and that they were supposed to be the remains of Queen Tii. Moreover, he has assured me that no possible mistake could have been made, because he himself and Mr. Ayrton had packed the bones, and they were received and unpacked by me in the anatomical department of the Cairo School of Medicine. The fact that the bones were soaked with paraffin wax, and that no other skeleton is known to have been so treated in Luxor, puts their identity beyond all doubt.

The skeleton is undoubtedly that of a young man of about twenty-five years of age.

It does sometimes happen that a skeleton presents features of such an indefinite character that even the most experienced anatomist hesitates before expressing an opinion as to sex; but these bones do not fall into such a category. All of them, and especially the skull, pelvis, and leg-bones, present the male characteristics in such a pronounced or even exaggerated form that a junior student of anatomy would be considered exceptionally stupid if he failed to recognise the sex. The skull is big and heavy-jawed, the frontal sinuses and superciliary ridges are exceptionally large, even for a man, and the mastoid processes are typically masculine; although the skull is exceptionally capacious, the face is disproportionately big. On the evidence of the cranium alone the sex is obvious.

The pelvis exhibits the most characteristic masculine features. The shape of the pubes and the pubo-ischial rami, the size and shape of the subpubic angle (67°), the form of the obturator foramen, the proportions of the pelvic cavity, and the shape of the iliac bones all conform to the definitely male type. The femur also serves to demonstrate the male sex in its size, inclination of shaft, and size of head.

Mr. Theodore Davis and those who have disseminated extracts from his letters have dealt rather unfairly with the two medical men, whose opinions they quote, in giving such wide publicity to statements which could have been made only in the most casual manner by anyone with any medical training whatsoever. It is so absurd as to be altogether incredible that "a prominent American obstetrician" would quote the figures 90° to 100° for the female subpubic (misquoted "pelvic" by Prof. Sayce and Mr. Hall) angle, and 70° to 75° as the average for this angle in the male, with the object of demonstrating the *female* sex of a pelvis *the subpubic angle of which is only* 67°!

But, quite apart from the very obvious male characters of the skeleton, there are even more obtrusive features equally fatal to the possibility of it being Tii's, which could hardly have escaped the observation of a medical man, however casual.

The teeth are practically unworn; three of the "wisdom" teeth had just been "cut," and the fourth was only just emerging from the jaw at the time of death; and a large number of epiphyses on ribs, vertebræ, clavicles, sternum, and pelvis were either separate or in process of joining. In other words, the bones are clearly those of a person of about half the age Queen Tii is known to have reached.

The archæological and historical remarks in Mr. Hall's letter do not concern me.

In a short time I shall publish a full account of this skeleton, with photographs exhibiting the evidences of sex and age, and the points of similarity and dissimilarity to the mummies of Amenhotep III., Yuaa, Thua, Thothmes IV., and perhaps some other royal mummies of the eighteenth dynasty.

G. ELLIOT SMITH.

Anatomical Department, The School of Medicine, Cairo, October 4.

The Interpretation of Mendelian Phenomena.

ALTHOUGH it is impossible within the limits of a short letter to attempt an answer to the question of the bearing of "Mendelism" upon biological problems in general, there are one or two points in Dr. Archdall Reid's letter in NATURE of October 3 which seem to require discussion.

Dr. Archdall Reid begins with the following statements:—"Mendelian phenomena are possible only when reproduction is bi-parental. They cannot occur, of course, when it is parthenogenetic." In the first of these statements the expression "bi-parental" should not be taken too literally, since in the majority of cases of Mendelian inheritance investigated hitherto the method of so-called self-fertilisation has been employed. I hope I may be pardoned for the assertion that the second statement is a little premature. For my own part I shall certainly await the result of experimental evidence upon the point before accepting it as conclusive.

In the absence of Dr. Archdall Reid's definition of what he means by "the problem of sex," I am not sure that I entirely understand the remainder of his first paragraph; but the suggestion may be made that "the function of sex," "the causation of variation," "retrogression of characters," and "mode of development" are less immediately to the purpose in the present condition of biology than the problems of the actual method of transmission of existing characters. Upon the problem of the "alleged transmission of acquirements" Mendel's facts may even be said to throw some light; but in any case it seems rather severe treatment to belittle the importance of a biological discovery merely because it does not immediately lead to the solution of all the most difficult problems which biology affords.

Once more it must be repeated that the appearance of a blended first cross is no criterion of non-Mendelian inheritance. In the case of a problem like that of man, complicated as it is by the fact that he has "crossed more often than any other animal," and further rendered intractable by the circumstance that he is not amenable to experiment, a great difficulty arises in discovering which are the actual allelomorphs concerned. For these natural characters pay no heed to our definitions; so that if an investigator makes the mistake of first rigidly defining the "characters" with which he proposes to deal, and does not keep a perfectly open mind, prepared to revise his definitions in the light of the evidence which experiment alone can afford, he runs a great risk of finding only confusion where a proper analysis would have shown the presence of perfectly definite methods of inheritance. It would be extremely interesting to students of genetics to learn upon what evidence Dr. Archdall Reid bases his positive statement that there is no segregation in the case of the mulatto.

There is certainly occasion for surprise in finding it maintained that "nature selects only mutations"; but that natural conditions lead to the obliteration of a host of mutations is as fair a deduction from the fact that such mutations appear under cultivation as the current deduction that the conditions of cultivation actually cause the occurrence of this kind of variation. We have the testimony of de Vries and others that the former process actually takes place. That the latter process does so is an assumption which still lacks the support of facts.

R. H. LOCK.

Botany School, Cambridge, October 7.

The Colour of Dye Solutions.

IT is generally accepted that the colour of dye solutions depends upon the chemical structure of the dye, and colour changes are usually attributed to some change in constitution; but certain recent investigations on colloidal solutions show that this argument must be accepted with caution. It is well known that colloidal solutions of the metals are highly coloured. Further, it is recognised that many dyes exist in solution in what, for lack of a better term, must be called the colloidal state. Some observations of my own point to the following statement as being true for certain dyes:—

The absorption spectrum of the dye in solution may be either (*a*) a characteristic absorption, consisting of one or more narrow bands and depending on the chemical structure of the dye molecule, or (*b*) a "resonance" spectrum due to colloidal particles, and much more remotely connected with chemical constitution. This spectrum is ill-defined.

The detailed experiments which have led to these conclusions will be communicated in a paper shortly to be published. A word or two is desirable in explanation of the term "resonance" spectrum. By this is denoted the type of absorption exhibited by colloidal metal solutions, glasses, and certain photographically prepared films (F. Kirschner, *Drude's Annalen*, 1904, xiii., 239; Kirschner and R. Zsigmondy, *ibid.*, 1904, xv., 573; K. Schaum and E. Schloemann, *Zeit. wiss. Phot.*, 1907, v., 109). It is probable that all absorption is due to resonance, no doubt, and hence the narrow-band type (*a*), but in this case the resonators would be the molecules or the contained electrons, whereas in case (*b*) the resonance of larger aggregates is the cause of the absorption.

The investigation is to be continued, but a striking case was found in one of the pinacyanols, a class of dyes recently introduced as photographic sensitisers. This dye gives in aqueous solution a flattish, ill-defined absorption, the solution showing all the characteristics of a colloidal solution. In alcohol and organic solvents the absorption was of a narrow-band type, entirely different, and *this spectrum was also obtained by heating the aqueous solution to boiling point.* The behaviour was quite analogous to that of starch, which gives crystalloid solutions at the boiling point. S. E. Sheppard.

Phys. Institute, Marburg a. L.

The Convection Explanation of Electrolysis.

At p. 12 of a recent text-book entitled "Electrochemistry," by Prof. R. A. Lehfeldt, the author mentions the convection explanation of electrolysis, and states that "Faraday was sufficiently impressed with it to form the hypothesis of *ions*, *i.e.* of charged particles in the liquid travelling under the action of the electric force."

So far from being impressed favourably by this "explanation," Faraday considered it might have a "dangerous influence" and "do great injury to science by contracting and limiting the views of those engaged in pursuing it." He therefore constructed his terminology of electrolysis specially to get clear away from this "explanation."

Again, Faraday did not form a "hypothesis of ions as particles." The word ion refers to the nature of the substance evolved at the electrode, not its dimensions. The ion of Faraday might weigh an ounce or a ton.

The opinions which the modesty of the great observer permitted him to express may be found in the seventh series of his "Experimental Researches." To attribute to him for any purpose, other opinions absolutely alien to these is, I submit, either scientifically reprehensible or grossly careless. J. Brown.

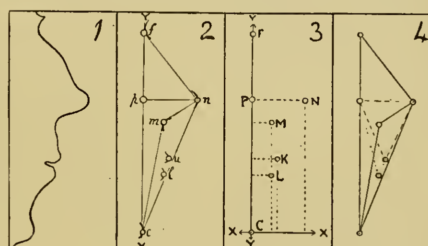
Belfast, August 18.

CLASSIFICATION OF PORTRAITS.

Experiments of various kinds that I have made to define the facial peculiarities of persons, families, and races by means of measurement led to the following results that seem worthy of publication. The most elementary form of portrait will alone be considered here, namely, the outline of the face from brow to chin, as in a shadow or in a silhouette. It contains no sharply defined points whence measurements may be taken, but artificial ones can be determined with fair precision at the intersections of tangents to specified curves. It will be shown that it is easy to "lexiconise" portraits by arranging the measurements between a few pairs of these points in numerical order, on the same principle that words are lexiconised in dictionaries in alphabetical order, and to define facial peculiarities with greater exactness than might have been expected.

The individuality of a portrait lies more in the relative positions of six cardinal features (see the figures below) than in the shapes of the lines that connect them, so long as the general character of the connecting lines is roughly indicated. A few standard types, perhaps ten in all (though I prefer to use more), represent as many concave, convex, and sinuous varieties of outline, between each specified pair of the six cardinal points, as need to be noted. I may recur to this in a future letter.

This will be apparent to the reader's satisfaction if he compares portraits under unfavourable conditions, as through a blurring medium, or out of focus; or, again, if he substitutes connecting links that differ somewhat from the true ones. Consequently my first endeavour was to define accurately six points that should severally be good representatives of the six cardinal features in the outline. Those features the limits of which are vague are expressed by *italic* letters in Fig. 2, and their representative points by the same letters in *capitals* in Fig. 3. The features are these:— *c*, the tip of the chin; *l*, the lower, and *u*, the upper lip; *m*, the hollow between the upper lip and the nose; *n*, the tip of the nose; *f*, the hollow between the nose and the brow. In order to find their respective representative points, proceed as shown in Fig. 2, by drawing (upon tracing paper) a tangent, YY, to both *c* and *f*. Then draw a short tangent to *n* parallel to YY (accidentally omitted in the Fig.). A tangent to



both *c* and *n* intersects the first of these lines at C and the second at N, and determines them. A line drawn from N tangential to *f* determines F. Thus the fundamental triangle CNF is obtained, in which YCFY is used as the axis of Y, and the length of CF (divided into 100 equal parts, here called "cents") determines the scale of measurement. In the life-sized portrait of an adult, 1 cent may be regarded as roughly equivalent to $1\frac{1}{4}$ mm. or to 1/20th of an inch. M, and consequently the triangle CMN, is determined by the intersection of one line drawn from C with another from N, both tangent to *m*. U and L lie at the intersections of tangents drawn in either case, parallel to X and CN respectively. They require less attention than the preceding letters, because *u* and *l* are usually small.

The positions of the six cardinal points may be expressed in either of two ways—(1) as in Fig. 3, by rectangular coordinates, YCY being the axis in Y, and XCX perpendicular to it, the axis in X. Or (2) as in Fig. 4, by triangulation. Here an additional line, NP, drawn perpendicularly from N to YCY, is convenient. I have compared both of these methods, and found each to have its advantages and disadvantages, depending on many variable causes, of which the scale of the portrait is one and the available instrument is another, and am inclined on the whole to prefer the method of coordinates.[1]

In my experiments I have chiefly used the side-view portraits by George Vance, R.A., of his distinguished contemporaries, published in 1809 (2 vols., folio, Longmans), which yielded sixty-eight pure profiles of about one-third the natural size. I lexiconised these in respect to the measures (entered to the nearest cent) of the two coordinates of N and M respectively (4 measures in all), and found, first, that no two of the numerical formulæ were the same, and, secondly, that in two-thirds of them the *smallest* difference between the most nearly resembling pairs was 3 cents in one or more of the four measures. This conspicuous difference, equivalent to between 1/6th and 1/7th of an inch in a portrait of the natural size, could never be due to the inherent imperfection of the art of measurement, but to some gross blunder. It follows that the collection of sixty-eight portraits was lexiconised with remarkable precision. The data were insufficient to enable me to speak with much assurance of the gain that would accrue from taking L and U into additional account, but their correlations with C, M, N, and F, seeming to be very small, the gain ought to be great. I am content to underrate this gain considerably, and to allow only fifteen-fold for it. On that basis a collection of 1000 profiles from brow to chin could be lexiconised and searched with great ease. In 667 cases each portrait would have a clearly distinctive formula; in the remaining 333 there would be doubtful duplicates, and even triplicates, just as in any list of the names of 1000 British persons there would be more than one Smith.

In the report of a committee appointed by the Secretary of State in 1894 (C. 7263, price 10*d.*) to inquire into the best means available for identifying habitual criminals, the following remark appears on p. 18:—"An enormous amount of time is spent in examining the books of photographs. It will be seen from the figures furnished by Chief Inspector Neave that on March 1 last twenty-one officers searched for twenty-seven prisoners—the total time spent being $57\frac{1}{2}$ hours—and made seven identifications. This was an average of more than two hours for each prisoner sought for, and more than eight hours for each identification." A similar search in a lexicon of portraits of the same size would occupy apparently fewer minutes than the above occupied hours.

I will go no further now into the results of my experiments than to say that I have applied the above method to portraits of persons of very different races, and have thus far found it efficient in all of them.

FRANCIS GALTON.

[1] In some cases brevity is very desirable, and may be obtained by regarding only the limits within which the variability of each link most commonly occurs and by dividing the interval between those limits into 8 equal parts. Then 0 would signify all measures below the lower limit, and 9 all above the upper one. The range of the rectangular coordinates to N and M within the limits above explained varies between 12 and 20 cents, so the value of each of the eight equal parts will vary from $1\frac{1}{2}$ to $2\frac{1}{2}$ cents according to the coordinate in question. These "parts" are more suitable for classification than cents, which are too small to be quite trustworthy. But I will not go further here into this question than to add that the 8 rectangular coordinates of M, N, L and U can be described in this way by only 8 figures, and the connecting outlines CL, LU, UM, MN, NF by 5 (or say 10) more, so that a portrait can be expressed (say be telegraphed) in a rude but recognisable form by only 13 (or 18) figures.

WEIGHTS AND MEASURES REGULATIONS.

THE new regulations, which came into force on October 1, apply only to weights, measures, and weighing instruments used for the purposes of trade. They are in some respects rather less stringent than the preliminary draft issued by the Board of Trade in August, 1906, a review of which appeared in these columns last year.

There are but few points of scientific interest in the regulations. Specific instructions as to temperature are now given for the first time to inspectors of weights and measures. Measures of length are to be verified by comparison with a local standard at or near the normal temperature, which is 62° F. for imperial measures. For imperial measures of capacity the standard temperature of their water contents is also 62° F.; for metric measures of capacity it is 4° C.; but metric measures graduated at 15° C. or 60° F. may also be verified for chemical or pharmaceutical purposes, or for volumetric estimations. Measures marked with the temperature at which they are graduated must be tested against measures standardised at the same temperature. An apothecaries' measure, marked with equivalents in weight, is permitted, provided that the words "of water" are marked on it in addition to the denomination.

Certain restrictions are placed upon the weighing instruments to be used by dealers in precious metals or precious stones, retail chemists or druggists, and silk merchants. These traders are permitted to use three kinds of weighing instruments, the first kind being chemical and assay balances provided with means for relieving all the bearings and knife edges, the second being beam scales of a lower order of sensitiveness and accuracy, which must be marked "Class B," and the third being instruments other than beam scales which satisfy the requirements for Class B. The first and third of these types of instruments are not to be marked with a "class."

The requirements of Nos. 69 and 78 of the regulations, prohibiting adjusting contrivances which are not permanently fixed to the weighing instrument, will render some kinds of analytical and assay balances ineligible for official stamping in the future. Traders who use such balances should be careful not to keep them upon their trade premises if unstamped, otherwise they may be liable to forfeiture if they come under the notice of an inspector of weights and measures.

Counter weighing machines of the "accelerating" type are prohibited by the regulations. It is often difficult to distinguish between a vibrating and an accelerating instrument, especially when these are sluggish or have been in use for some time. The requirement prescribed in No. 68 of the regulations that the machine shall balance when unloaded will, however, be sufficient in general to determine this point. When the machine is unloaded, if either of the pans be pressed down and then released, the beam will be set in oscillation about its horizontal balancing position, if the instrument is of the vibrating type; but if the instrument is accelerating, it will be found that one or other of the pans when pressed down will remain down, and the beam, failing to oscillate, will rest out of balance.

Spring balances are somewhat rigorously dealt with, but, on the whole, the Board of Trade has taken a fairly lenient view with respect to these instruments in permitting them to be used for ordinary trade, rather than restricting their use to such purposes as the weighing of postal parcels and passengers' luggage, as is the case on the Continent.

Weights, measures, and instruments at present stamped and in use, but which do not comply with the new regulations, may be continued in use for certain prescribed periods, and, with the exception of a particular type of spring balance, may be re-stamped from time to time.

Appendix 2 contains a useful list of all the denominations of weights and measures which are at present legal in this country. It will be seen from this list that weights of $\frac{1}{4}$ grain, which are frequently employed by chemists in compounding drugs, are not legal for use in trade.

ANCIENT KHOTAN.[1]

DR. M. A. STEIN'S promised scientific publication of the material gathered by him during the course of his first expedition to Chinese Turkestan has now appeared, and has been awarded the distinction of being published by the Clarendon Press, and so under the auspices of the University of Oxford; and worthily: for the importance of Dr. Stein's archæological discoveries is great. The significance of his finds will be found fully explained in two articles which appeared in NATURE on the occasions of the publication of Dr. Stein's first "Preliminary Report" (1901) and of his popular book, "Sand-buried Ruins of Khotan" (1903), which gave so good a general account of his work. It is therefore unnecessary to go over the same ground again now, and we can confine ourselves to a consideration of the fine volumes before us.

The Clarendon Press has produced the book in sumptuous style. The form of the broad page and the size of the type are both good and pleasant to read. The title-page is quite a work of art; as a specimen of a modern title-page with good type, well-sized and well spaced, it is worth seeing. The only fault we can find in the general get-up of the book is that the photographs in the first volume are printed on paper that is somewhat too thin and flimsy, with the result that the half-tone blocks have a somewhat cheap appearance which does not agree well with the fine appearance of the rest of the book.

FIG. 1.—Remains of dwelling completely eroded; Niya site. From "Ancient Khotan."

The same may be said of the first eighteen plates of the second volume, which contains the great body of the illustrations. In one of these also (plate iii.) the upper picture has been printed upside down, which is a pity. But to the rest of the plates nothing but unqualified praise can be given; the coloured ones are very good, especially those reproducing textiles.

From these plates the remarkable character of the art of Niya, Yotkan, and Dandan-Uiliq, having the chief "find-spots" in their chronological order, can easily be grasped. Especially interesting are the wooden remains from Niya, and the pottery and little clay *genre* figures from Yotkan. The strength of the classical tradition which came from Greece to India, and thence to Chinese Turkestan, is very evident to us as we turn over these pictures. Plate lxx., too, shows wooden chair-legs in the shape of the foreparts of sphinxes, with a headdress that reminds us of the triple horn above the heads of Assyrian bulls. Why not? Niya's art came from Gandhāra, and Gandhāra's from Seleucia on the Tigris. The analogy of these excavations to those of Egypt is well shown in such a plate as No. lxxiii., which presents to us antiquities in the shape of musical instruments, carding combs, brooms, hoes, &c., of the same kind as those that may be found on an Egyptian site. In both countries the dryness of the soil preserves objects that elsewhere would long since have perished.

The Kharoshthi letters on wooden boards, and the Chinese written slips found with them, also have a very Egyptian look, and we have a strange note of connection in the Judæo-Persian document written on paper, which was found at Dandan-Uiliq, but which, so far as its language and appearance are concerned, might just as well have been found at Oxyrrhynchus! After all, Tabaristan, where it was written, is not so much farther from the banks of the Nile than from those of the Tārīm. And in the reign of Trajan, long before this document was written, the great Chinese general, Pan-ch'ao, advancing ever westwards from Ch'angan (Si-ngan-fu, then the capital of China), had reached the Caspian, and tried to open up relations with the Romans. So that many a merchant may even in the first century A.D. have known the banks of the Nile, Tigris, Oxus, and Tārīm equally well, and we can well comprehend how classical art influenced that of China by way of the civilisation of which Dr. Stein has discovered the remains in Turkestan.

Dr. Stein's letterpress is very copious, since he includes in his work long dissertations on Chinese and other literary evidence as to the identification and history of the ancient places which he has found. When we say that his success, and that of his coadjutors, in this interesting work has been striking, we do not err; and, on the other hand, several of

[1] "Ancient Khotan; Detailed Report of Archæological Explorations in Chinese Turkestan, carried out and described under the Orders of H.M. Indian Government." By M. Aurel Stein. Two vols.; text and plates. Pp. xxiv+621; pp. vii+119. (Oxford: Clarendon Press, 1907.) Price 5l. 5s. net.

Dr. Stein's finds have amply confirmed the statements of the Chinese official records, especially with regard to the period of the isolation of the "Four Garrisons" of Turkestan after the Tibetans had driven a wedge northwards into the dominions of the T'ang, in the eighth century A.D. To this period belong the ruins of Dandan-Uiliq, while those of Niya, which show the most marked classical characteristics, are five hundred years older. It is at Niya that we find a document sealed with a Chinese and a Greek seal side by side!

The Tibetan evidence contained in graffiti (which Dr. Stein for some reason insists on calling "sgraffiti": "sgraffito-work" is something quite different) at Dandan-Uiliq and Endere is curious. We have apparent references to defeats of the Chinese: "At Pyagpag in the province of Glom-lom this army fought, and a tiger's meal was obtained (*i.e.* many were killed)"; followed by the savage remark, "Now eat until you are fat!" apparently an incitement to go and kill more Chinese. These Tibetan graffiti have been translated by Dr. Barnett, of the British Museum, and Dr. Francke, of Leh; from the transcripts of them and of the

FIG. 2.—Intaglio of a Greek Goddess. From "Ancient Khotan."

Buddhist sutras in Tibetan, also found by Dr. Stein, the curious reader can gain an idea of the sounds of the extraordinarily hideous Tibetan language, which would seem to have served as the model for Swift's Glumdalclitch, Brobdingnag, the Struldbrugs, and the rest of the names in "Gulliver's Travels," not excepting "Houynhnhnm."

The Chinese graffiti are translated by the great French Sinologist, Dr. Chavannes; and Prof. E. J. Rapson, of Cambridge, has begun the translation of the Kharoshthi letters of the Indian maharajas who ruled Khotan in the third century B.C., and of their officials and dependants. Chinese rule seems to have been maintained contemporaneously with that of the maharajas; but what powers were specially reserved to the latter we cannot quite see from this correspondence. Dr. Stein's new discovery (1907), that the Indian kingdom stretched away east to beyond Cherchen and Charkhalik to the Lop-nor, is of great historical importance.

For the details of Dr. Stein's exhaustive description of his discoveries we must refer the reader to the book. The congratulations of all archæologists to all concerned in its making go without saying. And not least congratulatory should be modern Chinese and Japanese literati, to whom the Chinese documents and antiquities of the Former Han and the Great T'ang dynasties should prove of the greatest interest.

H. R. HALL.

INTERNATIONAL METEOROLOGICAL COMMITTEE.

A MEETING of the International Meteorological Committee was held at Paris on September 10 and following days.

The committee consists of seventeen members, appointed at the conference at Innsbruck in 1905. Ten members were present, including the director of the Japanese service. Two places were vacant by death. The principal subjects discussed were the scheme of organisation of international meetings for meteorological purposes; marine charts and weather signals; a number of items of the international daily weather service, including reports by wireless telegraphy; and various propositions concerning the meteorology of the globe, in which were included one on the necessity for observing stations in the regions of centres of action of the atmosphere, another on the necessity for new charts of isotherms for the globe, and a third on the desirability of daily observations from selected stations, in order to trace the course of meteorological changes over the globe.

A number of special commissions were appointed to report upon, or carry out, the various proposals. M. Mascart, president of the committee, was unfortunately prevented by illness from attending the meetings with the exception of one held at his house for the discussion of the question of international organisation. At the close of the session he resigned the office of president, and Dr. Shaw, director of the British Meteorological Office, was elected president. M. Angot, M. Mascart's successor at the Bureau Central, takes his place also as a member of the committee. Dr. Hellmann, director of the Prussian Meteorological Institute, was elected secretary, in succession to Prof. Hildebrandsson, who retires upon his withdrawal from the post of director of the Royal Meteorological Observatory at Upsala. Dr. Hamberg, director of the Swedish Meteorological Office, was elected to succeed Prof. Hildebrandsson as a member of the committee. The other vacant places were filled by the appointment of Dr. Maurer, director of the Swiss office, and Mr. Stupart, director of the Canadian office.

NOTES.

WE notice with regret the announcement made in a Reuter telegram from Paris that M. Loewy, director of the Paris Observatory, and a member of the Academy of Sciences, died there on Tuesday, October 15.

AT 1.17 a.m. on October 11 the Cunard liner *Lusitania* arrived at Sandy Hook, having crossed the Atlantic in 4 days 19 hours 52 minutes. The total distance travelled was 2780 nautical miles, and the average speed was 24·002 knots. The highest day's run was 617 nautical miles.

REUTER'S correspondent at Mombasa reports that Dr. Koch, who has been examining the causes of sleeping sickness, left for Germany on October 15. His investigation camps in Uganda have been taken over by the colonial authorities. It is understood that Dr. Koch's investigations have not led to any fresh discoveries.

THE Peking correspondent of the *Times* reports that an Imperial Edict issued on October 9 orders the Board of Revenue and Commerce forthwith to introduce a uniform system of weights and measures throughout the Chinese Empire, the standards to be fixed within six months.

A remarkable long non-stop railway run was achieved by the Great Western Railway on September 16. A special excursion train, carrying only third-class passengers, the total load weighing approximately 148 tons, was run from Paddington to Fishguard, a distance of 263½ miles, without a stop, at an average speed of 53 miles an hour.

On October 12 the Clifton (Bristol) Scientific Club celebrated its twenty-first anniversary by entertaining Sir William Ramsay and other past members, when Sir William, who was one of the founders of the club, delivered an address on the recent history of chemical science and on the nature of matter. On the previous evening he visited Clifton College, where he gave an account of the experiments by which argon and other gases of the atmosphere were discovered.

We learn from the *Pioneer Mail* that a large meeting was held at Rangoon on September 19 to consider the establishment of a Pasteur Institute in Burma. It was resolved that the institute should be established at Maymyo. A committee was formed with powers to undertake measures preliminary to the formation of the institute. The subscriptions already amount to 80,000 rupees, which secures the success of the movement. Other subscriptions have been promised, which will be sufficient to enable the institute to start on a wide basis.

The announcement that bison are about to be taken from the Zoological Park in New York to Kansas reminds one of the carrying of coal to Newcastle. In the great plains of the Middle West, however, the encroachment of population has practically made these animals extinct. The zoological collections in the east are now to be drawn upon to re-establish, in the Wichita reservation, herds of sufficient size to ensure their permanency.

An exhibition has just been held in Boston, U.S.A., to illustrate the precautions that should be taken against tuberculosis. It included a representation, side by side, of two sleeping-rooms, with arrangements favourable and unfavourable respectively to the growth of the disease. There were also exhibits of tents for open-air treatment. A lecture on hygiene was given during the exhibition.

An exhibition promoted by Lady Aberdeen, as president of the Women's National Health Association of Ireland, with the object of educating the people on the great danger of tuberculosis, was opened at Dublin by the Lord Lieutenant on October 12. The exhibition is intended to be an object-lesson to teach people certain facts contained in Blue-books and the Registrar-General's reports. Its primary object is to reach the women of the country, and to bring these facts home to them as guardians of the home. In opening the exhibition, the Lord Lieutenant read the following message from the King:—"I am commanded by the King to express his good wishes for the success of the Tuberculosis Exhibition, the first of the kind ever held in Great Britain and Ireland, on the occasion of its being opened by you to-day. His Majesty is greatly interested in the problem of checking the progress of this disease, and he trusts that the exhibition may be the means of attracting the attention of the public to the terrible ravages caused by this scourge and to the efforts which are now being made to arrest its progress.—Knollys." After the exhibition has closed at Dublin it will be taken to various parts of Ireland, where lectures will be delivered upon it.

In connection with the indication by the London County Council of houses in London which have been the residences of distinguished individuals, a memorial tablet was, on October 7, erected on 88 Mile End Road, E., where Captain Cook, the circumnavigator, resided at one time. It is probable that his removal to this house took place in 1764, and his wife continued to reside there for some time after his death in Hawaii in 1779. The house does not appear to have been re-built since Captain Cook's tenancy, but it has been converted from a private dwelling-house into business premises by the erection of a shop on the forecourt. The tablet is of encaustic ware, terra-cotta in colour, and bears the following inscription:—"Capt. Cook, 1728–1779, Circumnavigator, Lived Here."

Reference has previously been made in these columns to the progress effected by the Congo authorities in the task of domesticating the African elephant. A recent visitor to the State establishment at Api writes as follows:—"Owing to an unfavourable season no attempt has been made to increase the number of elephants under training. The number in the colony at the present time is twenty-five, of which nineteen are employed in different kinds of work. During the four months of the wet season the elephants are not merely not worked, but are even allowed to rejoin those in a wild state—that is to say, they are turned out into the forest, but they seem to keep apart. They, however, attract some of the wild elephants to the vicinity of the establishment, but these are generally too old and intractable to provide useful recruits. On resuming the regular routine they manifest no indisposition to work, and submit themselves freely to the discipline of the establishment. The African elephant is of short stature, the young elephants at Api averaging from 4 feet 4 inches to 5 feet 7 inches at the shoulder."

The report of the Departmental Committee appointed to inquire and report as to the nature and extent of the benefit accruing to British arts and industries from the participation of this country in great international exhibitions, which has just been issued as a parliamentary paper (Cd. 3772, price 7*d*.), is a document of great interest. The committee found that the evidence it received went to show that international exhibitions are of little use to the textile and other great staple industries of the country. The committee is, however, in favour of the continued participation of this country in all really important exhibitions, owing to the indirect advantages resulting. One aspect of exhibitions to which it is considered that considerable importance should be attached is the effect which they have in encouraging national emulation and in stimulating individual exhibitors to improve their productions. Interesting examples of the effects which particular exhibitions have had on the development of different industries will be found in the evidence of Sir William Preece, K.C.B., Mr. Bennett Brough, and other witnesses. Sir William Preece attributes to the Paris Exhibition of 1881 many of the most important developments of the electrical industry. The exhibition at Paris of certain high-speed tool steels by an American firm is said by Mr. Bennett Brough to have contributed in a large degree to the development of what has become a British industry of great magnitude; and an exhibit by the Courrières Colliery Company, at the mines of which the death-rate from falls of roof was abnormally low, has since led to considerable improvement in the methods of timbering employed and a consequent decrease in the death-rate. The report concludes with important recommendations for securing in future continuity of organisation from exhibition to exhibition, and more effective representation of this country at any exhibition in which the Government may decide to take part.

In the September issue of the *Annals and Magazine of Natural History*, Mr. G. E. Mason describes the remains of a supposed new fruit-bat from Round Island, near Mauritius. The remains, which occur in a guano-deposit, appear to be very recent, and in the October issue of the same journal they are referred by Dr. K. Andersen to an existing species.

Articles on spermatogenesis in the water-beetle (*Dytiscus marginalis*), with remarks on the nucleolus, by Mr. W. D. Henderson, Carnegie research fellow at Aberdeen, and on the embryonic development of *Taenia serrata*, by C. von Janicki, of Basle, appear in *Zeitschrift fur wissenschaftliche Zoologie*, vol. lxxxvii., part iv.

Nos. 1558, 1559, and 1561 of the Proceedings of the U.S. National Museum are devoted to new echinoderms from the North Pacific, Mr. C. L. Edwards describing holothurians in the first of these issues, while free crinoids are discussed by Mr. H. H. Clark in the second and third. Attention is directed to the brilliant and varied colouring of the feather-stars of the multicolour group of Antedon, which exceeds that of all other crinoids. For classificatory purposes this colouring is, however, useless.

The colouring of the interior of the mouths of nestling perching-birds offers, according to Mr. W. P. Pycraft in *British Birds*, No. 5, an almost unknown field of investigation. It is suggested that the bright-coloured membranous margins of the gape are intended as a guide to the parents in feeding their offspring. In addition to this, the interior of the mouth in most nestlings is bright yellow, occasionally marked with black (hedge-sparrow) or white (bearded titmouse) spots on the tongue and palate, and it seems that this bright colouring attains its highest development in nestlings reared in deep shade. If this be confirmed, it seems obviously connected with the feeding process.

The greater part of vol. viii., No. 1, of the Journal of the Marine Biological Association is taken up with descriptions of various organisms collected in August, 1906, by the *Huxley* during a cruise on the north side of the Bay of Biscay. Among these, the most interesting is a second specimen of *Corallium maderense*, this genus of alcyonarians being previously unknown from the area in question. The axis, or "coral," is white, hard, and semi-translucent; and, although not likely to command a high price, in the opinion of Prof. Hickson, this coral might prove, if found in sufficient quantities, to have a marketable value.

In an article on the harm caused to the vision of school children by their studies, published in the *Popular Science Monthly* for July, Prof. W. D. Scott remarks that "the human eye which had been evolved for distant vision is being forced to perform a new part, one for which it had not been evolved, and for which it is poorly developed. The difficulty is being daily augmented. The invention of printing presses has been followed by an increasing number of books, magazines, and daily papers. . . . All things seem to be conspiring to make us use our eyes more and more for the very thing for which they are the most poorly adapted. It requires no prophet to foresee that such perversion in the use of an organ will surely result in a great sacrifice of energy, if not of health and of general efficiency." Certain mitigations of the evil are suggested in the case of young school children.

To the October number of the *Century Magazine* Prof. H. F. Osborn contributes an illustrated article on his experiences in the Fayum district of Egypt while in search of fossil vertebrate remains, with remarks on the nature and origin of the fauna and its bearing on the geographical distribution of mammals. Among the illustrations, special reference may be made to Mr. C. B. Knight's restorations of Arsinoitherium, Hyænodon, and Zeuglodon. In Eocene times the Fayum, in the author's opinion, was a savanna country, partly open, partly covered with scrub, and partly with forest, the temperature being much the same as at the present day. That Africa (when much less extended to the north than at present) was the home of the ancestral proboscideans, sea-cows, hyraxes, and probably hyænodonts, Prof. Osborn is fully convinced; but the absence in the Eocene deposits of remains of ancestral hippopotamuses, ruminants, horses, and rhinoceroses leads to the inference that "none of these quadrupeds had as yet reached Africa; that they were evolving elsewhere, either in Europe, Asia, or North America, and preparing for the great interchange of life which would occur when Africa should again be connected with the other continents." In referring on p. 824 to the *emus* of New Zealand, the author doubtless intended to write *moas*.

In vol. xx., part i., of the Proceedings of the Royal Society of Victoria, Prof. R. J. A. Berry reproduces a photograph of an aged half-caste Tasmanian woman now living on Kangaroo Island, South Australia. She is the daughter of a pure-bred Tasmanian woman by a European husband, and was born on the island about seventy-five years ago. In colour, as well as in her wide nostrils and mouth, weak chin, and dark eyes, she retains strong evidence of her Tasmanian ancestry, but her hair, although distinctly woolly, has departed somewhat from the aboriginal type. The latter is, however, better displayed in one of her daughters, who is, of course, a quarter-caste. The author believes "Mrs. S." to be the oldest surviving half-caste Tasmanian. Prof. Berry accepts the view that the Tasmanians were a branch of the Papuans, and that they reached Tasmania at an early period across Australia, when the continent had a direct land connection with Tasmania. Various cases have been known along the coasts of southern Australia of hybrids between Australian and Tasmanian aborigines, doubtless due to Tasmanians having been carried across Bass Strait by the sealers. The same number of the Proceedings contains a paper by Messrs. Chapman and Pritchard on fossil fish remains from the Australian Tertiaries; it describes seven new species, which are referred to genera which range in time from the Jurassic to the present. There is also the sixth of Prof. Ewart's contributions to the flora of Australia, and a paper by the same author on the movement of the soluble constituents in fine alluvial soils.

The theoretical articles in the fourth part of vol. v. of *Biometrika*, issued in September, include a note by Mr. Francis Galton on "grades and deviates," with a table giving the deviations in the normal curve corresponding to assigned percentiles; this table is due to Mr. W. F. Sheppard, who also contributes a memoir on the calculation of moments. Mr. A. P. di Cesnola gives an account of an investigation as to the action of natural selection in *Helix arbustorum*, by the method of the late Prof. Weldon, shells being ground so as to expose a longitudinal section of the spiral on which measurements can be made, and the frequency distributions compared for the earlier whorls in young and adults. The results show that there is markedly less variation in the adults, and consequently some periodic selection. The records of Prof. Weldon for inheritance in mice are reduced and discussed, so far as regards sex-ratio and size of litter; there is little, if any, inheritance in either case, but the figures exhibit some peculiarities. The remaining articles include investigations by Prof. F. Y. Edgeworth on the average time of absence of wasps and bees from the nest, by Miss Wright, Miss Lee, and Prof. Karl Pearson on the wing dimensions of wasps (*Vespa vulgaris*), and by Dr. J. Brownlee on means of estimating the severity of attack in cases of acute disease. There are a few miscellanea, and a bibliography of literature on biometry and Mendelism relating chiefly to issues of 1906.

On the subject of apogamy in the fern genus Nephrodium, Mr. S. Yamanouchi communicates a preliminary notice of his cytological investigations to the *Botanical Gazette* (August). In the normal gametophyte of *Nephrodium molle* sixty-four or sixty-six chromosomes were counted, and the double number in the sporophyte. In the apogamous developments, the sporophyte was followed from an initial cell, the nucleus of which contained the smaller number of chromosomes, and the same number was found throughout all the stages of the sporophyte.

The first two numbers for the current year of the *Journal Botanique* of the Imperial Society of Naturalists in St. Petersburg contain two papers by Mr. A. Elenkin on lichens. In the earlier he describes three new lichens for the genera Evernia, Aspicilia, and Lecania, all collected in Russia; in the later he discusses the comparative amount of growth in erect and horizontally growing species of close affinity. The description of a new species of Eremurus from China derives its chief interest from the fact that, as the author, Mr. O. A. Fedtschenko states, this is the first record of that genus from China, and a considerable extension of its distribution south-eastwards beyond the previous limit in or near Nepal.

Mr. C. E. C. Fischer contributes to the *Indian Forester* (August) a list of host plants of various species of Loranthus and Viscum observed in the North Coimbatore Division of Madras. It is stated that these parasites are most frequent in dry, deciduous forests at elevations between 3500 feet and 4500 feet, where practically every tree is attacked. The occurrence of one parasite growing on another parasite is recorded. The method of exploiting the trees of *Terminalia Chebula* for their fruits, the myrobalams of commerce, is described by Mr. J. E. C. Turner. The sound fruits become ridged when they are dried in the sun, and the pericarp becomes exceedingly hard; others do not wrinkle, owing to the decomposition attributed to a fungus of part of the mesocarp into a black powder that has a small value for making ink. For sowing, the damaged fruits are preferable, since germination is not hindered by a hard pericarp.

Within recent years an algal disease, known as the "red rust" of tea, caused by *Cephaleuros virescens*, one of the Chroolepidæ, has become a serious pest in the tea districts in India. Dr. H. H. Mann and Mr. C. M. Hutchinson, scientific officers to the Indian Tea Association, after following the course of the disease for some years, have published an account of their observations in the botanical series of the Memoirs of the Department of Agriculture in India (vol. i., No. 6). The growth on the leaf, being usually confined to the surface, would be unimportant, except for the fact that the sporangia there formed provide the means for the spread of the disease. This is effected either by transference of the sporangia as a whole or of the zoospores. The real danger is due to the penetration of the young stems of the tea plant by the alga, when, if the alga prevails, the leaves turn white and the stems are killed.

It is well known that tide curves show that, in addition to waves of very short duration due to wind, and those caused by the regular flow and ebb of the tide, pulsations sometimes called "marine seiches" or "vibrations of the sea" occur, with periods of fifteen to twenty minutes, but differing considerably in various localities (see Nature, January 12 and April 20, 1899). In the *Annuario* of the R. Nautical Institute of Catania, Sicily (vol. i., 1907), Prof. Giovanni Platania contributes an interesting paper on the subject, with the results of some fresh researches made by himself in the Gulf of Catania. Opinions differ as to the origin of these vibrations, which are observed under different meteorological conditions; the author thinks that the principal cause is variations of atmospheric pressure. The micro-barograph recently devised by Dr. Shaw and Mr. Dines for recording the minor and sudden fluctuations of the atmosphere will probably help further to elucidate the phenomenon.

The current issue of the *Central* (vol. iv., No. 12) contains an interesting account of research work carried out recently in the electrical department of the Central Technical College. There is also a well-illustrated description of the cyanide process for the extraction of gold and silver from their ores, written by Mr. Reginald Krall.

The British South Africa Company has issued a copiously illustrated monograph on Rhodesia, covering 120 pages. It contains much information for travellers generally, and for sportsmen in particular. The illustrations have been admirably reproduced, and the five coloured maps are excellent. The volume should prove of special use to teachers as a class-book.

The mode of formation of many placer deposits is not clearly understood, and the source of the gold has not been definitely determined. In view of this uncertainty, a recent paper by Mr. J. B. Tyrrell in *Economic Geology* (vol. ii., No. 4) is of special interest. He describes the conditions that prevail in the Klondike district of Canada, a country of exceedingly rich gold-bearing placers, where the origin and processes of deposition and concentration of the gold into its present position are easily recognised. His investigations show that the district owes its phenomenally rich placers, not to the wearing down of highly mineralised gold-bearing veins, but rather to the favourable conditions of long-continued and uninterrupted concentration from a great mass of rock that contained only very minute quantities of gold.

Three valuable monographs have been issued by the Corps of Mining Engineers of Peru. In *Boletin* No. 51 Mr. F. M. Santolalla describes the mineral resources of the province of Huamachuco. The mineral deposits may be divided into three groups, the veins in eruptive rocks, such as the gold veins of the Toro, the lead-antimony-silver ores of Cerro Negro, and the magnetic iron ores of San Pascual and Potosi de Serpaquino. The coal deposits of the province have been known from time immemorial. In short, the mineral resources might be worked with great advantage if better means of communication were available. In *Boletin* No. 52 Mr. H. C. Hurd investigates two schemes for diverting the waters of the Rio de

Lambayeque. Lastly, in *Boletin* No. 54 Mr. G. Klinge gives the mineral statistics of Peru for the year 1906. The production included 79,969 tons of coal, 70,832 tons of petroleum, 20,226 tons of salt, 2598 tons of borates, 1830 tons of sulphur, 230 tons of silver, 13,474 tons of copper, 2568 tons of lead, 2304 kilograms of mercury, and 1247 kilograms of gold.

M. A. PELLETAN, in the October number of the *Journal de Physique*, expresses his regret that in France there is so much difficulty in finding persons capable of determining the elements of an optical instrument by any of the modern methods. It seems singular that in a country through which a knowledge of mathematics is more widely spread than elsewhere, that knowledge should find fewer practical applications than it does in almost any other country. M. Pelletan suggests the formation of a Government office to which engineers whose knowledge or leisure would not allow them to cope with mathematical difficulties might bring their problems for solution. In the meantime, he gives a clear *résumé* of the general methods of treating geometrical optics which have been developed from Hamilton's characteristic function. These methods are not so well known in this country as they deserve to be, and we have not yet risen to the point of regretting our want of knowledge of them.

THE measurement of the angle between the optical axes of a biaxial crystal has always played an important part in the identification of the crystal, and several methods of making the measurement are in common use. There has, however, been little comparative or critical study of the accuracy of the different methods under different conditions. A considerable portion of the *American Journal of Science* for October is devoted to such a study from the pen of Mr. F. E. Wright, of the Carnegie Institution. During the course of his experimental work, Mr. Wright has constructed a double-screw micrometer ocular with the screws at right angles to each other which he uses to determine the position of any point on the interference figure produced when a thin plate of the crystal is examined in plane polarised convergent light. By this means he is able to obtain more accurate results than were possible with the ordinary micrometer in Becke's method. He advocates the use of the stereographic projection in preference to any other.

AN interesting account of the processes recently devised for liquefying air on an industrial scale, and for extracting oxygen directly from the liquefied product, is contained in an article by Prof. E. Mathias in the *Revue générale des Sciences* (No. 17, p. 697). Particular attention is directed to the method of liquefaction developed by Claude, in which the principle of expansion with the performance of external work has been adopted with remarkable success. The process patented by Thrupp in 1898, and that described by Linde in 1901, are also described. The problem of separating air into its constituents oxygen and nitrogen, which has formed during the past few years so prominent a goal for the endeavours of engineers of all countries, is dealt with at somewhat greater length, the many schemes suggested being considered in detail. Such success has attended the efforts made to separate the gases of the air industrially by liquefaction that the expenditure involved in preparing 1 kilo. of pure nitrogen on the large scale has fallen below a penny. The article is illustrated by nineteen drawings showing the principle of the various types of plant in use.

A SEVENTH and enlarged edition of the translation by H.R.H. Princess Christian of Prof. Friedrich Esmarch's "First Aid to the Injured," with additional illustrations, has been published by Messrs. Smith, Elder and Co., at 2*s*. net.

NEARLY half of the thirteenth edition of Mr. W. H. Harling's illustrated catalogue of mathematical drawing instruments is new matter. Every requirement of the architect, draughtsman, and student appears to be anticipated. The needs of teachers of practical mathematics have been borne in mind, and considerable space is given in the additional pages to particulars concerning instruments for measuring with precision lengths, angles, and other dimensions.

MR. H. K. LEWIS has published a third edition of "Hygiene and Public Health," by Dr. Louis C. Parkes and Prof. Henry R. Kenwood. The present work grew out of Dr. Parkes's "Hygiéne, or Public Health," which appeared in 1899, and was reviewed in NATURE of January 30, 1890 (vol. xli., p. 290). A certain amount of new matter has been introduced into the present edition, but some parts of the previous issue have been compressed and abbreviated. The size of the page, too, has been slightly enlarged.

A FIFTH edition of the late Prof. P. G. Tait's well-known "Properties of Matter" has been published by Messrs. A. and C. Black at 7*s*. 6*d*. The work appeared first in April, 1885, and was reviewed at length in our issue of August 6, 1885 (vol. xxxii., p. 314), by Lord Rayleigh. The present edition has been edited by Prof. W. Peddie, of the University College, Dundee. The recent advance of physical science has necessitated some additions, but these have in every case been placed within brackets and initialed by the editor, so that the original plan of the book has been preserved.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—A telegram from the Kiel Centralstelle announces the discovery of a new comet by Mr. Mellish on October 13. Its position at 16h. 0m. (Madison-Wisconsin M.T.) on that date was R.A. = 8h. 31m., dec. = 9° 24′ S., and the comet was moving slowly in a north-westerly direction.

This position lies between one-quarter and one-third the distance from ι to C Hydræ, and the comet is apparently travelling towards Canis Minor. At present it rises a little to the south of east at about 2 a.m., and crosses the meridian at 7 a.m.

SUN-SPOT SPECTRA.—At the June meeting of the Royal Astronomical Society, Prof. Fowler announced that he had found a terrestrial origin for the numerous short, hazy lines, known as "band" lines, in sun-spot spectra which have hitherto remained unorigined. These lines, it now appears, are part of an extensive "fluting" spectrum ascribed by Liveing and Dewar, in 1881, to a compound of magnesium and hydrogen (Proc. Roy. Soc., vol. xxxii., p. 190), and investigated by Sir Norman Lockyer.

The brightest fluting begins near λ 5211, and fades off towards the violet; a second includes the well-known hazy spot lines at λλ 5163·2, 5160·1, 5156·8, &c., whilst others begin at λ 5620 and on the violet side of Hβ. A comparison of the laboratory wave-lengths obtained by Prof. Fowler with those observed in the sun-spot spectrum places the identification beyond doubt, and it is estimated that probably several hundreds of the sun-spot "band" lines will be found to agree, in position, with those occurring in the laboratory spectrum (Monthly Notices R.A.S., vol. lxvii., p. 530, June).

Q

The Red Spot on Jupiter.—Mr. Stanley Williams publishes his observations of the Great Red Spot during the most recent opposition of Jupiter in No. 4202 of the *Astronomische Nachrichten* (p. 23, September 30). He records the spot as being as faint as ever it was, and the observing conditions, especially at the commencement of the opposition, were very poor. The rotation period satisfying the observations is 9h. 55m. 42·27s., from 594 rotations, and the longitude is $20°{\cdot}87 \pm 0°{\cdot}23$.

Mr. Williams directs attention to the abbreviated rotation-period which obtained between the oppositions of 1905–6 and 1906–7; during the former it was 9h. 55m. 41·46s., whilst in the interval it was 9h. 55m. 36·25s. This difference is too great to attribute to errors of observation, and indicates a real change in the spot's position. Observations lead to the conclusion that this change of position is in some way due to the large mass of dark material known as the Pyramid Spot, or South Temperate Disturbance, for on three occasions such changes of position have synchronised with the passage of the Disturbance past the Red Spot. The general discussion of a large number of observations of this phenomenon may, as Mr. Williams suggests, throw considerable light on the nature, and possibly the mass, of the Red Spot.

The Proper Motions of Stars in the Cluster Messier 92.—In No. 4165 of the *Astronomische Nachrichten*, Dr. K. Bohlin compared some measures of the stars in the cluster Messier 92, made on an astrographic plate taken at Stockholm in 1898, with those made by Schultz at Upsala in 1873, and found discordances which were attributed to proper motions during the intervening twenty-five years.

Prof. Barnard has had this cluster under observation, with the 40-inch Yerkes refractor, for some time past, and in No. 4202 of the same journal he discusses his observations with the view of testing the theory of proper motions. A comparison of the three sets of measures leads him to the conclusion that the existence of actual proper motions is very doubtful, for the cases of agreement are practically equal in number to those in which the measures do not agree. In a second paper he compares the definite measures made by Schultz of the stars in the bright part of the cluster with those made by himself, and definitely expresses his confidence in the opinion that the discordances are not due to proper motion, but rather to the uncertainty of the measured positions. The knowledge that such uncertainty existed led Prof. Barnard to undertake visual micrometer measures of various clusters with the 40-inch refractor, and he hopes to publish the results of the work in the course of the next twelve months.

The Dominion Observatory, Ottawa.—From notes in the current Journal of the Royal Astronomical Society (Canada), vol. i., No. 4, p. 264, July-August, it is evident that valuable results may be expected from the investigations now being carried out at the Dominion Observatory, Ottawa. The new spectrograph is performing very satisfactorily, and with the one prism gives spectra of first-type stars, in which $H\beta$, $H\delta$, $H\epsilon$, and $H\gamma$ are accurately measurable; $H\gamma$ was the only hydrogen line usable on the earlier spectrograms. Seven spectroscopic binaries are under regular observation, and, in addition to the results already published for α Draconis and ι Orionis, it is hoped that the provisional elements of four other binaries will soon be completed. A new method, a modification of Hartmann's, has been applied to the reduction of the plates with considerable accuracy and a great saving of labour. Experiments, having for their object the production of a flatter field, are being carried out, and it is hoped to obtain a field of 8°, instead of the 2° or 3° at present available. A 6-inch first-quality plane grating has been supplied by Dr. Brashear for use with the cœlostat telescope in solar research. Dr. R. G. de Lury, Mr. R. M. Motherwell, and Mr. J. N. Tribble have been appointed to the staff for work on solar research, micrometer observations, and radial-velocity determinations respectively.

The Perseid Meteors.—A watch for Perseids was kept at Greenwich from August 10 to 13, but very few brilliant meteors were seen, the display, on the whole, being considered a very poor one. The actual numbers of meteors bright enough to be plotted were twenty-seven on August 10–11, sixty-four on August 11–12, and eight on August 12–13. On the last-named night clouds interfered with the observations, but the other two nights were quite cloudless (*Observatory*, No. 387, p. 366, September).

BOTANICAL CONGRESS AT DRESDEN.

The German Botanical Society has this September celebrated its twenty-fifth anniversary at Dresden under the presidency of Prof. Schwendener, who justly emphasised the promptness of publication and value of the contents of the society's journal. Owing possibly to the wording of the invitation to members to contribute papers to the meeting, only one communication was made, by Dr. Winkler, on parthenogenesis in plants. The same botanist aroused great interest, and a short but lively discussion, by exhibiting a growing plant obtained by grafting *Solanum nigrum* with a tomato variety, and by encouraging, to the exclusion of other buds, a composite bud, arising at the point of contact and fusion of the two plants. The resulting shoot shows, from node to node upwards, especially well seen in the leaves, alternately, right and left, the characteristics of each plant. The term "graft-bastard" proposed was objected to by many. No doubt more will be heard of the specimen if it forms flowers. Prof. Bower and Colonel Prain were elected honorary members of the society.

In the earlier part of the week (September 8–15) the Society of Applied Botanists and that of the Systematists held their meetings. The applied botanists were present in force, and many important papers were read. The society by resolution agreed to urge on the Government the necessity of making better provision in many of the technical colleges for botany in its various branches. A few weeks previously the professors in the universities and technical colleges met to form a union, one object of which is to secure greater freedom of action and less Government interference, without, however, loss of Government funds.

Ule's finely illustrated account of the flora of the Brazilian province of Bahia, Hiltner's soil-bacteria investigations, and Lindner's beautiful mould cultures, were outstanding features of this part of the meeting. The systematists made a delightful excursion to the Bohemian Mountains (Rollberg, &c.) to compare their varied flora with the more uniform flora of the Elbe sandstone. On the basaltic Rollberg *Asplenium septentrionale*, *Woodsia Ilvensis*, *Ribes alpinum*, *Allium strictum*, and many other interesting alpines were obtained.

In the following week the German Society for the Advancement of Science and Medicine met also in Dresden. The botanical section was strongly represented under the presidency of Prof. Pfeffer, who contributed a paper on sleep movement in plants, Wettstein one on the phylogeny of the angiosperm flower, Molisch one on ultra-microscopic organisms, while Prof. Drude gave a demonstration in the botanic garden of his cultural work on *Cucurbita Pepo*. He showed a well-established hybrid between *C. Pepo* and *C. institiia*, the fruit having the mottled colour of the latter, the size and form of the former. Throughout Prof. Drude and his assistants, Drs. Schorler, Naumann, and Schwede, did everything possible to ensure the comfort of visitors and the success of the meetings. The forestry school and arboretum at Tharandt were visited; but, owing to sudden illness, Prof. Neger was unfortunately absent. Nobbe's Seed Station, formerly at Tharandt, is now at Dresden under Dr. Simon's direction. The botanical garden at Dresden, though small, shows many interesting features. There are groups illustrating geographical distribution, *e.g.* plants characteristic of South Africa, Australia, &c. The illustrative plants throughout the garden are kept small to economise space. By using differently coloured labels, the periods of introduction into European cultivation of our garden plants are indicated.

T. J.

WATER AND ICE, TO-DAY AND IN THE GLACIAL EPOCH.

MR. G. K. GILBERT'S survey of the Niagara Falls (see NATURE, vol. lxxv., p. 607) is not to stand alone. In the "Summary Report of the Geological Survey Department of Canada for 1905" (Ottawa, 1906) Dr. J. W. Spencer promises a full account of the Niagara district, which he is agreeably confident will reveal "discoveries of the greatest importance" (p. 91). Soundings have been made in the gorge below the falls, in areas previously untested, and wells have been sunk to prove the depth of an interesting buried channel, filled with glacial drift.

In contrast with this region of attractive turmoil and erosion, Mr. T. W. Kingsmill takes us to the lower Hwangho, in China, where the river "is prevented by the laws of hydraulics from excavating its bed, and has in consequence to flow on the surface" ("The Hydraulics of Great Rivers Flowing through Alluvial Plains," Shanghai, North China Herald Office, 1906). If once this great body of water effects a breach in one of its banks, it "shows no disposition, when the flood subsides, to return to its bed, but invariably finds some easier course to the sea." The Hwangho, according to Mr. Kingsmill's interesting historic sketch, broke its right bank in 1854, and from that date to 1870 wandered over a wide stretch of country, depositing a layer of sand from 6 feet to 8 feet thick. In Horan, not far from Mangtsin, 250 feet of river-alluvium, thoroughly pervious to the water above it, were passed through in sinking for a coal mine. Much of the drainage thus reaches the sea by underground channels, and the main river actually diminishes in volume below Mangtsin. The extensive deposits that are forming in the Gulf of Pechili, at the rate of 208,000 tons per day (p. 31), increase the difficulty of controlling the river in the interior. We learn that fishermen on stilts may be met with out at sea miles before the low coast is sighted. Mr. Kingsmill's suggestions for correcting the stream are enlivened by the printing of a discussion of them by Mr. Tyler. Mr. Kingsmill proposes to continue banking up the river; Mr. Tyler would organise floods at selected points, and let the river build its huge conoidal plain under proper supervision. The silt would then be disposed of in an orderly manner, and the river-bed would cease to rise. The titanic struggle of man with the Colorado River (NATURE, vol. lxxv., p. 501) suggests, however, that Mr. Tyler's dumping-grounds might at times get more water and less silt than they were prepared for.

There are many districts that have been assailed by diluvial flooding and deposition in comparatively recent times, where now desiccation has set in, with the accompaniment of the formation of löss and sand-dunes. The extremely uncomfortable conditions that prevailed in Europe at the close of Glacial times are shown by Prof. Steinmann to have been paralleled in South America ("Uber Diluvium in Süd-Amerika," *Monatsberichte d. deutschen geol. Gesell.*, 1906). The author believes that the vast extent of fluvio-glacial deposits, which have filled up the hollows of the Cordillera and spread so freely over Patagonia, can only be accounted for by a series of glacial epochs. He sees, moreover, in the level expanses of calcareous mud round the salt-lakes of Bolivia and Argentina the evidences of former fresh-water lakes, in which Bythinia flourished. "The traces of the last ice-age may be followed across the equator as far as Cape Horn." The climatic differences that prevail at the present day are now shown to have existed, both in Europe and South America, during the melting of the last ice-sheets; and "hence we shall do well to discard all attempts at explaining glacial epochs that are not of a universal character."

In a paper furnished with an abstract in French ("Till Fragan om Ost-Finmarkens Glaciation och Nivåförändringar," *Bull. Comm. géol. de Finlande*, No. 18, 1907), Herr V. Tanner describes the course of the ice in Finmark in glacial times as being from S.W. to N.E., and traces the variations in the sea-level by observations on terraces cut in the rock and on gravelly raised beaches. While the ice was melting from the land, the continental mass was rising, and thus offered a more and more extended front to the action of the waves.

While the terminal tongues of glaciers in Alberta and British Columbia have not in all cases shown a marked retreat in recent years, Messrs. George and W. S. Vaux prove that the ice-masses have become greatly reduced (*Proc. Acad. Nat. Sci. Philadelphia*, December, 1906, p. 568). The Illecillewaet Glacier has withdrawn about 250 feet in eight years; but its annual rate of recession is becoming slower, and its rate of flow is now actually greater than in 1899. Conical moraines appearing through the ice on the Wenkchemna Glacier (p. 577) are witnesses of the immense amount of ice removed in recent times by surface-melting.

FIG. 1.—Margin of the Malaspina Glacier, August 11, 1906, showing mingling of moving ice-blocks with trees still in leaf.

The famous Malaspina Glacier of Alaska has, however, started on a new career. Prof. R. S. Tarr ("Second Expedition to Yakutat Bay, Alaska," *Bull. Geographical Society of Philadelphia*, January; see also *Bull. Geol. Soc. America*, June) describes the rapid and unexpected changes that are taking place in it, and in certain other glaciers close to its eastern margin. Crevassing has occurred in previously quiescent and moraine-covered masses, accompanied by a marked advance. Prof. Tarr found that the alder and cottonwood trees growing on the Malaspina Glacier developed their leaves in 1906, but were then in part swallowed up and over-ridden by the active ice. The scene of visible movement, with falling trees and ice-blocks, and sliding soil from the moraines, is paralleled by the attack of the adjacent Atrevida Glacier on its marginal forest. Other glaciers as yet have not been influenced; and Prof. Tarr refers these remarkable movements to the shaking of the district by the earthquakes of 1899, or even of some earlier date. The fall of masses of snow into the gathering-grounds would thus have taken seven years to influence the ice-front; but the author points out that the crushing of the resisting masses in the lowlands is just what might be expected from a sudden addition of snow to the reservoirs in the hills. Changes of level, moreover, amounting to as much as 47 feet, took place in Alaska in 1899, and these may in part account for local variations. The description of the broad alluvial fan of the Hayden Glacier, with its streams changing in position and depth from day to day, is impressively interesting, as an illustration of the rate at which our own "glacial gravels" may have been distributed.

Perhaps Prof. Tarr's remarkable but modest paper will be hailed by M. Edouard Piette as an argument in favour of his more startling views ("Déplacement des Glaces polaires et grandes Extensions des Glaciers," Saint Quentin, 1906, pp. 36). M. Piette attributes the glacial climate of the northern hemisphere to the release of ice-masses by earthquakes at the pole. He urges that this would be assisted by the uprush of volcanic vapours and hot springs along the fissures, while cataclysms like that of the Straits of Sunda would fling the ocean waters irresistibly against the polar ice-cap. The Atlantic continent from Ireland to Iceland fell in about the same time by an "affaissement définitif," and the whole ice sped southward, leaving the pole for a time free. We confess that we can read M. Piette's paper far more sympathetically, now that we have the advantage of Prof. Tarr's conclusions; but there is a whirl of death and horror about his description of the great catastrophe that reminds us of the old diluvial theories, to say nothing of Dante's second circle. We read, moreover, that icebergs nowadays (p. 6), running aground on the coasts "d'Irlande ou d'Ecosse, y déterminent des froids intenses, capables de geler la végétation." Such a phenomenon would attract thousands of excursionists, and would surely be mentioned in our veracious daily papers.

The erosive power of glaciers is clear, wherever joints or any other planes of division in a rock are so arranged as to slope up against the direction of movement of the ice. "Plucking" then becomes a feature of the district. But, even on ice-smoothed surfaces, signs of rock-fracture under the pressure of the glacier are occasionally found. Prof. G. K. Gilbert discusses these "crescentic gouges" (*Bull. Geol. Soc. America*, vol. xvii., 1906, p. 303) as due to the presence of subglacial boulders. A line of type omitted on p. 313 renders one of the sentences obscure; but the argument put forward is that ice must have "greater power of resistance [to flowage] than some students have been disposed to admit. . . . The more rapid the flow the stronger the resistance. Therefore the crescentic gouges . . . may testify also to the relative rapidity of glacier movement." Prof. Gilbert's photographic illustrations are excellent, as are those of subglacial potholes in a subsequent paper on moulin work (*ibid.*, p. 317), in which it is pointed out that such moulin-hollows may be bounded during their formation on one side by rock and on another by the ice, leaving a rock-surface with flexuous incurvings when the glacier has disappeared by melting.

Prof. R. S. Tarr ("Glacial Erosion in Alaska," *Popular Science Monthly*, vol. lxx., 1907, p. 99) discusses the broader features of glacial erosion as displayed in hanging valleys. He postulates, in common with other writers, a considerable deepening of the main valley by ice; but may we not presume that the lateral valleys were largely developed and cut back by the frost-nibbling, under glacial conditions, on which Profs. Penck and Davis lay such proper stress? A main valley, with feeble lateral tributaries, may be occupied up to a certain level by ice, which widens it, deepens it somewhat, and wears back the poorly developed projecting spurs. The lateral valleys are at the same time rapidly weathered back under the new and more strenuous conditions of high-level erosion, and rocky cirques are formed at their heads in place of confluent stream-grooves. Tributary ice gathers in each lateral hollow, and the erosion above it, and also below it where a rushing stream emerges on the crevassed main glacier, cannot operate below the level where the two masses unite; and finally, if melting is rapid, hanging valleys are left, which will in time be cut down by ordinary weathering to the level of the main valley-floor. If the main glacier diminishes by ablation slowly, the tributary glaciers and their subglacial streams cut down their valleys to keep pace with the falling surface, and these valleys finally cease to be of the hanging type, though showing glaciated floors. This seems to have been the case in much of central Connemara. This is not the place, however, to attempt to modify the theory of the deepening of glacial valleys so brilliantly put forward by Prof. W. M. Davis. Suffice it that Prof. Tarr disposes successfully of several of the fantastic theories put forward to account for a phenomenon of very wide occurrence in glaciated areas.

In the *Verhandlungen der schweizerischen naturforschenden Gesellschaft*, St. Gallen meeting, 1906, pp. 261–307, Herr J. Früh, of Zürich, writes a general essay, "Ueber Form und Grösse der glazialen Erosion," illustrated by personal observations on the topography of Switzerland. Hanging valleys, Alpine lakes, and "Uebertiefungen" are discussed, and useful references are given to Davis, Penck, and Brückner.

Lastly, we must not forget the work of water in its immense circulatory systems below the surface. The investigation of the "Underground Water Resources of Alabama," by Mr. E. Allen Smith (Geological Survey of Alabama, Montgomery, Alabama, 1907), has provided us with a neatly bound volume which is in many ways a guide to the geology of the State. The conditions favouring underground flow and the emergence of springs are discussed in pp. 32 to 63 in a manner that will interest engineers in general, as well as the ordinary citizen between the Tennessee River and the Gulf of Mexico. The great region for artesian water-supply in Alabama lies along the band of Cretaceous limestone, the Selwa Chalk, which passes just south of Montgomery. Several medicinal springs occur among the Tertiary strata towards the Gulf, including one (p. 320) that has been said to give protection against malarial fever.

G. A. J. C.

ENDOWMENTS FOR SECONDARY EDUCATION.

WHILE writing this article the following questions have been in mind:—(1) What are the number and extent of the educational endowments of our great public and other endowed schools? (2) What were the intentions of their founders? (3) How far are such intentions at present realised? (4) Can the endowments be made more generally available so as to increase their benefit to the public with the minimum departure from those intentions?

The answer to the two latter questions must be that it is largely a question of degree; from the nature of the case an expression of opinion, not a precise estimate, is all that can be attempted. The first two questions relate to definite matters of fact, the answers to which *ought* to be ascertainable, but are only approximately to be determined. A better reply to (1) would be forthcoming had either the late or the present Government fulfilled their promises to obtain a return, to be presented to the House of Commons, giving statistics of the finance of all endowed schools. We are informed that the Charitable Trusts Division of the Board of Education is considering the details to be sought in such inquiry, and it is to be hoped that considerations of its cost will no longer be allowed to stay its fulfilment. In the meantime, the following condensed account, based on such materials as were obtainable, is submitted as calculated to correct some of the grosser errors prevalent with regard to the subject of our ancient endowments. The writer wishes to acknowledge his indebtedness to the writings of Mr. A. F. Leach (Charity Commissioner) and to the courteous help of the officials at the Education Board, of course without implying that they have any responsibility for the statements which follow.

Endowed Schools before the Reformation.

The records included in Mr. A. F. Leach's book entitled "English Schools at the Reformation" (Constable) show that 200 grammar schools at least, and more probably

300, flourished before the Reformation. The majority of these were abolished or crippled by the Government of Edward VI., who, by the strange irony of fate, is commonly credited with founding many of our endowed schools. Generally, it is correct to say that a King Edward VI. school means a foundation which was maimed by Edward VI., *i.e.* by the actual regent at the time. These schools were of various types, some existing as independent institutions, while many were connected with one of the following:—cathedral churches, monasteries, colleges, hospitals, guilds, or chantries. The endowments varied widely, Eton and Winchester having well-paid masters and seventy scholarships apiece, while Launceston paid an old man 13*s.* 4*d.* a year to teach young children. In addition to public schools and grammar schools there were choristers' schools and elementary schools. What we now call secondary education existed in fact, though not in name; with scholarships tenable at the schools, and exhibitions thence to the universities. According to the above authority, the boys were mainly of the middle classes, with younger sons and poor relations of the upper classes, and occasionally bright boys from the real poor. The character of the learning certainly supports this contention, Latin, dialectic and rhetoric, being taught up to a standard fitting the youth of sixteen to eighteen years of age for entrance to the university. Without entering into details (which it were easy to do), it can be asserted that the English schoolboy of the sixteenth century was immeasurably superior to his successor at the present day in respect to knowledge of Latin. Further, it appears to be true, alike of the past and the present, that, given good *quality* of education, the numbers seeking to avail themselves of its provision will take care of themselves. In round numbers, we find in the England of 1546 a population of two and a half millions, with 300 grammar schools, or one school for 8300 people. This compares well with the one school for 23,000 of the year 1865. One is tempted to wonder, though of course it is mere idle and somewhat melancholy speculation, what would have resulted had some wise statesman developed these disconnected but useful, and, for their day, efficient, institutions into an organised system of national education. Should we have become as a nation more scientific and artistic, but less robust and individual? As facts are, and as they have to be faced, the opportunity was lost, destruction and spoliation took the place of development, and to-day we are left with endowments, not indeed to be despised, but utterly inadequate to provide a tithe of the cost of higher education of the country.

1864 TO PRESENT DAY.

Under the chairmanship of Lord Clarendon, a commission of inquiry reported in 1864 on "The Revenues, Management, Instruction, and Studies of Eton, Charterhouse, Merchant Taylors', St. Paul's, Westminster, Winchester, Harrow, Shrewsbury, and Rugby." In 1868, the date of the Public Schools Act, there were 2956 scholars in these nine schools, and their net aggregate income, including exhibitions, was about 65,000*l.* a year. In 1905 the number of scholars was 4100, and their income, as to which only partial information is accessible, has increased in far larger proportion than the number of scholars. The position of Eton and Winchester Colleges is one of such independence that the Board of Education has no information as to their present financial position. They are undoubtedly wealthy, and their national importance makes periodical audit and publication of financial statements the more desirable. In 1890 the gross income of St. Paul's School endowment was stated to be 15,426*l.* A recent question raised by a member of the House of Commons has fortunately led to an investigation of the case of Harrow School. Here it appears that the endowment is worth about 1000*l.* annually, roughly half of which goes to the lower school of John Lyon, and the rest might easily be spent on clerical, legal, and office expenses connected with the foundation. In short, Harrow School is supported by the fees of the pupils. If any reader of this article should have been under the delusion that our ancient endowments are vast stores of unused or misused wealth, this fact may prove one step in his disillusionment. It is to be hoped that the Board of Education will give us information about the income of the remaining five schools. Not being subject to the Endowed Schools Acts, they are not included in the Roby Return of Charitable Foundations presented to the House of Commons in 1892 (and reprinted in the Report of the Secondary Schools Commission of 1895). It does not appear from the reports of either the Clarendon or the Schools Inquiry Commission that the segregation of these schools was justified on any clear legal, proprietary, educational, or national ground. The following extract from the Clarendon Report is of interest:—

"Are the classes by whom these benefits are now enjoyed the same as those for whom they were originally intended? There is no doubt that the collegiate schools were primarily though not solely designed for the assistance of meritorious poverty; the independent grammar-schools primarily though not solely for the benefit of some particular town, village, or neighbourhood. . . . Speaking generally, it must be said that the difficulty of assigning a precise meaning to the word poverty, the doubt what class of persons, if any, at the present day really answers to the ***pauperes et indigentes scolares*** of the Lancastrian and Tudor periods, and the further doubt whether poverty is not after all best served by giving the widest encouragement to industry, coupled with the interest which every school has in collecting the best boys from the largest surface, have tended, and will continually tend, to render the qualification of indigence practically inoperative. We do not think it necessary to recommend any change in this respect."

One more extract refers to local privileges, often the right to gratuitous education:—

"The question we have to consider is, whether the maintenance of the local privileges in favour of these persons, and of the few permanent residents who desire a public-school education for their sons, is recommended either by respect for the founder's intentions or by any other sufficient reason. We think that it is not." (We may note that "these persons" refers to immigrants attracted to the town or village by cheap education through the foundation.)

Following the "Clarendon" Commission there was "The Schools Inquiry Commission" under Lord Taunton's chairmanship, which reported in 1867 on all the remaining schools, numbering 100 first-grade and 247 second-grade endowed grammar schools, including twenty-two in Wales. Of these, a few have ceased to exist or have become elementary, while occasionally the endowment has become a bursary or scholarship. Perhaps one-seventh have thus been lost to secondary education; the remaining six-sevenths still form to-day the core of the public secondary education of England.

Despite the remarkably able character of the commission and its arduous labours, we cannot altogether rely on the accuracy of an important part of the information contained in its voluminous report and minutes of evidence (twenty-one volumes), that part, viz., which purports to give the ancient history of the foundations. The commissioners mainly relied for this history on the earlier reports of the commissioners for inquiry concerning charities, 1818 to 1837. In a chronological list of schools given in his "English Schools at the Reformation," Mr. A. F. Leach assigns a different date from that given by the commission in a large majority of cases, differences amounting in some cases to centuries! As Mr. Leach is probably our best authority on this subject, we can feel but little confidence in the findings of the commission with regard to the original documents, deeds, and charters, particularly of the older foundations. This consideration does not, of course, affect the accuracy of their statements as to the position of the endowments in 1867, but it gives some support for further amendment of the Public Schools Act of 1869, which was avowedly based on the Taunton Report. Apart from amendments in detail, this Act governs most of our grammar schools to-day.

The powers of the Charity Commission to establish and amend schemes, which were transferred to the Board of Education by an Order in Council in 1901, were powers under the 1869 Act. For example, head and assistant masters are dismissible "at pleasure" in nearly all endowed schools at this day, because the law of 1869 so enacts. Its importance may be indicated further from the fact that during 1905 alone there were 649 orders made, 470 relating to secondary and 179 to elementary education, by the Board in its exercise of these powers. Returning to the 1867 report, we find that there were in England and Wales 782 distinct foundations, 820 schools, 36,874 scholars, and annual income 210,000*l.*, exclusive of the nine great schools. Including these, but excluding elementary schools, we have 40,000 scholars and an income of 277,000*l.* a year. This was for a population of twenty-one millions. In an appendix is an interesting table showing the estimated number of boys (eight to fifteen years) of upper and middle class parents to be:—in towns, more than 15 per thousand; and in rural districts, 11 per thousand. Local inquiries made the number of boys in day schools other than elementary to be 16 per thousand of the population, so that private schools were responsible for the greater number. It is known that the standard represented by "secondary education" in most of these schools (public and private) was very low, in many cases decidedly below that of a good board school in the last decade.

In 1895 the Commission on Secondary Education, under the chairmanship of Prof. James Bryce, reported that for seven selected counties the number of boys was 2·48 and of girls 3·6 per thousand of the population in endowed and proprietary schools. In London the proportion of boys was slightly higher, that of girls decidedly less. Nor could it be seriously contended that private schools made up by their number, size, and efficiency for this most serious state of affairs. It has to be acknowledged that the attempt to leave secondary education to be provided by private enterprise and endowments has had disastrous effects. The great improvement made in the last decade, though in part due to a raising of the tone and standard of teaching in schools, both private and endowed, could not have advanced so far as has already been the case; still less could it make the needful progress we hope for in the immediate future, without the aid of the national exchequer and the local rates. It may be thought that by pooling the endowments and re-distributing them the expense to the rate-payer and tax-payer might have been avoided. The writer is not of this opinion. Some re-distribution would undoubtedly be of advantage, by making the endowments more generally available, and thus much benefit might accrue, as a comparatively small addition to the funds of a struggling school will often make a relatively enormous increase in its efficiency; but unfortunately the sums available are far less than is often supposed. The precise amount is not readily ascertained. The annual reports of the Charity Commission give no information on the subject; the "Statistics of Public Education in England and Wales," published by the Board of Education, despite its comprehensive title, merely deals with grant-aided schools; the balance-sheets of county education committees usually omit to give the endowments of the schools aided; and the inquirer has to fall back upon the Roby Return.

The return gives the gross income for the year 1890 of each individual charitable trust, but does not specify which part, if any, is educational. The 1895 Bryce Commission Report adds notes on the apportionment of each trust to educational and other uses, but often the directions are hopelessly intricate. No digest or summary is attached to these documents, and the present writer must be held responsible for the following statements, based on a rough analysis of the return:—In 1890 the number of foundations the endowments of which could provide entirely for the education of 100 boys (at 18*l.* per annum) was thirty-five; moreover, the number of boys and girls being educated at the schools of each foundation exceeded the number which the endowment alone would suffice to educate efficiently, the difference being made up by fees at the more expensive schools, and in other cases partly by fees and partly by Exchequer and local grants. When it is considered that in 1905 the Board paid grants amounting to 211,254*l.* on 51,779 scholars in 575 secondary schools, that these schools had in addition 30,000 scholars not earning grants, and that the annual increase in grant-earning scholars is estimated to be 30,000, it is obvious that no large measure of financial relief to the community is to be found in re-distribution of endowments. What has happened is rather the inverse process; the municipal authorities have rescued impoverished schools with too meagre endowments.

THE NEAR FUTURE.

The control exercised by the Board of Education over schools aided by grants of public money has greatly increased during the last two years, and is destined to become more and more penetrating. It is inevitable that this development of bureaucratic influence should bring with it the usual concomitant advantages and evils. To make the most of the advantages, and to minimise the evils of centralisation should be our goal. We want local public interest in our schools, and a strong profession of teachers. One of the worst results of the extreme regard paid to the "individuality" of our schools has been to produce a body of schoolmasters suspicious of, if not hostile to, organisation, even of their own profession. This unfortunate sentiment is happily growing weaker, and will become evanescent as soon as it is realised that the schools themselves are becoming subject to a common authority, with its potency for good or ill to all under its sway. What the country as a whole needs is a proper devolution of responsibility to local education committees, with reservation to the central authority of certain functions the performance of which locally is open to serious objection. Among the latter may be placed the training of teachers, and the inspection of schools as regards conditions of health, while the local authorities should supply statistical information required by the Board. Each endowed school should have a board of governors, including members representing the local authority, and while the management of the school should be entrusted to the governors by the scheme, it should nevertheless be the duty of the latter to present to the former a yearly budget. Any pooling and re-distribution of endowments might be so limited as to preserve the benefits of each foundation to the area of the local authority in which it exists. This would largely limit the vehement opposition usually raised to any proposal to translate an endowment to a populous centre from a village where it is wasted, at the same time fulfilling in a reasonable manner the intention of the pious founder to provide for the native inhabitants of the place he endowed. For the smaller endowments (by far the greater number of those existing) this plan implies the extension of that municipalisation of endowments for which a precedent was set at Derby last year. With reference to the larger endowments, a word of caution is not out of place.

The leading public schools of England are among our most important national assets. Dating, as some of them do, from six, seven, or even eight centuries back, they have the advantage of unrivalled traditions, of inestimable value in influencing their character and tone. It would be a disastrous policy to destroy these for the comparatively trivial pecuniary gain to be achieved; but the question of reforming their constitution raises important questions of principle, which cannot be more than hinted at in this article. It appears to the writer that some mild infusion of democratic influence might be of mutual advantage to the schools and the neighbouring communities. There appears to be justice behind the claim for admission of fit boys from every social rank, and although such admission would only be of real benefit to the exceptional boy of poor parentage, the principle is not to be lightly disregarded. By sacrificing their "splendid isolation" and becoming associated with the national system of education, the great schools would be more truly doing their duty to the country, and the benefits reaped from their association with schools of all grades would not all be on the side of the humbler institutions. For these and other reasons one may hope that the Government will proceed with part ii. of the Education Bill (1906), which was dropped last year, a reprint of which those interested may find in "The Schoolmaster's Year-book for 1907" (Sonnenschein). Briefly, it conferred upon the Board enlarged powers to make new schemes and to amend old ones, with considerable simplification of procedure. Universities and their colleges were excluded from the operation of the Bill, and the segregation of the great schools of the 1868 Act was to be continued by their reservation from the more sweeping clauses; indeed, Eton and Winchester would only be affected so far as their governing bodies consented. Safeguards relating to the religious character of certain foundations were introduced, although Clause 16 states, and very rightly, that "in making a scheme regard shall be had primarily to the educational advantages to be derived from the scheme." May we not hope that the matter will be discussed and legislated upon in this spirit?

G. F. Daniell.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The next combined examination for sixty-six entrance scholarships and various exhibitions at Pembroke, Gonville and Caius, King's, Jesus, Christ's, St. John's, and Emmanuel Colleges will be held on Tuesday, December 3, and following days. Mathematics, classics, and natural sciences will be the subjects of examination at all the above-mentioned colleges. A candidate for a scholarship or exhibition at any of the seven colleges must not be more than nineteen years of age on October 1, 1907. Forms of application must be sent in on or before Tuesday, November 26.

Mr. A. H. Lees, of King's College, has been appointed to the studentship in medical entomology for the period of one year. The studentship was recently established on the basis of a grant from the "Tropical Diseases Research Fund," administered by the Colonial Office. Mr. Lees will pursue research under the direction of the Quick professor of biology.

Of the four fellowships awarded last week at Trinity College, two were for classics; one of the remaining two was awarded to Mr. A. S. Eddington, senior wrangler in 1904, and first class, first division, part ii. of the mathematical tripos, 1905; and the other to Mr. V. H. Mottram, first class, part i. of the natural sciences tripos, 1903, and first class (physiology) in the same tripos, part ii., 1905.

Mr. A. Wood, who took his degree in chemistry and physics in 1904 as an advanced student, has been elected to a fellowship at Emmanuel College.

Mr. A. Berry, of King's College, has been appointed chairman of examiners for the mathematical tripos, part i. (old regulations), 1908.

At a Congregation to be held to-day, the honorary degree of Doctor of Science will be conferred on Prof. Emil Fischer, of Berlin.

Liverpool.—Prof. J. Reynolds Green, F.R.S., lately professor of botany to the Pharmaceutical Society of Great Britain, has been elected to the Hartley lectureship in plant physiology, recently instituted in the botanical department through the generosity of Mr. W. P. Hartley, of Aintree.

Dr. J. H. Grindley has been appointed principal of the Government School of Engineering at Ghizeh, Cairo. The school is under the Egyptian Ministry of Education for the training of engineers for the various departments of the Egyptian public works.

Mr. W. MacGregor Wallace has been elected lecturer on applied mechanics in place of Dr. Grindley (resigned).

Manchester.—The honorary degree of Ph.D. has been conferred upon Prof. Ernest Rutherford by the University of Giessen.

The following appointments have been made:—Dr. C. H. Weizmann, lecturer in chemistry; Mr. J. N. Pring, demonstrator in electrochemistry; Mr. F. H. Gravely, assistant lecturer and demonstrator in zoology. Mr. Frank Howson has resigned the position of demonstrator in physiology on his appointment to a similar post at the Armstrong College.

Dr. R. S. Hutton, on leaving Manchester, is resigning his position as lecturer in electrochemistry and assistant director of the physical laboratories, but has been appointed a special lecturer in electrochemistry.

The Herter lectures before the medical department of the Johns Hopkins University are to be given this session by Prof. E. A. Schäfer, F.R.S., professor of physiology in the University of Edinburgh, at the end of April, 1908.

We have received the current issue of the year-book of the Michigan College of Mines. It covers 136 pages, and contains full details of the courses arranged for the session 1907–8. The courses are admirably planned, and the situation of the college in the copper- and iron-ore district of Michigan, where its students live in a mining atmosphere, has brought to the institution a large measure of success.

Under the will of the late Dr. Nathaniel Rogers, the Senate of the University of London offers a prize of 100*l.*, open for competition to all members of the medical profession in the United Kingdom, for the best essay or dissertation setting forth the results of original investigations made by the candidate on any medical pathological subject during the preceding two years. Candidates will be permitted to present papers published during the preceding year as the dissertation. The essay or dissertation, by preference typewritten or printed, must be sent in not later than May 1, 1908, addressed to the clerk of committees at the University.

The prospectus for the session 1907–8 of the Belfast Municipal Technical Institute should prove of real assistance to intending students seeking guidance in planning their courses of work. It is quite clear from the volume, which runs to nearly 250 pages, that the chief object of the institute is to provide instruction in the principles of those arts and sciences which bear directly or indirectly upon the trades and industries of Belfast, and to show by experiment how these principles may be applied to secure industrial advancement. The classes are designed to assist persons engaged during the day in handicrafts or business, and desire to supplement the knowledge gained in the workshop or warehouse. The time-table of classes is published as a separate pamphlet, and with it a sensible letter of advice to students from the principal of the institute, Mr. Fras. C. Forth, indicating several directions in which students can assist the staff to secure success in the work of the various departments. Arrangements have been made for full courses of study in the various branches of science, art, technology, and commercial subjects.

Among the advanced lectures on scientific subjects announced in connection with the University of London to be held during the present session may be mentioned a course of eight lectures, by Mr. A. D. Hall, on the function of the mineral constituents of the soil in the nutrition of plants, to be given at the Chelsea Physic Garden on dates to be announced later. Mr. J. B. Leathes commenced a course of eight lectures on October 15 at the University physiological laboratory on problems in animal metabolism. At the same place four lectures on the construction of diets in health will be commenced by Dr. E. I. Spriggs on November 8. Three lectures on the principles of classification will be given at University College by Mr. G. A. Boulenger, F.R.S., beginning on October 28, and three lectures by Mr. J. T. Cunningham on sexual dimorphism, beginning on November 18. The University reader in meteorology will deliver at the University a course of twelve lectures on meteorological organisation and methods of dealing with meteorological observation, commencing on October 21.

The *Electrician* for October 11 contains an interesting description of the electrotechnic institute of the Technical University in Karlsruhe (Baden), by Mr. Stanley P. Smith. The writer describes the general lay-out and equipment of the institute buildings, which were specially designed for the various branches of engineering carried on within them, but the description mainly deals with the electrotechnic institute itself. The cost and equipment of this building was between 2700*l.* and 2800*l.*, and from the plans and description given there is no doubt that it is very perfectly arranged and fitted up. The general idea of the curriculum followed is also given, and it will be of interest to both engineers and others to note that the course at Karlsruhe includes political economy and labour problems. There is also a greater tendency in Germany for the various branches of engineering to be treated by professors who are also engaged in practical work. On another point the institution at Karlsruhe differs from the colleges in this country, namely, the students themselves. There appear to be no student organisations, and the sociability so characteristic of an English college is almost entirely wanting.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 27.—"The Annealing of Copper, with Special Reference to Dilatation." By Prof. T. **Turner** and D. M. **Levy**. Communicated by Prof. J. H. Poynting, F.R.S.

The authors have employed a special form of extensometer, in conjunction with a Le Chatelier pyrometer, in order to trace the changes in the length of metallic rods during the process of annealing, and have thus obtained continuous curves connecting dilatation and temperature. The rods, which were $\frac{1}{4}$-inch in square section and 35 inches long, were uniformly and regularly heated in a gas-fired furnace. The chief feature of the apparatus was the use of water-cooled copper tubes for connecting the rod with the extensometer, a plug of non-conducting material being used to prevent any cooling of the end of the rod by the water. By this method the whole of the rod was in the furnace and uniformly heated, while the rest of the system was maintained at a constant temperature. The water-cooled tube attached to one end of the rod was firmly clamped, the other being free to move. On to this tube was screwed a brightly polished brass disc, against which pressed a finely rounded projection attached to the short arm of a bell-crank lever, which, traversing a scale, indicated the expansion of the rod.

The scale was divided into millimetres, each millimetre representing 1/1200-inch expansion, corresponding to a magnification of 48 : 1. The suitability and delicacy of the apparatus were ascertained by testing bars of wrought iron and steel; from the former a regular line was obtained, while the latter gave a curve showing a marked change of volume at the critical point (about 690° C.), thus agreeing with Le Chatelier's results obtained by an entirely different method. Hard-drawn copper bars gave a perfectly regular line, similar to that obtained with wrought iron; annealed copper also gave a straight line. Experiments on rods of brass of different composition, on gun-metal, and on phosphor bronze gave similar results.

It thus appears that the change from the hard, elastic condition of worked copper and copper alloys to that of extremely soft metal is not accompanied by any alteration in length. On the other hand, it is known that allotropic changes in an element, such as occur in pure iron at about 880°, or such chemical constitutional changes as occur in iron-carbon alloys at critical temperatures, are accompanied by marked alterations in volume, and the authors therefore conclude that the changes brought about by mechanical work, or by annealing of worked metals, produce only internal re-arrangement of the metallic molecules, but are of a different order from the chemical and physical changes, such as are correctly regarded as allotropic.

"Experiments on a New Kathode Dark Space in Helium and Hydrogen." By F. W. **Aston**. Communicated by Prof. J. H. Poynting, F.R.S.

This paper is a description of a new dark space, close up to the kathode and inside the Crookes dark space, discovered by the author while investigating the length of the latter phenomenon in helium, and later found to be exhibited in a less marked degree in hydrogen. The length of the new dark space, which under measurable conditions varies from 0·2 mm. to 1·0 mm., is almost unaffected by the pressure of the gas, but varies roughly with the inverse square root of the current density.

Careful observations show that *the fall of potential across the new dark space is constant* for the same gas under all observed conditions, and is in helium 30 volts, in hydrogen 15 volts. The phenomenon may be accounted for by the supposition that the energy required to ionise a molecule of helium is a definite quantity, and that an electron liberated from the surface of the kathode virtually at rest must fall freely through a definite potential in order to acquire that energy, so that the new dark space may be regarded as *the distance through which the electrons fall in order to attain sufficient energy to ionise the gas by collision with its molecules.*

The intense blackness of the new dark space in pure helium bears out this theory, by which also the following effect was predicted:—Since the behaviour of electrons liberated from molecules of the gas by collisions should be the same as that of those derived from the kathode, if the ionisation just beyond a potential distance from the kathode of 30 volts is sufficiently concentrated there will be a further maximum of ionisation—and therefore of light—just beyond a potential distance of 60 volts, another beyond 90 volts, and so on, each getting less definite than the previous one, so that the light in the Crookes dark space should be striated in appearance. By suitable adjustment of conditions, several successive striations can be seen and photographed in helium. Combining the potential differences obtained from the length of the new dark space with the accepted values of e and m for the electron, the following values of the energy required to ionise and the velocity of the ionising electron are obtained:—

Hydrogen ...	$1·7 \times 10^{-11}$ ergs	$2·25 \times 10^{8}$ cm. per sec.
Helium	$3·4 \times 10^{-11}$,,	$3·2 \times 10^{8}$,,

Not the slightest indication of the phenomenon has yet been observed in any other gas.

Received July 5.—"The Dispersion of Double Refraction in Relation to Crystal Structure." By Dr. T. H. **Havelock**. Communicated by Prof. J. Larmor, Sec.R.S.

In this paper the object is to consider to what extent it is possible to regard double refraction, whether produced artificially or occurring in natural crystals, as due simply to an æolotropic distribution of similar particles. The ordinary theory of double refraction amounts to considering the medium as a collection of crystal molecules in cubical order, all the varieties of dispersion being postulated of the single particle; and similarly in artificial double refraction, the æolotropy is assumed to originate wholly in the individual molecule, and to be effected through the quasi-elastic force under which the polarisation electrons are supposed to vibrate. On the other hand, a theory which confines the effect to a re-arrangement of the molecules in space will express the result by a modification of the effective electric force operative at each particle. From this point of view the author develops a theory of the optical properties of a homogeneous assemblage of isotropic particles. If the medium behaves like a uniaxal crystal, it is found that the double refraction, equal to the difference between the two principal indices, is proportional to $(n_0^2-1)^2/n_0$, where n_0 is a mean value measuring the refractive index of a medium composed of the same particles in the same density, but arranged in simple cubical order.

This gives a law of dispersion of the double refraction, provided the dispersion of the mean index n_0 is known. The formula is applied first to the double refraction produced artificially in simple isotropic media. Experimental data are available for the dispersion of the double refraction produced in carbon disulphide by an electric field, and these results are found to agree well with the formula given above.

In the case of natural crystals, where the effect is larger, the theory indicates that the quantity

$$(n_1^2-1)^{-1}-(n_2^2-1)^{-1}$$

should be independent of the wave-length, n_1 and n_2 being the ordinary and extraordinary indices of the crystal. This relation is found to hold very well for quartz over a wide range, and gives in this case the equation

$$n_2^2-n_1^2=0·01441(n_1^2-1)(n_2^2-1).$$

It follows, further, that the double refraction decreases in absolute value with the mean index n_0, that is, it decreases in general with increasing wave-length. This is the rule of dispersion in most actual crystals, but there are various exceptional cases of anomalous dispersion, and to cover these a modified theory of uniaxal crystals is given in the following terms. The molecules (or crystal units) of the medium are not necessarily to be supposed ellipsoidal in shape, but are optically æolotropic, so that the subsidiary equations connecting the polarisation of a particle with the effective electric force are æolotropic, with an axis of symmetry; the particles are supposed to be arranged in a homogeneous assemblage, such that the effective cavity may be taken as a spheroid of small ellipticity with its axis of symmetry coincident in direction with that of the crystal unit. Hence an explanation is given of the anomalous dispersion of the double refraction in regions free from absorption, that is, when a medium composed of the same crystal units arranged in regular cubical order would give regular dispersion. The theory is considered finally in its general application to dispersion in biaxal crystals.

The author has attempted to connect the varieties of dispersion of double refraction with the structure of the crystal under the following assumptions. The crystal unit contains vibrating electrons, so that their combined effect is expressed by three principal equations connecting the polarisation of the unit with the effective electric field; if, then, these units are arranged in regular cubical order, we have a medium with principal refractive indices along three fixed directions in space, and in this case it is assumed that there is regular decrease of the double refraction with increasing wave-length in regions away from absorption bands; but considering in general any other homogeneous assemblage, the effect is expressed by a change in the effective electric field acting on the crystal unit; this effect is estimated by supposing, as a sufficient approximation, that the effective cavity is slightly ellipsoidal instead of being spherical. Thus differences of packing of the crystal molecules are represented optically by variations in the ratios of the axes of the effective cavity and in their directions in space compared with the polarisation axes of the individual unit. Combining these assumptions, it is shown that they are sufficient for a descriptive theory covering the varieties of dispersion of double refraction found in natural crystals.

PARIS.

Academy of Sciences, October 7.—M. Henri Becquerel in the chair.—The spectrum of the Daniel comet, 1907*d*: Jean **Bosler**. The spectrum of the nucleus of the comet was photographed on the nights of August 8 to 9, 18 to 19, and 19 to 20, with exposures of forty minutes, one hour, and one hour and ten minutes. Details are given of the lines observed, which appear to indicate the presence of hydrocarbons and cyanogen. There are also some lines of which the origin is uncertain.—Trigonometric series: Marcel **Riesz**.—The execution of a geodesic chain of precision in the Savoy Alps: Paul **Helbronner**. Particulars are given of the immediate objects of the survey, together with a list of the thirty-three stations, mostly mountain peaks, proposed to be included in the survey. Of these, twenty-six were completed between June 12 and September 28.—Spectroscopes with mirrors: Maurice **Hamy**. The substitution of mirrors for objectives is often used in spectroscopes. The present note gives a study of the theory of the best position to give the face of the last prism or grating to obtain a field of images as flat and as extended as possible.—The thermoelectricity of nickel; the influence of foreign metals: H. **Pécheux**. Three specimens of nickel were studied, the chemical analysis of each being determined. Couples were formed of each of these with pure copper, and the thermoelectromotive forces studied for a temperature range of 640° C. The curves of electromotive force of the three couples were not parallel, but the results are comparable, differing only by about 0·25 per cent. on the average. The simultaneous existence of copper and cobalt in a specimen of nickel produces the most marked deviations of E.M.F.—Phenyl migrations in the aromatic iodohydrins by the elimination of HI from the same atom of carbon: M. **Tiffeneau**. The theory developed in previous papers regarding the migration of the phenyl group in compounds of the type

(Ar)R—C(OH)—CHI—R′

has been extended and confirmed by a study of the corresponding ether oxides.—The phases of development of the Epicaridæ; experimental verification of the nature of the Microniscidæ: Maurice **Caullery**.—The presence of Tyroglyphinæ in the long bones of the wings of birds: E. L. **Trouessart**.—The existence of statoblasts in the scyphistome: Edgard **Hérouard**.—The necessity of cultures in the study of the gonococcus: A. **Guépin**. The absence of the gonococcus, and of any other pathogenic microbe, can only be admitted as proved after negative results have been obtained from systematic cultures.—Some new fossil plants from the travertine of Sézanne: René **Viguier**.

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 18.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Indicated Power and Mechanical Efficiency of the Gas Engine: Prof. B. Hopkinson.

THURSDAY, OCTOBER 24.

CHEMICAL SOCIETY, at 8.30.—The Constitution of Phenol- and Quinolphthalein Salts: a Contribution to the Quinonoid Theory of Colour: A. G. Green and P. E. King.—Poly-ketides: J. N. Collie.—Production of Orcinol Compounds by the Action of Heat on the Sodium Salt of Ethylacetoacetate: J. N. Collie and E. R. Chrystall.—A Simple Gas Generator for Analytical Operations: J. M. Sanders.—Some Double Ferrocyanides of Calcium, Potassium and Ammonium: J. Campbell Brown.—Halogen Determination in Organic Substances: J. Moir.—Racemisation by Alkali as applied to the Resolution of *r*-Mandelic Acid into its Optically Active Isomerides: A. McKenzie and H. A. Müller.—The Optical Activity of Cyclic Ammonium Compounds: F. Buckney and H. O. Jones.—Keten. A New Anhydride of Acetic Acid: N. T. M. Wilsmore.—The Action of Phosphorus Pentachloride on Hydroxy-trimethyl Succinic Ester. 1:2-Dimethyl Trimethylene 1:2-Dicarboxylic Acid: H. Henstock and B. E. Woolley.

CONTENTS.

THURSDAY, OCTOBER 24, 1907.

WAY-SIDE FRUITS.

Wild Fruits of the Country-side. By F. Edward Hulme. Pp. x+221; illustrated. (London: Hutchinson and Co., 1907.) Price 5s. net.

THE subject of this book is one that may be most conveniently studied in the autumn season, when so many trees are in a fruiting condition. Mr. Hulme has written 212 pages, which are illustrated with thirty-six full-page coloured drawings, prepared by the author, and twenty-five half-tone pictures, which are reproductions from photographs. There are three chapters, and the species of plants are grouped into these chapters as follows:—Chapter i., plants of the hedgerows; chapter ii., trees of the forest; and chapter iii., plants of the moorland, the meadow and the stream.

The notes vary in length according to the estimated importance and interest of the species, and the text is largely composed of quotations from the old writers on the folk-lore of the species, and medicinal uses to which parts of the plants have been applied. The author attempts to trace in most cases the derivation of the names, and, in addition, supplies brief descriptions of the structure of the flowers and fruits. We have nothing but praise for the coloured plates, which in all instances appear sufficiently faithful to nature to enable the novice to identify the fruits, notwithstanding the drawings lack such botanical details as can only be shown after dissection of the fruits, and illustration of the sections. Those representing the common spindle tree (*Euonymus europaeus*), hawthorn (*Crataegus oxyacantha*), sweet briar (*Rosa rubiginosa*), and oak (*Quercus Robur*) are especially commendable.

Having said so much as to the merits of the book, we cannot be silent in respect to its defects. The text has evidently been written hurriedly, and the composition needed more careful revision than has been exercised. The following sentence, for instance, is not more ambiguous than many others that might be selected from each chapter. On p. 13, in respect to the privet (*Ligustrum vulgare*) the author writes:—

"After these somewhat offensive or altogether delightful flowers succeed the berries, and these, if unmolested by the blackbirds, thrushes, bullfinches, and other birds to whom they are acceptable, remain on the plant throughout the winter."

The punctuation is reproduced faithfully. Or, as on p. 203:—

"Large tracts have, however, of late years been ploughed up, a proceeding little to the benefit of anyone, and, so far as it goes, destructive of a wild beauty that might well have been suffered to remain, and which we, Staffordshire-born, can only regret the loss"!

On p. 14, in a sentence which refers to the privet, the word *generic* has been made to read *genuine*. On p. 52 the yew (*Taxus baccata*) is referred to as "a genuine ancient Briton," but on p. 57 it is also described as "a welcome and sturdy guest," which is surely suggestive of an exotic species rather than "an ancient Briton."

The use that is made of capital letters is altogether inconsistent. In the headings all the specific names commence with capitals, a practice which is indefensible when applied to botanical nomenclature, yet on p. 181 *Viscum cruciatum*, when printed in the text, has no capitals, not even one for the generic name.

We can see no reason for the author adopting the out-of-date name *Sarothamnus* for the common broom, the correct name for which is Cytisus. The plant should be invariably described as *Cytisus scoparius*. The list of illustrations at the commencement of the book has probably escaped the author's revision after the type was set. This would explain the generic word Rubus being misspelt Robus in three instances, and scoparius misspelt scaparius.

The subject of this work is an extremely interesting one, and notwithstanding the imperfections we have mentioned, the book may be recommended to those who are about to spend a holiday in a country district, or to students in schools, but especially to those who desire to acquire some knowledge of the folk-lore connected with some of the commonest fruiting plants in our native flora.

COSMOLOGICAL SPECULATION.

Two New Worlds. (1) The Infra-World; (2) The Supra-World. By E. E. Fournier d'Albe. Pp. ix+157. (London: Longmans and Co., 1907.) Price 3s. 6d. net.

THE first part of this book is an elaboration of an analogy already familiar to the scientific public. The Infra-world is a universe in which an earthly atom is a solar system: the positive atom is its sun, the electrons are its planets. The author points out that the scale of distances in our own and the infra-world is approximately in the ratio $10^{22}:1$, this being the ratio of the average diameters of our solar system and an atom. Further, the infra-year, measured by the period of revolution of an electron about its positive atom, is, for a particular case, reduced by the same factor. In this coincidence Mr. Fournier finds justification for regarding the world of atoms as a veritable universe on a smaller scale.

The detailed account of the Infra-world which is presented in the first six chapters, though interesting in itself, is perhaps to be regarded mainly as preparing the way for the conception of a Supra-world, in which our solar system functions as an atom. It is not possible here to discuss the reasoning by which the author seeks to establish the existence of ultra-galactic universes; the arguments he employs are simple and reasonable, and will appeal strongly to the reader who is willing to be guided by probability in a region where logical certainty is at present unattainable. It is sufficient here to remark that the author's presentation of the Supra-world is based on the assumptions:—

"(1) That the material universe is infinite in three-dimensional space, and eternal both in the past and the future.

"(2) That the law of gravitation holds good throughout infinite space and time.

"(3) That the luminiferous ether has the same properties throughout space."

The Infra-world, our own universe, and the Supra-world are represented as three links in a chain of indefinite extent.

We learn from the preface that this book contains "an attempt to penetrate the mystery of space and time with the help of the most modern resources of scientific research." Mr. Fournier's success in achieving this object must depend upon what is required of one who penetrates a mystery. Certainly, the relativity of space and time could scarcely be more clearly and forcibly brought home than is done in these pages.

The limits of this notice do not permit a discussion of the author's speculations regarding the interrelation of "personality" in universes of different orders. The chief value of this work undoubtedly consists in the point of view which is here presented—a point of view which is valid for anyone who accepts the author's proof of the existence of universes of the next lower and higher orders to our own, whether he prefer to interpret conscious or subconscious activity in terms of motion, or matter in terms of consciousness.

Though necessarily incapable of verification, these speculations, which are well and clearly expressed, will hardly fail to evoke something more than a passing interest.

F. L. USHER.

CHEMICAL METHODS IN MEDICINE.

The Chemical Investigation of Gastric and Intestinal Diseases by the Aid of Test Meals. By Dr. Vaughan Harley and Dr. Francis W. Goodbody. Pp. viii+261. (London: Edward Arnold, 1906.) Price 8*s.* 6*d.* net.

THE continual increase in our knowledge of the physical mechanisms of the body necessitates a corresponding increase in the complexity of the methods which the physician has to employ in his endeavour to locate the seat of disease and to determine its character. Every year the medical man has therefore to start his career with expert knowledge of instruments and methods that were not dreamed of by his predecessors, and every year the extent of his armamentarium is added to by the growth of our knowledge of diseases. Many of these methods which the present-day practitioner has to acquire are physical, such as the use of the thermometer, of the stethoscope, the ophthalmoscope, and the various other instruments which have been devised for throwing light into the cavities of the body.

Until recently his chemical methods were practically limited to the testing of the urine for sugar and for coagulable protein. Disorders of digestion were, and in many cases still are, treated purely empirically. Yet it cannot be a matter of indifference whether any given derangement of digestion has its primary seat in the stomach, the bowel, or the nervous system, whether it is accompanied with increase or diminution of the acid secretion of the stomach, or whether it is attended by an absolute failure on the part of the alimentary canal to assimilate in proper proportion to the food which is presented to it. It is of no use to label a series of drugs as good for indigestion, to administer them one after another, in default of knowledge on such important points as these. It is to aid the practitioner in his investigation of gastric and intestinal diseases by the latest methods that this book has been written.

Prof. Harley and Dr. Goodbody confine themselves entirely to the chemical methods, and even here are eclectic in treatment, mentioning only the methods which they have found during twelve years' trial of practical value.

It is to be hoped that the publication of this book may help to render more general the application of science to practice in the treatment of this important class of disease, since the book contains records of a number of analyses made by the authors on different patients, which furnish a useful guide to the results which may be expected in practice.

It is impossible to avoid the impression that the increased technical knowledge required for the diagnosis and treatment of disease must tend more and more to specialism along certain lines, and must handicap the private patient as compared with his poorer brother who is treated in a hospital. Without the resources of skilled assistance and a well-equipped laboratory, it is impossible for a busy practitioner to make all the investigations which are necessary to determine the diagnosis and to control the treatment of a number of cases of diseases. It is possible that in future years every consulting physician will regard a hospital for observation, and a private laboratory with skilled assistants, as necessary adjuncts to his consulting-room. At the present time, if the disease be one of doubt or difficulty, the pauper in the hospital has a better chance of enjoying the benefit of the latest discoveries than has the private patient.

We have no doubt that practitioners, whose time is not already entirely absorbed by the round of visits, will find this book of considerable value. It will not have failed of its object if it teaches such men to carry out a proper investigation of the gastric contents in cases of disordered digestion instead of simply guessing at the causation of the disorder. In one or two places the authors are hardly explicit enough for the purposes of those men who are working out the methods by themselves. Thus, on p. 31, no idea is given of what the colour-changes on titration of the gastric juice consist when dimethyl-amido-azo-benzol is used as an indicator, nor is the rationale of Töpfer's method for determining the acidity of gastric juice made sufficiently clear. These and a few other slight drawbacks can easily be amended in a subsequent edition.

WILD LIFE AND ADVENTURE.

Wild Life in Australia. By W. H. D. le Souëf. Pp. xv+439; illustrated. (Christchurch: Whitcombe and Tombs, Ltd.) Price 7*s*. 6*d*. net.

The Life-Story of a Squirrel. By T. C. Bridges. Pp. vii+230; illustrated. (London: A. and C. Black, 1907.) Price 6*s*.

Adventures in the Great Forests. By H. W. G. Hyrst. Pp. 330; illustrated. (London: Seeley and Co., Ltd., 1908.) Price 5*s*.

Heroes of Pioneering. By E. Sanderson. Pp. 352; illustrated. (London: Seeley and Co., Ltd., 1908.) Price 5*s*.

IN re-publishing, with considerable additions, the series of natural history articles which originally appeared in the *Victorian Naturalist* and the *Emu*, the author of "Wild Life in Australia" has assuredly been well advised; for within this unassuming little volume is to be found a valuable store of information concerning the animals and plants of various districts in Australia. The province of Victoria, the Riverina district of New South Wales, the islands of Bass Strait, Queensland, and Western Australia are in turn discussed; and in each case the treatment of the subject is full of interest, although the amount of space devoted to each district is by no means large. The most important observations in the book are those relating to the life-history of the duckbill or platypus. Many of our readers will recall that in 1901 Mr. G. Metcalfe, at a meeting of the Zoological Society, denied that the platypus lays eggs. Mr. le Souëf, on the other hand, definitely states that at the end of October the creature lays one or two eggs, which are of elongated form and furnished with a leathery shell. The egg is believed to be soon hatched, and the newly-hatched young is naked, and about one inch in length. A nest and broken eggshell were, according to the author, forwarded to Dr. P. L. Sclater. The point in dispute may now be regarded as settled. Mr. le Souëf adds that the platypus is a good climber, and that when on land it folds inwards the portion of the web projecting beyond the toes, so that the latter may be enabled to obtain a grip of the surface.

So far as the naturalist is concerned, "The Life-Story of a Squirrel" is effectually condemned by the illustrations, which (although of passable excellence from the conventional standard) represent the squirrel as being wholly red above, with long ear-tufts, at all seasons. In the winter scene facing p. 142 the characteristic grey flanks are not shown; while in the plate facing p. 32, which is stated in the text to represent a larch, and must therefore, as the tree is in leaf, indicate summer, the squirrel is likewise shown with ear-tufts and the chestnut tail of winter. The text is not of a nature that commends itself to our taste, or, it may be added, to that of certain young people to whom we have shown the volume. For our own part, we like either a sound book on natural history or a good novel; the attempt to combine the two does not appeal to us.

Of the two remaining volumes mentioned above, a brief notice must suffice, seeing that both are based on more or less well-known stories of travel and adventure or on striking historical events, and appear to be mainly intended for boys. In both instances the authors are to be congratulated on their selections and on the interesting style in which these are placed before the public. In his preface Mr. Hyrst records a protest against the destruction of forests which is proceeding only too rapidly in many parts of the world, quoting a statement to the effect that seven acres of primeval forest are felled to meet the requirements of the paper-maker for a single day's issue of a New York journal. Adventures in the great forests of the world, ranging from Major Stedman's expedition in Surinam in 1772 to the journeys of Speke and Grant, Winwood Reade, and other comparatively modern African explorers, are recorded in a style which should attract all juvenile readers. Mr. Sanderson carries his readers further backwards in time, commencing with Sir Walter Raleigh in Virginia, and continuing his narrative down to the establishment of British supremacy in Rhodesia and Nigeria.

OUR BOOK SHELF.

The Collected Mathematical Works of George William Hill. Vol. iv. Pp. vi+460. (Washington: The Carnegie Institution, 1907.)

THE fourth volume of Hill's mathematical works brings the re-publication of these papers up to date, and a little beyond it; for it includes four memoirs that have not appeared elsewhere, and are of very considerable interest. It is, indeed, difficult to overstate the interest of the whole volume—at least, to those occupied in the subjects treated of. Newcomb, in his "Reminiscences," permitted himself a good-natured grumble at Hill's "lack of the teaching faculty." It seems to us that for true instruction as to what the problems of celestial dynamics actually require, and what are the most hopeful ways of approaching them, nothing has appeared since Laplace's "Mécanique Celeste" that so well deserved study as these four volumes. One cannot do them justice in a brief notice. Generally we should say their unique force is a force of character, a serious purpose to adhere only to real problems, to which great analytical facility, with clearness and fastidious elegance, and immeasurable patience are subservient.

Passing over the minor papers, and one of much interest not hitherto published—No. 84, "On Dynamic Geodesy"—the chief part of the volume is engaged in the attempt to find integrals of the planetary equations of motion which shall be valid for an indefinite lapse of time, and so supply some conclusive information as to the permanent future stability, and equally as to the past history of our system. This may be said to be the problem of vital interest at the present time in this branch of astronomy. Construction of tables of the actual motions of the planets is so far perfected that their remaining interest is almost wholly technical. On the other side, if we may take the opinions expressed by Hill in No. 60, "Remarks on the Progress of Celestial Mechanics since the Middle of the Century," the efforts of even very brilliant analysts have not succeeded in throwing much light upon the problem of representing the motions by more general integrals.

Without claiming too much for what Hill himself here contributes, his memoirs are instructive as giving almost a history of the efforts, extending over many years, of his patient and trenchant mind to effect some real advance. The ideas to which he most recurs are those of Delaunay and Gyldén, to both of which it is evident that he attaches high value.

The paper No. 79, "Integrals of Planetary Motion Suitable for an Indefinite Length of Time," supplies a solution of the problem in outline, but in complete and not in unfinished outline, so far as it is illustrated by the system of Jupiter and Saturn.

The volumes are published by the Carnegie Institution of Washington. Vol. iv. contains an index, but it is of the perfunctory character that makes it little more than a list of names; Delaunay's name is followed by a list of no fewer than eighty-three reference numbers, without other clue; it would be shorter and equally useful to write DELAUNAY—*passim*.

R. A. S.

Stray Leaves and Some Fruit on Cancer, based upon Physiologic Chemical Principles. By Henry D. McCulloch. Pp. 49+3. (London: John Bale, Sons and Danielsson, Ltd., 1907.)

THE title of Dr. McCulloch's book is original, and there is no doubt as to the "stray leaves," but in our opinion there is very little "fruit," and we find very little of either "physiologic" or "chemical" principles in the foundation of the heterogeneous collection of quotations which form the bulk of the book—if, indeed, it can be said to have any foundation whatever.

In the present state of the cancer question, such undigested material can only be another obstacle to the real study of this most difficult of problems. A particular form of protozoal infection is assumed without any proof, or mention of work on this theory, as the cause of cancer; and the author thinks that "by proper culture, and introduction to the leucocyte, a vaccine or perfect remedial agent, vicariously prepared in a living animal, will be possible."

Dr. McCulloch makes an attempt to explain the *rôle* of the leucocyte in the natural production of specific vaccines in cancer. Certain leucocytes being phagocytes eat up the opsonised microorganisms under certain conditions, and return to the lymphatic glands and there degenerate; their remains are propelled to the "gland reservoir," where a chemical dissociation and rearrangement of their constituents is brought about, and are finally converted into the immunising agent. This occurs in the early stages of cancer, which are not recognisable. When these conditions fail, the leucocytes perform segregation, and hence the metastasis in the cancer growth.

The dissociation and rearrangement which occur, according to the author, are said to be brought about by enzymes. No doubt these play a part in the process, and it might have been thought that the author would have made an attempt to try to isolate them, or, at any rate, determine what enzymes were present. The assumption of an enzyme is not sufficient proof for its presence, since enzymes are specific in their actions, by which means they are identified. A "nascent enzyme" has not yet been described. The author has also introduced "hormone" in the hope that the word may help to explain the unknown.

The presence of so many quotations might have included the following, by a distinguished physiological chemist:—"The less a physiologist knows about chemistry, the greater is his inclination to work at the most difficult chemical subjects—the proteins and ferments. If even this subject be not sufficiently obscure to him, he can study the phenomena of coagulation. He feels most at home in the still more obscure subject of the pathology of coagulation and of the ferments; it is good to fish in the dark! *These authors have built up a literature which no one can become master of, and which is only a drag and a brake to science.*"

In this book of quotations, Dr. McCulloch finishes up with one in Sanskrit, of which he gives a voluminous interpretation, which appears to have even less to do with cancer than many of the many others of which the book is made up.

R. H. A. P.

Helianthemum Canum (L) Baumg. und seine nächsten Verwandten. By Dr. E. Janchen. Pp. 68. (Jena: Gustav Fischer, 1907.) Price 2.50 marks.

Helianthemum canum is a highly variable species, and therefore one for which it is difficult to define the limits. In the volume of Engler's "Pflanzenreich," dealing with the Cistaceæ, Dr. W. Grosser differentiates two varieties that are each again subdivided into several forms. The herbarium worker may follow such a splitting of interrelated forms, but it is extremely unlikely that he could separate them in the field where intermediate forms would probably be found. Dr. Janchen puts forward an alternative limitation of *Helianthemum canum*, and one or two nearly related species. Broadly, he merges in *canum* part of the species recognised by Grosser as *marifolium*, and maintains *italicum* and *rupifragum* as independent species. There appears to be considerable support for Janchen's arrangement, and the adoption by Grosser of two varieties under different species as *H. canum v. marifolium* and *H. marifolium v. canum* is decidedly confusing, but the determinations of Dr. Janchen are also based solely on herbarium material, although a crucial test could be obtained either by a study of the plants as they grow or by cultivating them from seed. Undoubtedly, such methods are arduous but not impossible, as all the plants under discussion are European. It is only right to add that Dr. Janchen himself recognises the necessity for determining the systematic limits in such variable species by the methods indicated.

Limnologia: Studio Scientifico dei Laghi. By Dr. G. P. Magrini. Pp. xv+242; illustrated. (Milan: U. Hoepli, 1907.) Price 3 lire.

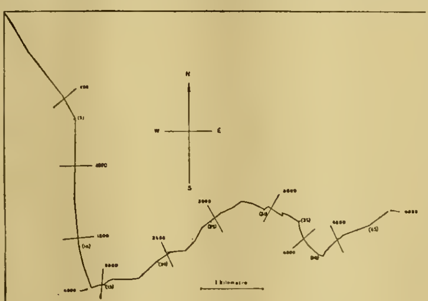
THIS valuable little work forms Nos. 372–373 of Hoepli's well-known scientific series of manuals. As the title implies, it deals entirely with the phenomena of lakes, and is intended to be preliminary to a somewhat similar work on the much larger subject of oceanography. Limnology owes its name to Prof. F. A. Forel, whose standard monograph on the Lake of Geneva is recognised as a model in this branch of inquiry. The present volume deals more particularly with the geographical and physical sides of the question, touching but very lightly on the more difficult subject of biology; it summarises the methods of observation which experience has shown to be the best, including descriptions of the instruments used, the improvements recently introduced in them, and the principal results hitherto obtained. The occurrences of *seiches* are attributed partly to the sudden cessation of wind which had been previously blowing over the lake, and partly to small differences of pressure at various points of the lake (acting on the water as on the mercury of a barometer); it is, however, pointed out that although it may be possible to indicate some of the causes that produce *seiches*, it is very rare that the particular cause of any individual *seiche* can be precisely determined. An appendix contains a list of the positions and areas of the principal Italian lakes. The author admits his especial indebtedness to Profs. Forel and Delebecque, to whose works, and to those of Prof. Chrystal and others, frequent references are made in the compilation of this useful manual.

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 intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

Upper Air Research in Egypt.

The Helwan Observatory (under the Survey Department of Egypt) has recently acquired apparatus to enable it to join in the study of the upper regions of the atmosphere. As a commencement, some fifteen ascents of small "pilot" balloons were made during the month of August. On three occasions the balloons were watched to a height of 5000 metres, but rather a large percentage of the balloons used burst at much lower altitudes. A better type of balloon has been ordered, and it is hoped that observations may be regularly made with them up to 5000 metres or 6000 metres. The balloons are of 2 feet nominal diameter, and are filled with dry hydrogen made from zinc and sulphuric acid. They are observed as they ascend by two observers at the ends of a base line 1 kilometre in length. The theodolites are of the very convenient type made by S. and A. Bosch, of Strassburg, specially for this work. The result of a month's work shows that at this season the surface wind (N. to N.W. as a rule) is from



PILOT BALLOON Aug 27th 1907

HELWAN. EGYPT

LAT 29° 52' N. LONG 31° 20' E GR

heights in metres

interval in minutes from the start

1000 metres to 2000 metres thick. Above this there is a layer of varying thickness of winds from W. to W.S.W., whilst above 4000 metres other winds are reached, but the number of observations is at present too few to generalise about this region. An interesting ascent is shown in the figure, which represents the horizontal projection of the flight of a balloon on August 27, with contours showing the position of the balloon at intervals of 500 metres. In this case, above the stratum of S.W. wind there was a layer of N.W. winds, whilst above this a S.W. current was again entered.

Besides this study of the winds, kite ascents will very shortly be commenced. The apparatus acquired for these consists of a winch of the pattern designed by Mr. W. H. Dines, F.R.S., driven by a Crossley petrol engine of 4 horse-power. The observatory is indebted to Mr. Dines and also to Mr. J. E. Petavel, F.R.S., who watched the manufacture of the winch and introduced many minor alterations which use of a similar machine at Glossop had suggested. The machines are housed in an iron building on the flat desert plateau behind the observatory.

During the September international days (September 4, 5, and 6) five ascents of pilot balloons were made. The height to which they were followed varied between 2500 metres and 3300 metres.

Helwan. B. F. E. Keeling.

Newton's Rings in Polarised Light.

An erroneous statement regarding the above-mentioned subject is made in Preston's "Theory of Light" (p. 363, 1901 edition) and also in Edser's "Light" (p. 519, 1902 edition). As the error is a rather serious one, it seems worth while to point it out.

When the rings are seen between two lenses of the same substance, by light polarised perpendicularly to the plane of incidence, reflected at an angle greater than the polarising angle of the substance, it is stated that the centre of the rings is bright. That this is wrong can be seen. For :—

(1) Stokes has shown from the principle of reversibility that, whatever be the nature of light, the centre of the rings seen between lenses of identical refractive indices is black at all incidences of the light.

(2) Since the centre of the rings is black *at all incidences* for common light and for light polarised in the plane of incidence, it follows by resolution that it is also black when the light is polarised in a perpendicular plane.

(3) When the angle of incidence is less than the polarising angle, the coefficients of reflection *in glass* and *in air* at the bounding surfaces of the two media are opposite in sign. It is argued that, on increasing the incidence, the coefficient of reflection *in air* changes sign as the polarising angle is passed, and therefore at such incidences the two coefficients agree in sign, and destructive interference no longer takes place. Really, however, it appears from Fresnel's formula (coefficient $= -\tan(i-r)/\tan(i+r)$) that both the coefficients change sign as the incidence passes through the polarising angle, and therefore continue to differ in sign, as can be directly shown from the principle of reversibility. Destructive interference does, therefore, take place.

(4) I have shown by experiment that the statement is not true.

(5) Airy has shown (Lloyd's "Wave Theory," p. 178, and Jamin's "Optique Physique," p. 503) that when the two lenses differ in refractive index, the centre of the rings seen in light polarised perpendicularly to the plane of incidence is white only when the incidence lies between the angles of polarisation of the two media. Outside these limits the centre is dark.

C. V. Raman.

Science Association Laboratory, Calcutta, September 12.

Mr. Raman's criticism of the statement made on p. 519 of my "Light for Students" is quite justified. Some time ago I noticed the error myself, and devised the following experiment, to which the same objections cannot be raised, while at the same time it is more easily performed than that in which two lenses of different refractive indices are used.

An ordinary black tea-tray is filled with tap water, and the surface is then touched by the end of a glass rod which has been dipped in oil (I find that the heavy paraffin oil used for engine lubrication answers well). The oil spreads over a fairly large area, Newton's rings being exhibited round the edge of this. On viewing the colours through a Nicol at an angle slightly greater than 45° no change is produced when the light transmitted is polarised in the plane of incidence, but on turning the Nicol through a right angle the colours change to their complementaries. In this case the light is reflected from the lower surface of the film at an angle slightly greater than the angle of polarisation for that surface, while it is reflected from the upper surface of the film at an angle less than the polarising angle. I presume that if Lloyd's single mirror fringes were observed through a Nicol, a similar change would occur on rotating the Nicol; I should be obliged if anyone who has tried this experiment would let me know whether this actually occurs. Edwin Edser.

Thermodynamics of Diffusion.

In his review of "Thermodynamics" (Nature, July 25) and again in the *Philosophical Magazine* for July, Mr. Burbury directs attention to a result stated by me regarding the gain of entropy resulting from slow diffusion of gases at constant pressure and temperature.

May I direct attention to the context in connection with which this result is stated in "Thermodynamics" (§§ 124, 126, 156)?

It cannot be deduced from the laws of thermodynamics or the definitions of a perfect gas (§ 124). These leave the change of entropy in the form of an undetermined constant.

It must necessarily be based entirely on experimental evidence (§§ 126, 156). It is in all probability *approximately* true for actual gases, but of this the experimental physicist is the only competent judge. As applied to "perfect gases" it should be regarded, in common with Boyle's law, as one of the "definitions of a perfect gas," a definition selected partly on account of its simplicity and partly on account of its approximate agreement with the properties of actual gases (§ 156).

An irreversible transformation does not, *ipso facto*, imply a gain of entropy. Unless a compensating transformation exists (§§ 50, 51), and unless the final result involves nothing more than a loss of available energy, we have no justification for applying the methods of thermodynamic analysis. If diffused gases could never be separated, we should have an instance in point; but do such exceptions exist?

Mr. Burbury asks why should different gases behave differently from different portions of the same gas? This question must be decided by the experimental physicist, subject to some further condition, *e.g.* that the gases are in the presence of a liquid which dissolves one of them or of a membrane which is permeable to one of them only. In other words, the matter resolves itself into the question, Why should the conditions of equilibrium of a gas in such circumstances depend on its *partial* pressure instead of on the total pressure of the mixture?

If the experimental physicist had told me that the total pressure, and not the partial pressure, was the determining factor, I should have asserted that no entropy was gained by diffusion, and should have written zero as the value of my constant C.

But then we should have no vapour of water in our atmosphere unless the temperature rose above the boiling point of water. These, generally speaking, are the views which the book was intended to convey; but may I direct attention to the large number of open questions in thermodynamics that have hitherto only received scanty attention in the hands of mathematical physicists?

G. H. BRYAN.

IN the passage in my review to which Prof. Bryan takes exception I had in my mind his definition of available energy at p. 35 and p. 43:—"The available energy of a system *under given conditions* is the quantity of energy which *under these conditions* can be converted into work"; and in the same passage the conditions are also spoken of as "external" conditions. Let the system consist of two gases occupying equal halves of a cylinder, both at the same temperature and at pressure p, separated by a piston impervious to either, and the whole surrounded by air at the same pressure p. It seems to me to be impossible under those conditions to convert any of the energy of the system into work; but if it can be done, it must be possible to explain how. The context of p. 125 does not seem to me to explain it.

S. H. BURBURY.

The Nomenclature of Radio-activity.

THE name "ionium" which Dr. Boltwood proposes for the new radio-active element, of which he announces the discovery in NATURE of October 10, is open to serious objections. I do not mean merely linguistic objections—it is too late to consider them; beside such a hybrid as "ionisation" the philological barbarity suggested by Dr. Boltwood is insignificant; but it is a first principle of scientific nomenclature that a name should connote some of the distinctive properties of the thing named. A thoroughly satisfactory system for naming radio-active elements has not been put forward, but that adopted by Prof. Rutherford in designating the members of the series descended from radium is at least better than none.

According to this system, the products arising successively from the disintegration of a radio-active element are denoted by the name of that element followed by the letters X, A, B, C, &c. The principle of this plan has been adopted by universal consent in the nomenclature of the products of radium, thorium, and actinium, but for historical reasons slight divergences from the simplest form of the system have been permitted. Only one disintegration product of uranium (other than the radium series) has been known hitherto; its name, uranium X, is in accordance with Prof. Rutherford's nomenclature. Dr. Boltwood now announces the discovery of a descendant of uranium subsequent to uranium X; it appears to me desirable that this product should be known as uranium A, and should not be given any purely fanciful and meaningless name such as its discoverer suggests.

NORMAN R. CAMPBELL.

Trinity College, Cambridge, October 12.

On Correlation and the Methods of Modern Statistics.

IN my last letter (October 3, p. 566) I ventured to express the modest hope that "an astronomer may be permitted to dissent from these applications of modern statistical methods." Prof. Pearson refuses the desired permission with such warmth of language and wealth of argument that I find it difficult to make a suitable renewal of the request. Perhaps I may be allowed to confine my reply to the point of most general interest.

With regard to the supposed relation between magnitude and colour, Prof. Pearson wishes "to say a strong word" about my criticism of a conclusion respecting the bulk of the lucid stars, which I said was based on a record in which the white stars had no frequency. I have re-read Miss Gibson's paper, and am unable to see that my criticism in any way misrepresents the facts.

In section (3) of her paper Miss Gibson discusses the relation between magnitude and colour, basing her results upon the Cape list of 159 stars, from which all stars less coloured than deep yellow are excluded.

In section (4) she fits various types of frequency curve to statistics of counts of the lucid stars. In this part of the paper there is no mention whatever of colour or spectral type.

At the end of section (4) we have the conclusion, to which I ventured to take exception:—"Thus we have the suggestion, even if it be only of the vaguest kind, that the bulk of the lucid stars may belong to a separate universe within which magnitude is not mainly determined by parallax or distance, but is more closely associated with colour, and thus probably with chemical or physical condition." The phrase "*but is more closely associated with colour*" is undoubtedly there. If it does not arise from section (3), its origin is "wrop up in mystery"; if it does arise from section (3) my criticism was not so unjustifiable as Prof. Pearson would with strong words call upon the reader to believe.

ARTHUR R. HINKS.

Cambridge Observatory, October 18.

New Zealand Birds.

DURING the past twenty-five or thirty years many reports have been published in regard to the extinction of New Zealand birds, and an impression has gone abroad that our avifauna, with its striking peculiarities and its wealth of interest to ornithologists, will soon be lost. Some time ago, when I was inquiring into the results of the acclimatisation of English birds, I had thousands of circulars distributed in all parts of the colony, and on those circulars I placed questions dealing with the position of the native birds. When the circulars were returned to me I found that every native bird was accounted for, in some cases in many different districts.

I feel, therefore, that I am able to sound a brighter note than has been sounded by most writers on New Zealand ornithology. From personal observations, I can say that several species the extinction of which was announced twenty years ago are fairly plentiful, and are increasing. I may mention specially the stitch-bird (*Pogonornis cincta*), the bell-bird (*Anthornis melanura*), the North Island robin (*Miro australis*), and the tui (*Prosthemadera novae zealandiae*).

I do not know of a single New Zealand bird which we can say with any degree of certainty has become extinct since European occupation of the country, except perhaps the quail (*Coturnix novae zealandiae*), and it is reasonable to suppose that it may still be represented on some flats that settlement has not reached. My inquiries extended only to the mainland; I did not deal with the islands included in the colony's boundaries.

Jas. Drummond.

Christchurch, New Zealand, September 8.

Showers from near β and γ Piscium.

On October 12, at 9h. 50m., I saw a second-magnitude meteor at $346^\circ+3^\circ$, and it appeared to be nearly stationary at that point, but I recorded the object imperfectly, as I was looking toward the western sky at the time.

On October 2, 1902, I noticed a small meteor almost stationary at $345^\circ+3^\circ$, and several others directed from the same point. This shower in Pisces is rather a prominent one in the months of August and September, and it has frequently been observed. The following are some of the determinations of the radiant:—

July 25 to Aug. 12, 1879	$343^\circ+3^\circ$	Weiss	6 meteors
Aug. 10, 1897	345+3	Libert	6 ,,
Aug. 13–16, 1893	347+0	W.F.D.	6 ,,
Aug., 1893	347+0	Corder	6 ,,
Aug. 16–20, 1885	345+0	W.F.D.	7 ,,
Aug. 15–21, 1901	345+0	W.F.D.	7 ,,
Aug. 19, 1900	346+1	W.F.D.	fireball radiant
Aug. 21, 1901	341+5	W.F.D.	meteor radiant
Aug. 21–23, 1879	350+0	W.F.D.	10 meteors
Aug. 24–Sept. 7, 1886	346+1	W.F.D.	5 ,,
Sept. 1–4, 1885	346+0	W.F.D.	9 ,,
Sept. 3–14	346+3	Schmidt	
Sept. 8, 1899	347+3	W.F.D.	fireball radiant
Sept. 14, 1901	345+1	W.F.D.	,, ,,
Sept. 14, 1875	348+0	Tupman	,, ,,
Sept. 15–20, 1876–1879	346+0	W.F.D.	10 meteors
Sept.	344−3	Schmidt	
Sept. 1858–63	346−3	Heis-Neumayer	
Sept. 17, 1885	345+0	W.F.D.	4 meteors
Sept. 17, 1898	343+0	W.F.D.	meteor radiant
Sept. 20–Oct. 4, 1886	347+0	W.F.D.	5 meteors
Sept.–Oct. 1, 1891	345+0	Milligan	
Sept. 27, 1906	347+2	W.F.D.	fireball radiant
Sept. 29–Oct. 2, 1877–1902	347+3	W.F.D.	13 meteors

Possibly several showers may be involved in producing these radiants. As they nearly agree with the radiant point computed for Daniel's comet on September 12, they possess an interest of rather special character, and it is to be hoped that observations will be augmented, particularly at the middle of September.

Bristol, October 14. W. F. Denning.

The "Quaternary" Period.

In Dr. Wright's interesting review of "Les Grottes de Grimaldi," by M. L. de Villeneuve (Nature, October 10, p. 590), I find the following:—"M. Rivière attributed them [the deposits] to the Quaternary period, M. Mortillet, on the other hand, regarded them as Neolithic." Now it is impossible to conceive any defensible use of the word "Quaternary" that does not include the Neolithic. Many authors have condemned the expression on the ground that the Pleistocene and Recent are nothing more than the latest and very subordinate portions of the Tertiary period. For my own part I believe that the great influence which man has already exerted on the character and distribution of the forms of life upon the earth, as well as on the purely physical conditions of its surface and the still greater changes that his activity must occasion even in the near future, are ample justification for marking his effective appearance on the scene by the commencement of a new period in the earth's history, a period the threshold of which we have scarcely passed. If, however, the Quaternary "period" is to be considered to close at the end of the Pleistocene, it becomes so insignificant in comparison with the long ages of its predecessors that it would be better to dispense with it altogether.

John W. Evans.

Imperial Institute, London, October 11.

The separation of the Quaternary period from the Recent period, which begins with the Neolithic, is attributable to the fact that an interruption was supposed to have occurred in Man's occupation of Europe. According to this view, the Recent period begins with his reappearance. Of late years it has been shown that such a view is untenable, and that no such interruption occurred. There is therefore much reason in Dr. Evans's contention that the Quaternary period should be extended to include the Recent period. The term "Quaternary" has, however, a recognised meaning which could not be changed without entering into a discussion of the reasons for the step—a discussion which would be quite outside the province of the writer of a short review.

William Wright.

To Deduce the Polar from the Intrinsic Equation.

I shall be grateful if one of your mathematical readers can give me the polar equation of the spiral which satisfies the condition $\rho s = c$, *i.e.* the spiral the curvature of which is a linear function of the arc. A. B. Porter.

324 Dearborn Street, Chicago, September 19.

The curve in which the *radius* of curvature is proportional to the arc is easily seen to be an equiangular spiral. If, as your correspondent assumes, the radius of curvature is *inversely* proportional to the arc, the problem is more complicated, and it is best in the first instance to express the Cartesian coordinates in terms of a third variable before attempting to form the polar equation. If instead of $\rho s=c$ we write $\rho s=\frac{1}{2}k^2$, we get with the usual notation

$$\tfrac{1}{2}k^2\frac{d\phi}{ds}=s,\ \text{whence}\ \phi=\frac{s^2}{k^2}$$

(choosing axis so that $s=0$ when $\phi=0$).

Put

$$u=\sqrt{\phi}=\frac{s}{k}$$

and we have

$$x=\int ds\cos\phi=k\int\cos u^2du=\frac{k}{2}\int\frac{\cos\phi\,d\phi}{\sqrt{\phi}}$$

$$y=\int ds\sin\phi=k\int\sin u^2du=\frac{k}{2}\int\frac{\sin\phi\,d\phi}{\sqrt{\phi}}.$$

By a suitable choice of origin, the lower limit of integration can be made to be zero in each case.

The integrals are known functions closely allied to the well-known error function. In fact, we have

$$x+iy=k\int_0^u e^{iu^2}du=\frac{k}{\sqrt{i}}\,erf\,u\sqrt{i}$$

To find the polar equation, we first transform the coordinates to new axes of X and Y, making an angle α with the old axes. Thus

$$X=x\cos\alpha+y\sin\alpha=k\int_0^u\cos(u^2-\alpha)\,du$$

$$Y=y\cos\alpha-x\sin\alpha=k\int_0^u\sin(u^2-\alpha)\,du$$

If now r, θ are the polar coordinates, we may adapt the last results to polar coordinates by taking $X=r$, $Y=0$, $\alpha=\theta$. The polar equation is thus the eliminant of the two simultaneous equations

$$r=k\int_0^u\cos(u^2-\theta)du$$

$$0=k\int_0^u\sin(u^2-\theta)du.$$

In terms of ϕ we have

$$r=\frac{k}{2}\int_0^\phi\frac{\cos(\phi-\theta)}{\sqrt{\phi}}d\phi,\quad 0=\int_0^\phi\frac{\sin(\phi-\theta)}{\sqrt{\phi}}d\phi$$

while the inclination ψ of the tangent to the radius vector is given by $\psi=\phi-\theta$.

This method can be applied to find the polar equation of a curve the radius of curvature of which is any function of the arc, but, as in the present example, the integrations cannot always be evaluated in terms of the functions discussed in elementary text-books. G. H. B.

SOME SCIENTIFIC CENTRES.

XI.—THE PHYSICAL LABORATORIES OF MANCHESTER UNIVERSITY.

SIXTY years ago John Owens, fine-spinner of Manchester, left 97,000*l.* "for providing or aiding the means of instructing and improving young persons of the male sex in such branches of learning and science as are usually taught in the English universities, but subject, nevertheless, to the two following fundamental rules and conditions, that the students, professors and teachers . . . shall not be required to make any declaration as to or submit to the test of any of their religious opinions. . . ."

The trustees rented for the purpose of the college a large private house in Quay Street in the city, formerly inhabited by Richard Cobden. The college was opened in 1851, with a staff of five professors, among whom appears the name of Edward Frankland as first professor of chemistry.

Though the chemical laboratory became almost at once very successful, a special fund of 10,000*l.* being raised for its development, it was not until much later that the chair of physics, or, as it was then called, "natural philosophy," was founded, Prof. A. Sandeman being its first occupant. He was succeeded by Prof. R. B. Clifton, F.R.S., now of Oxford, who was again succeeded in 1866 by Prof. William Jack.

On Prof. Jack's removal to Glasgow, Dr. Balfour Stewart, F.R.S., was called from Kew Observatory, where he was then superintendent. A small physical laboratory was opened by him at Quay Street in 1871, when eight students attended for instruction.

In 1873 the college was removed from the city to its present site in Oxford Street, to the fine new building erected from the designs of Mr. Alfred Waterhouse, R.A. The accommodation assigned to the physical laboratory consisted of three small rooms in the basement, quite at the back of the college. With the addition of a private laboratory for the professor, and a workshop, these constituted Prof. Stewart's quarters for experimental work up to his death, which occurred in 1887. Though much of Prof. Stewart's work while at Kew, such as his classic research on the air-thermometer, was of an experimental character, after he came to Manchester he seems to have devoted his attention more particularly to the theories of terrestrial magnetism and of the sun, rather than to laboratory research. The writer, who attended his classes in 1887, remembers how Prof. Stewart displayed an almost affectionate interest in demonstrating the use of certain instruments, such as, for example, the magnetometer, in which he always showed an especial delight.

Photo.] [*Warwick Brookes, Manchester.*

FIG. 1.—Prof. A. Schuster, F.R.S., in his laboratory.

On Prof. Stewart's death, after an illness brought on by an extremely rough sea voyage from Ireland, Prof. Arthur Schuster, F.R.S., who then occupied the chair of applied mathematics in the college, was called to succeed as Langworthy professor of physics and director of the physical laboratories.

Although from time to time the quarters assigned to physics had been considerably enlarged, the demand for a larger laboratory soon became very urgent, and, a generous donor having promised a large sum for the purpose, the council decided to build a new physical institute on a plot of ground close to the main buildings.

An interesting volume[1] has recently been published giving a description of the new physical laboratories and of the work done at the college during the occupation of the chair of physics by Prof. Schuster. It was compiled in commemoration of the twenty-fifth anniversary of his professorship, which was celebrated last summer by a large gathering of his old students and assistants, a specially bound copy being presented to Dr. Schuster by them on the occasion. Its compilation was largely the work of Dr. Hutton, head of the electrochemical department, who recently succeeded Dr. Lees, F.R.S., as assistant director of the laboratory. This book contains plans of the building and some excellent illustrations of the various departments, together with biographical notes and a bibliography of the scientific achievements of the professor, his staff, and pupils during the period named. The frontispiece of the work is a fine portrait of Prof. Schuster, by Lafayette.

As an account of the new laboratory appeared in these columns previous to its opening by Lord Rayleigh in June, 1900,[2] attention will only be directed here to a few of the more important features, and more particularly those connected with the research work.

From his earliest associations with physical science Prof. Schuster had always been specially interested in spectroscopy, having received his inspiration from contact with the foremost pioneers in this branch, Bunsen, Kirchhoff, and Roscoe. Hence it was only to be expected that the facilities for spectroscopic research in the new laboratory should be of a unique character. Probably one of the most important pieces of special apparatus is the large concave grating of $21\frac{1}{2}$ feet radius, of very high quality, specially ruled by the late Prof. Rowland for Dr. Schuster. The mounting, the details of which have been improved by Prof. Schuster, and subsequently by Mr. Duffield, is arranged so that the grating and camera are fixed to carriages, sliding on specially stout iron beams, so connected that as the camera moves away from the plate the grating moves towards it. With this arrangement, as Rowland showed, the different portions of the spectrum are always in focus, whatever the position of the camera on its beam. Mr. Duffield communicated last year to the British Association a preliminary account of a research in which he has been engaged using this equipment, for the study of the effect of pressure on the arc-spectrum of iron, the pressures being varied up to 100 atmospheres.

Other spectroscopic apparatus are a 33-plate echelon-spectroscope by Hilger; a printing comparator for the measuring of spectrum photographs, from the designs of Prof. Kayser; a quartz spectrograph; and a smaller specially mounted concave Rowland grating of one-metre radius.

A very important development of the special work of the laboratory is the department of electrochemistry, which, owing to the efforts of Dr. Hutton and Dr. Petavel, F.R.S., has now established a wide reputation. The details of the equipment have been previously described,[3] but mention must be made of the special electric furnace in which reactions can be studied in gaseous pressures ranging up to 200 atmospheres, and also of the various modifications of the carbon-resistance furnace, designed by Dr. Hutton for different purposes. Accounts of more than one important research undertaken in the department are now in the press.

No record of the physical work at Manchester would be complete without a reference to the long series of painstaking researches by Dr. Lees on thermal conductivity. Alone, and in conjunction with students as collaborators, he has published during the past fifteen years ten papers, many of them of great importance on the subject. He was the first to work with sufficient accuracy to determine with certainty the sign of the temperature coefficient of thermal conductivity in a number of materials, and the value of his work was recognised by his election as a Fellow of the Royal Society last year.

The physical department at Manchester was one of the first to recognise the importance of electrical engineering, and in the old buildings a considerable sub-department was the "dynamo house," where, under Dr. Lees's tuition, many now occupying high positions in the world of electrotechnics received their training. When the department was reorganised on a larger scale, the Hopkinson Memorial Wing was built and equipped by the friends and relatives of the late Dr. John Hopkinson for the purpose. This was placed under the supervision of Dr. R. Beattie. In this house and its annexes are installed a representative collection of all the more important types of modern machines, including specially designed generators for experimental work of all kinds, as well as some machines of historic interest, such as the pair of early alternators presented by Dr. Henry Wilde, F.R.S., to illustrate the property of synchronous running originally discovered by him.

A meteorological station in Whitworth Park, erected by the generosity of the Whitworth trustees, has been splendidly equipped under the care of Dr. C. G. Simpson, and quite recently a kite station at Glossop Moor on the Derbyshire hills has been fitted up under the superintendence of Dr. Petavel with improved Dines apparatus, for winding in and paying out the steel kite-wires, worked by a small engine. This is the most westerly station in Europe for kite-flying, and may therefore acquire considerable importance in the international scheme for the investigation of the upper atmosphere.

Dr. Petavel's researches on radiation and on high-pressure explosions led to his recently being elected to the Fellowship of the Royal Society, and have caused him to be regarded as an authority on both these branches.

After mention of these particular developments of the work of the laboratory, we may note that in the volume referred to, the mere bibliography of the scientific publications of Prof. Schuster and his pupils occupies no less than eighty pages, covering an extremely wide range. Students have been attracted to the laboratory, not only from all parts of England, but from abroad, especially of late years. This is due in some measure to the splendid provision made for research, but undoubtedly in a greater degree to the eminence Prof. Schuster has attained as an original investigator, and pioneer in many important branches of physics. His early work on the discharge of electricity through gases, carried out in the old building with the help of his extremely able private assistant, the late Mr. Arthur Stanton, contributed largely to laying the foundations of the modern theory of the charged atom, which has seen such marvellous developments at the hands of the Cambridge school of physics. His work as an astrophysicist has taken him almost all over the world on eclipse expeditions, and, as a representative either of the British Government or of the Royal Society, to many scientific con-

[1] "The Physical Laboratories of the University of Manchester." A record of twenty-five years' work. Prepared in commemoration of the twenty-fifth anniversary of the election of Dr. A. Schuster, F.R.S., to a Professorship in the Owens College, by his students and assistants. Pp. 142. (Manchester: The University Press.) Price 5s. net.

[2] NATURE, vol. lviii., pp. 621–2.

[3] Hutton and Petavel, Journ. Inst. Elec. Eng., 1903, vol. xxxii. pp. 222–247.

ferences. His influence on the research done by his pupils at Manchester is easily traced, and all of them would acknowledge the inspiration and encouragement of many a half-hour's chat with the professor, perambulating the corridor to and fro in a thoroughly characteristic manner.

Some months ago Prof. Schuster announced his intention of vacating the chair of physics to allow more leisure for the literary work and theoretical research to which he has recently devoted himself more particularly. To the satisfaction of his colleagues at Manchester, it has been decided, however, that his connection with the college shall not cease, but that he will continue to direct some of the research, and the council has therefore appointed him "honorary professor." His place as Langworthy professor and director of the laboratory has been filled by the appointment of Prof. E. Rutherford, F.R.S., of Montreal, who arrived in Manchester a short time ago and organised some researches, though not nominally in charge of the laboratories until the commencement of the October session. Prof. Schuster at present is engaged in the study of the permeability of iron at high temperatures under high pressures, especially with a view to discover the effect of high pressures in changing the temperature, between 800° and 900° C., when the metal suddenly loses most of its magnetism. Pressures up to 1000 atmospheres are contemplated. A second problem under investigation is the effect on the rate of decomposition of radio-active substances of extremely high pressures, such as are met with deep down in the earth's crust. In both these problems the design of the high-pressure portion of the apparatus has been due to Dr. Petavel, and for the latter purpose Mr. Cook, the university mechanician, has succeeded in constructing a combined pump and ram, in which pressures up to 37,000 pounds per square inch can be maintained without perceptible leak over long periods. The effect on radium of pressures up to 2000 atmospheres has been studied, and an account of the experiments will be ready shortly.

The accompanying photograph of Prof. Schuster in the laboratory was taken specially by Mr. Warwick Brookes.

J. A. HARKER.

A NEW METHOD OF COLOUR PHOTOGRAPHY.

THE latest method of colour photography is distinguished as the "Warner-Powrie" process, and is well illustrated at the first exhibition of the Society of Colour Photographers, which will close on October 26. It will presumably be some little time before the plates are generally obtainable, but so far as can be judged from the examples shown and the details of their preparation, it is a process that will offer special advantages. Mr. Powrie has been working at the subject for many years, and has succeeded in producing a triple-coloured lined screen with better and finer lines than has been possible by previous methods, and without either gap or overlap. He discards ruling in favour of a very ingenious method of printing that does away with all need for the troublesome registration that becomes almost impossible with fine lines. The glass is coated with a bichromated colloid, exposed under a black-lined screen that has spaces half the width of the lines, and developed in warm water. This leaves the colloid in lines with spaces of bare glass twice as wide as the lines. By immersion in a solution of a green dye the lines are stained, and by the application of formalin or chrome alum the colloid is made quite insoluble and the dye fixed. The plate is coated again, exposed under the same black-lined screen, the only precaution being that the green lines already made shall be covered with the black lines of the overlying screen. After exposure and development the plate is immersed in a solution of a red dye to stain the second set of lines, and again treated with a hardening agent. The plate is coated once more, and this time exposed alone with its back to the light, so that the red and green lines already made serve to protect the coating from light action. So after development all the remaining spaces are exactly filled with colloid, and this is then dyed blue. The prepared plate is coated with a suitable photographic emulsion, and can be used in a similar way to the "autochrome" plates of Messrs. Lumière, which we have already described. The chief difference between the two apparent by mere inspection is that the colours are in lines instead of as a random grain. But the lines can be made so fine that they are invisible to a normal eye without assistance.

It is obvious that the "autochrome" and the "Warner-Powrie" plates, and any plates in which the surface is apportioned to three colours for colour reproduction, must absorb about two-thirds of the light that would pass through them if the colours were not there. A simple colour, such as red, is produced by a silver deposit that covers the green and blue colours that are in the area that is required to be red, and this area is therefore one-third red and two-thirds black. A print on a "bleaching-out" paper (as the "Uto") would give its colours mixed with a double area of black, and therefore be uselessly dark. It is difficult, if possible, to obviate this with a random distribution of the colours, but Mr. Powrie, with his plates, overcomes the difficulty by separating the plate and the paper with a thin sheet of celluloid or glass, and by two mirrors on opposite sides of the printing frame gets oblique light in two directions, as well as direct light at right angles to the surface, and so causes each coloured line in the plate to give a line on the printing paper three times its width. In this way, each colour—red, green and blue—produces its effect over the whole surface of the paper, the colour patches are continuous (free from black), and what should be white parts are completely bleached instead of being coloured like the original. In the same way, but using ordinary plates, and red, green and blue light separately for the exposures, a separate negative can be obtained of each of the three colours, with a continuous image on each, and these can be used for any method of three-colour printing. A single exposure on a single plate will thus give all that is necessary for the preparation of the three colour records which hitherto have been obtained by separate and generally consecutive exposures on the original.

C. J.

MR. HOWARD SAUNDERS.

IT is with unfeigned regret that we record the death of Mr. Howard Saunders, after a long and painful illness. Mr. Saunders was born in London in 1835, and was therefore seventy-two at the time of his death. He was educated privately—to a great extent at Dr. Gavin Smith's school at Rottingdean, near Brighton, where he is said to have developed that taste for ornithology by means of which he attained eminence in later years. Immediately after leaving school he entered on a business career, and at the age of twenty joined a mercantile house at Callao. Five years were spent by him in Chili and Peru, where archæological studies appear to have chiefly occupied his leisure. In 1860 he crossed the Andes, reaching the headwaters of the Amazons, and descending that river to Pará, in Brazil, where he made his first long halt. Few Englishmen had at that time made a similar journey, which appears to have been fraught with difficulty.

After this journey Mr. Saunders returned to England, and devoted himself to the study of ornithology in real earnest. In South America he had acquired an intimate acquaintance with the Spanish language, so that in the numerous visits he paid to Spain between the years 1863 and 1870 he found himself thoroughly at home. Owing to these frequent visits he became a recognised authority on the ornithology of the Spanish peninsula, and in the year 1869 he published in the *Ibis* the first of a series of important papers on that subject.

To those members of the British public interested in birds, Mr. Saunders is, however, much better known as the editor of the third and fourth volumes of the fourth (and last) edition of "Yarrell's British Birds," the late Prof. Newton, who had edited the two earlier volumes, having found himself unequal to the task of continuing the work, at the rate of issue deemed necessary by the publishers. This work is alone a monument to the extensive knowledge and unflagging industry of Mr. Saunders. In addition to the conciseness and yet fulness of his descriptions, the text of these two volumes is noteworthy on account of the minuteness of detail with regard to the geographical distribution of the various species. The first part of vol. iii. appeared in 1883, and the last volume was completed in 1885.

This, however, was by no means the only work on British birds by Mr. Saunders. In 1887 he published a list of the birds of our islands; and in 1888–9 "An Illustrated Manual of British Birds," which originally appeared in parts, and of which a second edition was issued during the years 1897–9. Terns, gulls, and skuas were a group of birds in which Mr. Saunders was specially interested, and he was engaged by the Trustees of the British Museum to write the volume on this group (Gaviæ) for the famous series of "Catalogues," of which this volume is the twenty-fifth. It was published in 1896. He was one of the contributors to the "bird volume" of the scientific results of the cruise of the *Challenger*, which appeared in 1881, and likewise wrote the article Birds in the "Antarctic Manual." He was also joint-author of the "Birds of Lancashire," and had, indeed, an almost unrivalled knowledge of the county distribution of British birds. His papers in the *Ibis*, in addition to those on the birds of Spain, are numerous, and, needless to say, valuable.

At an early stage in his career Mr. Saunders became a member of the British Ornithologists' Union, at the meetings of which he was a regular attendant, while he also took a large share in the management of that body. He was a Fellow of the Linnean, the Zoological, and the Royal Geographical Societies, and served on the council of each, as well as contributing largely to the publications of the second named. The Society for the Protection of Birds also claimed his interest. For several years (1880–5) Mr. Saunders was secretary of Section D of the British Association; he was also a member of the American Ornithologists' Union, and on the foreign list of the Société Zoologique de France and of several other Continental scientific bodies. In addition to ornithology, Mr. Saunders also took an active interest in geographical research, especially that connected with the exploration of both polar regions. His death will be felt as a personal loss by a large circle of scientific friends, both in this country and abroad. R. L.

NOTES.

THE first Press messages by wireless telegraphy were transmitted by the Marconi system across the Atlantic Ocean, between Ireland and Cape Breton, on October 17. Several congratulatory messages were exchanged between the two continents. The Governor-General of Canada dispatched a message from Ottawa congratulating the King "on the establishment of a fresh link between Canada and the Motherland," to which His Majesty replied on the following day by the same method of communication:—"His Majesty the King to Earl Grey, London, October 18.—I thank you for your telegram. I am delighted that wireless Transatlantic telegraphy should unite the bonds between Canada and the Mother Country so closely.—EDWARD R." The Irish station is situated on a headland facing the Atlantic, about four miles from Clifden, in Galway, and is the largest wireless installation in the United Kingdom. A number of tall masts, arranged in a line facing seawards, contain a network of wires on which messages are received and dispatched. The operators have a telephonic apparatus with a sensitive sounder attached to their ears, and it is their trained sense of hearing and distinguishing the Morse signals transmitted that enables them to detect the signals. It is stated that signals are sent and received simultaneously, and that a speed of about thirty words per minute has already been attained. Full particulars of the modifications in the apparatus and plant which have made the success of last week possible will doubtless be forthcoming in due course. Mr. Marconi and those at work with him are to be congratulated upon their triumph over practical difficulties, and men of science have reason for satisfaction in this remarkable development of means of communication by means of ether waves. The Marconi Company state that any delays in the transmission of messages by their system between North America and the United Kingdom are attributable entirely to delays on the land lines. The company claims that with a private wire from its station at Glace Bay to Montreal, and from the Irish station to London, the service between London and Montreal will immediately compare favourably with the cable service in point of speed.

THE Faraday lecture was delivered by Prof. Emil Fischer, professor of chemistry in the University of Berlin, at a meeting of the Chemical Society held on October 18 at the Royal Institution. Sir William Ramsay, K.C.B., president of the society, was in the chair. An abridgment of the lecture appears in another part of the present issue. At the conclusion of his discourse a medal was handed to Prof. Fischer by Sir William Ramsay as a mark of appreciation by the Chemical Society of his scientific work. Sir Henry Roscoe proposed a vote of thanks to the lecturer, and remarked that the great interest of the lecture is due, not only to the fact that Prof. Fischer is a master of his subject, but also because the application of synthetic chemistry to biology is a subject that at the present time exceeds in interest and importance any other branch of the science. In seconding the vote, Sir James Dewar mentioned that the centenary of the isolation of potassium and sodium by Davy fell on the day following that of the lecture.

THE death is announced of Prof. A. Fürtwangler, professor of classical archæology in the University of Munich, and a prolific writer on archæological subjects.

THE council of the Royal Meteorological Society has awarded the Symons gold medal for 1908 to M. L.

Teisserenc de Bort, of Paris, in recognition of the services which he has rendered to the science of meteorology. The medal was established in memory of the late George James Symons, F.R.S., the founder of the British Rainfall Organisation, and is awarded biennially. The presentation will take place at the annual general meeting of the society on January 15, 1908.

At the sixth annual meeting of the Northern Scientific Club, held at Newcastle on October 17, Sir W. H. White was elected president, and gave an address upon the application of the gyroscope for steadying ships. He showed a working model of Dr. Schlick's apparatus, which, he said, when applied to cross-Channel boats and coasting passenger steamers, would so prevent the rolling of these vessels as to allow persons troubled with sea-sickness to travel on the sea in comfort.

A message was received in New York on October 9 from Dr. Frederick A. Cook, the explorer. It was dated August 26, from Etah, and ran as follows:—"I have hit upon a new route to the North Pole, and will stay to try it. By way of Buchanan Bay and Ellesmere Land, and northward through Nansen Strait over the Polar Sea, seems to me to be a very good route. There will be game to the eighty-second degree, and here are natives and dogs for the task." Dr. Cook's expedition is provisioned for two years, and is wintering thirty miles further north than Commander Peary did two years ago.

The experts of the U.S. Forestry Service, after a fortnight's work on the ground principally affected, are still in the dark as to the origin of the blight that has attacked the white pine of New England during the summer. At Brunswick, Maine, it is feared that the beautiful Bowdoin pines, of which Hawthorne and Longfellow wrote, will soon be a thing of the past. The blighted trees are recognised by the fact that the tips of the needles of this year's growth have turned a peculiar reddish-brown colour, so that the trees look as though they had been scorched. The national Government has established several sample plots, not only at Brunswick, but also at Peterboro, New Hampshire, where a scientific study of the problem is to be carried on.

The Philosophical Institute of Canterbury, New Zealand, is making arrangements for an expedition to some southern islands included in the colony's boundaries. The expedition will be under the leadership of the Hon. R. McNab, Minister of Lands and Minister for Agriculture, who is interested in the history of the islands, and has written an interesting work dealing with the old sealing and whaling days in the islands and the southern part of the mainland. The expedition will be under the auspices of the Government, and will be taken to the islands in one of the Government's steamers. It will leave New Zealand about the end of November or the beginning of December, and will visit the Auckland Islands and Campbell Islands. About twenty New Zealand men of science will take part in the undertaking. They will be divided into two parties, one going to each group. Work will be done in regard to terrestrial magnetism, zoology, geology, and botany, and reports will be prepared dealing with the results of the investigations.

The jubilee of the East Kent Scientific Society was celebrated on October 16 by a conversazione held at the Simon Langton School, Canterbury. Biological, chemical, and physical exhibits were on view, and several interesting demonstrations were provided. The society numbers eighty-six members.

Reuter's correspondent at St. Petersburg states that reports have reached there of an earthquake in Central Asia. On October 21, between 9 a.m. and 10 a.m., a strong but gradually diminishing shock of earthquake was recorded at Katta-kurgan. Other advices state that an undulatory earthquake occurred on October 21 at Samarkand, lasting from 8.45 to 10.30, and causing cracks in many buildings. The dome of one mosque and the minaret of another collapsed.

We learn from the *Agricultural News* of the West Indies that Mr. W. R. Buttenshaw died suddenly in Calcutta on September 9, at thirty years of age. Mr. Buttenshaw, who was a graduate of the University of Aberdeen, entered the service of the Imperial Department of Agriculture for the West Indies as lecturer in agricultural science at Jamaica in 1899, and was appointed scientific assistant in charge of publications at the head office at Barbados in 1903. He left Barbados in May last to take up an appointment as botanist in the Indian Agricultural Service.

Cardiff is now to have a seismograph. Mainly through the instrumentality of Principal E. H. Griffiths, F.R.S., the local Naturalists' Society took the matter up, and approached the City Council with the offer of a seismograph and several other instruments to complete the set belonging to the corporation if only the latter would suitably house and maintain the same. The city fathers, after some demur on the score of economy, have now unanimously agreed to the proposal. An excellent site has been found for the seismograph on Penylan Hill alongside the public observatory, where will also be installed all the instruments necessary for a complete meteorological outfit. This announcement was made amidst applause at the annual meeting of the naturalists on Thursday evening, October 17, by the retiring president, Prof. Haycraft.

The Harveian oration was delivered by Dr. F. Taylor at the Royal College of Physicians on October 18. In the course of his address, Dr. Taylor remarked that Harvey's injunction to search and study out the secrets of nature by way of experiment should be addressed to the lay public, not, indeed, that they may experiment themselves, but that they may promote and forward such experimentation, or at least not hinder and obstruct it. Consideration of the value of experiment and research leads to the reflection how enormous has been the progress, on the one hand, made in medicine in the last few years, and how large, on the other, is our ignorance of natural phenomena in relation to disease and its treatment or control. Dr. Taylor referred to the work of Prof. E. Starling, to whom the Baly medal for the present year has been awarded, on the chemical relations of the functions of the body, as being particularly in accordance with the spirit of Harvey. Two advances which have had important results are the improvements in surgical practice which, initiated by Lord Lister, have led to the present theory and practice of asepsis in surgery, and the advances on the therapeutical side which are intimately connected with the subject of prevention and immunity, and the treatment of disease by antitoxins and the later opsonic methods. The field for research is enormous, the necessity for research patent, and even if the number of workers who can conduct research on the highest lines is limited, whether on social, financial, or moral considerations, there can be no doubt that the medical profession as a body will continue actively to support the maxim contained in Harvey's injunction to search out the secrets of nature by experiment.

FROM Tuesday to Saturday of this week boys of all ages have a delightful opportunity of seeing well-made models of engines, boats, electrical and other devices, and tools used in making them, at the Royal Horticultural Hall. Besides seeing the models at rest or at work, they are able to attend lectures on some of those attractive features in mechanics, physics, or chemistry that made the Polytechnic such a favourite resort in the old days. The *Model Engineer* is to be congratulated on the success of its first exhibition, or at any rate on what ought to be a success, the only misfortune being that, as the younger boys are at school now and the older boys are at work, many who would have attended with delight are perforce out of reach. Our interest in an exhibition such as this is more with its educational aspect than in general with the exhibits themselves. A boy with a mechanical or scientific turn obtains exactly the kind of encouragement which is wanted; his vague ideas as to making something, however fantastic (before the days of bicycles he generally hankered after making a velocipede), are corrected by seeing pleasing things that will really work of every kind of difficulty, from the simplest to the most elaborate, and, what is more important, he learns precision and how to read a drawing, for the instructions given at the exhibition and in the *Model Engineer* are accompanied by proper scale elevations and sections that would do credit to an engineer's office. The boy of the present day has a great advantage over his predecessor owing to the great development and moderate price of small precision tools. These are to be seen in their usual variety; but it is a little sad to notice under the same roof beautiful small precision lathes, with hollow mandrels and draw-in chucks, hailing often from Germany, and old-fashioned designs of cheap lathes with short and solid mandrels. Of course money is the difficulty, and the boy is tempted by the greater capacity of the gap lathe. Perhaps as an educational instrument it has its value. Among the pleasing subjects of lectures is the gyroscope, but, judging from the syllabus, the lecturer has missed the opportunity which the now popular "diabolo" would have given him if his dexterity is equal to his knowledge of demonstrating the laws of precession. We can only repeat our regret that such a treat should not have been arranged for the holidays.

THE *Times* of October 15 contains a further communication from Dr. Stein announcing the results of his work in north-western China during the last few months. Leaving the Lop-nor region, where, at Miran, he had made discoveries proving that in the second century A.D. the Indian kingdom in Turkestan, of which he had previously found such important remains at Niya, between Khotan and Cherchen, extended eastwards almost to the borders of China, Dr. Stein proceeded along the ancient trade-route across the desert of Gobi towards the oasis of Sha-chau, still, as of old, the westernmost outpost of Chinese population and speech. This route has been avoided in modern times until now, on account of its difficulties. Dr. Sven Hedin did not essay it, and it had not been crossed for many years until, not long ago, two British officers from India performed the journey. Their feat was chronicled in the Journal of the Royal Geographical Society, but is not mentioned by Dr. Stein in his letter. The discoverer has found a very interesting relic of ancient Chinese authority in this region in the shape of a previously unknown "great wall" of defence, erected in the early days of Chinese conquest by the Han emperor Wu-ti, at the close of the second century B.C. Dr. Stein traced its course for 140 miles, and found many interesting remains of its original builders and later garrisons in the shape of Chinese records on wood, chiefly referring to matters of military administration, besides numberless miscellaneous antiques, which had been perfectly preserved by the dry climate and soil. Buddhist antiquities of a thousand years later have also been found on sites to the south of this wall, and with these researches Dr. Stein is still occupied.

AN informal conference of representatives of museums, with members of the Museums' Association and other persons interested, was held at Salford, on October 18, by the invitation of the Museums and Libraries Committee of the Salford Corporation, who entertained the visitors. The meeting was well attended, the museums of Liverpool, Manchester, Leeds, Hull, Leicester, Bolton, Chester, and Warrington being represented among others. The afternoon was spent in the inspection of the Peel Park Museum and the recently opened natural history branch at Buile Hill Park, and Mr. B. H. Mullen, curator, afterwards gave a brief account of the recent extensive changes and developments carried out in the Salford museums. Mr. G. A. Dunlop, Warrington Museum, in a paper on the preparation of botanical specimens for exhibition, described in detail processes of drying flowering plants in silver-sand and boxwood sawdust, exhibiting samples of successful results with the latter medium, in which leaves and delicate floral structures were perfectly preserved. The forms were practically permanent; the colour of specimens exposed to the light might be expected to last about two years. An effective dry method of preserving succulent plants was, however, still a desideratum. Mr. H. Murray, Manchester Museum, followed with notes on wet methods of preserving plants for exhibition. Mr. E. E. Lowe, Leicester Museum, read a paper entitled "What should be the Curator's Ideal?" in which he offered evidence of the need for an all-embracing scheme or classification, as of an ideal museum, which should cover the whole field of museum work, and from which curators might select, and by which they might verify and coordinate their work in such sections of the whole as they might severally find it practicable to include in their programmes. Mr. Lowe submitted an outline of some portions of such a scheme, and was encouraged to proceed with the project.

THE first meeting of the new session of the Royal Geographical Society will be held on November 11, when Mr. Mackintosh Bell, director-general of the New Zealand Survey, will give a paper on the Great Douglas Glacier and its neighbourhood. Arrangements have also been made for papers by Dr. Hunter Workman, on the exploration of the Nun-Kun mountain group, in the Himalayas, and its glaciers; Dr. Vaughan Cornish, on the Jamaica earthquake; Mr. A. H. Harrison, on his search for an Arctic continent; and Dr. Tempest Anderson, on his visit to the volcanoes of Guatemala and St. Vincent. Among other papers provisionally arranged are the following:—the Duc d'Orléans, on his exploration in and around Novaya Zemlya; the Count de Lesdain, on his journey from Peking to Darjiling through Central Asia and Tibet; Mr. Laurence Gomme, on the story of London maps; Dr. T. G. Longstaff, on the Trisul district of the Himalayas; Mr. A. W. Paul, on Bhutan; Dr. W. S. Bruce, on his recent expedition to Prince Charles Foreland, Spitsbergen; and Dr. Johnston Lavis, on the influence of volcanic action on some features of the earth's crust. A series of lectures on the geographical conditions which affect the development of the British Empire is being arranged for, one or two of the lectures to be given each session; the lectures at present decided upon are:—on the British Islands, by Mr. H. J. Mackinder, and on Australia, by Prof. J. W. Gregory, F.R.S. Beginning on Thursday, January 23, and continued weekly, a course of six lectures will be given by Dr. H. R. Mill on the geographical distribution of rainfall in the British Islands.

From Mr. John Wheldon we have received a copy of a catalogue of ornithological literature, comprising nearly 1000 books and papers.

A paper by Messrs. W. K. Brook and S. Rittenhouse on the life-history and development of the hydroid *Turritopsis nutricula*, in which both the hydroid-stock and the free-swimming medusas are described, is published in the Proceedings of the Boston (U.S.A.) Natural History Society, vol. xxxiii., No. 8.

In the list of additions to the Zoological Society's menagerie in the Regent's Park, attention may be directed to a specimen of Phillips's dik-dik antelope from Somaliland, the first of its kind ever exhibited in the gardens. A true zebra from Cape Colony is likewise an important addition to the collection.

The council of the Ealing Scientific and Microscopical Society deplores, in its report for the past year, the lack of interest displayed by local residents in matters scientific, and the consequent want of expansion in the membership roll of the society. Unless at least twenty new members are enrolled during the coming year, the society's expenses must be cut down. Among the reports of addresses delivered during the year, attention may be directed to one on the continuity of the germ-plasm, in which an abstruse subject is explained in a remarkably clear manner.

It has long been known that the North American cat-fishes of the genera Noturus and Schilbeodes can inflict painful wounds with the spines of their pectoral fins, but some difference of opinion has hitherto prevailed whether a sac opening by a pore in the axillary region of these fishes is a true poison-gland. In the September number of the *American Naturalist* Mr. H. D. Reed, after careful examination of several species of these cat-fishes, states that the pore, which is the aperture of a gland, is present in all, and that in at least one species the secretions of the gland are poisonous. It has also been found that in species in which the spines are not strongly serrated, glands of the same type are developed on the pectoral and dorsal fin-spines. In these species, in which they attain their highest development, the glands are structurally similar to those of the weaver-fishes.

Among a number of interesting articles in the October issue of *Science Progress*, special reference may be made to one by Mr. F. V. Theobald on the economic relations of birds to agriculture, horticulture, and forestry. Despite the enormous amount of literature on British ornithology, the author is of opinion that our present information concerning the majority of the species is insufficient to admit of a definite pronouncement as to their utility or harmfulness, and that it is consequently necessary to study their food in a much more systematic manner than has hitherto been attempted. Some birds Mr. Theobald does not hesitate to condemn to destruction, among these being the black-cap, blackbird, and sparrow-hawk. Attention may also be directed to an article by Dr. A. Dendy on the pineal gland. Although its wonderful developmental history is fairly well known, we are still ignorant of the function of this organ. To remedy this we require a series of investigations into the physiology of the pineal organs, both in those animals in which they still exist as a sense-organ, and in those in which the epiphysis cerebri has assumed the character of a ductless gland.

The Bulletin of the Johns Hopkins Hospital for September (xviii., No. 198) is longer than usual, and contains a number of important papers on pathological subjects. Prof. W. G. MacCallum gives a short outline of an experimental course in pathological physiology which the students of the Johns Hopkins Hospital have the privilege of attending.

From Messrs. G. W. Bacon and Co. we have received a set of the first part of their "Photographic Nature Drawing Cards," reproducing illustrations of leaves. The size of the prints averages about 5 inches by 3 inches, and on each a single leaf is figured. They are nicely printed, and serve to indicate general shape, outline, and veining, but obviously the advantage lies with natural specimens.

A catalogue recently received of Leitz microscopes contains several new designs and fittings. A novel and improved form of fine adjustment, providing endless movement by means of a cam, is supplied with the better stands; being fitted to the connecting piece between the frame and the tube-holder, it is possible to curve the frame so as to give accommodation for large objects on the stage. In the so-called museum microscope there is a circular drum on which a dozen preparations can be fixed that rotates under the objective. Special features are combined in the mineralogical microscopes, and an opaque illuminator for fitting on the end of the tube has been designed. A pamphlet describing Edinger's drawing and projection apparatus has also been published.

The July number of the *Philippine Journal of Science*, vol. ii., No. 4 of the botanical series, is assigned to the identification of specimens collected by Mr. E. D. Merrill and others on Mt. Halcon, Mindoro. With regard to new plants described by Mr. Merrill, the most notable is a species of Centrolepis providing the first record for the order Centrolepidæ in the Philippines. The order is typically Australian, as four out of six genera are entirely confined to Australasia, and out of twenty species of Centrolepis this and one other only occur outside Australia. Several other plants of the collection bear out the same affinity; *Dianella caerulea, Halorrhagis halconensis*, and *Cladium latifolium* afford good examples. Two new genera are proposed, Halconia under the order Tiliaceæ, and Mearnsia under the order Myrtaceæ. A small parcel of mosses collected on the same expedition was referred to Dr. V. F. Brotherus. His determinations and those of the orchids consigned to Mr. O. Ames are also published.

Dr. Virginia Ridsdale has published a thesis (Lord Baltimore Press, 1906) dealing with the arrangement ot the real branches of plane algebraic curves. The Harnack and Hilbert processes of small variation from specially degenerate curves are applied to curves with the maximum number of branches, and the various possible arrangements of internal and external ovals are discussed. The author concludes that the theorem with which the paper professes to deal can be stated in several alternative forms. This theorem relates to the greatest and least numbers of ovals for a curve of given degree.

The Weekly Weather Report of the Meteorological Office for the week ending Saturday, October 19, states that the rainfall was more than the mean in all districts except Ireland N. In nearly all parts of the kingdom, except Scotland N. and Ireland S., the excess was very large. Several parts of the country recorded falls of much more than an inch within twenty-four hours, and some places more than 2 inches. Most of the heavy falls occurred either on October 15 or 16. At Lincoln (about $1\frac{1}{2}$ miles from the centre of the city) as much as 3·50 inches were recorded on October 16, and at Leith 2·61 inches on October 15, while over a large area of Great Britain measurements of between 1 inch and 2 inches were registered. The largest aggregates for the week were 4·92 inches at Bournemouth and 4·62 inches at Portland Bill.

THE report of the Government Meteorological Department on rainfall registration in Mysore for 1906 shows very clearly, both statistically and graphically, that the district average for the year was somewhat above the mean of the past thirty-seven years in all parts except in Shimoga and Kadur, but was, on the whole, not sufficient to make up for the deficiency of the two previous years. The greatest rain in twenty-four hours was, as usual, at Augumbe (Shimoga), where 15 inches fell on July 21 and $11\frac{3}{4}$ inches the following day. The director, Mr. J. Cook, states that though the interest of the observers in their work has greatly increased in recent years, many of the gauges are still badly exposed.

AN interesting pamphlet by Mr. D. W. Horner, entitled "Observing and Forecasting the Weather: Meteorology without Instruments," has recently been published by Messrs. Witherby and Co., 326 High Holborn (post free, 7*d.*). On reading this booklet we were impressed by the fact that much useful work can be done by the public generally without expense, and with advantage to themselves, by recording their observations as recommended. The greater part of the pamphlet deals with the importance of cloud observations, and the author points out how anyone possessing an ordinary photographic camera may obtain useful pictures of clouds and lightning flashes. To make the chapter on wind more complete, a table of the velocities corresponding to estimated force by Beaufort's scale is given; the equivalents were in general use until very recently, but have been slightly modified by a publication of the Meteorological Office (No. 180, 1906) bearing upon the subject. With reference to the supposed influence of the moon on the weather, the author states that there is "grave reason for doubt" that Sir W. Herschel compiled a table until recently published in almanacs; any doubt on the question was removed by Sir J. Herschel's denial in *Good Words*, 1864.

MESSRS. SANDERS AND CROWHURST have issued a new series of lantern slides from Mr. W. Farren's photographs illustrating wild bird life, taken from nature. The slides include many instructive pictures of birds and their habits. Enlargements of the photographs are also issued.

A SECOND edition, being the third impression, of Dr. R. Wallace Stewart's "Higher Text-book of Magnetism and Electricity" has been published by Mr. W. B. Clive. This edition contains an additional chapter on the electron theory of matter and radio-activity, written by Mr. J. Satterly.

A SECOND edition, which has been revised and enlarged, of Dr. Ernst Cohen's "Vorträge für Arzte über physikalische Chemie" has been published by Mr. W. Engelmann, of Leipzig. An authorised translation of the first edition, by Mr. M. H. Fischer, was published by Messrs. Henry Holt and Co., of New York, in 1903, and the English version was reviewed in NATURE of July 16, 1903 (vol. lxviii., p. 245).

FROM Messrs. Philip Harris and Co., Ltd., of Birmingham, we have received a specimen of their recently introduced students' clinometer and compass. It consists of a silvered dial of some $2\frac{1}{2}$ inches diameter divided into degrees in the two uppermost quadrants, and provided with a pair of sights of the usual folding pattern. About this dial revolves a metal collar carrying a spirit level, to which is affixed an index point indicating the angular elevation of the object under measurement. No fine degree of accuracy can be expected, of course, from a dial of so small a radius, but, with the accompanying compass, the instrument should be found extremely useful in educational work, such as is involved in the practical study of physical geography, inasmuch as it will familiarise the student with the principles of the angular measurements of elevation and azimuth. The clinometer would be simpler to use, it appears to us, and would give greater accuracy, if some method were devised of attaching the collar carrying the level and index to the stand, thereby leaving the sights and dial to move independently of the latter, which could then be accurately levelled at the commencement of the observation and afterwards left undisturbed.

OUR ASTRONOMICAL COLUMN.

MELLISH'S COMET, 1907*e*.—A second telegram from the Kiel Centralstelle informs us that the comet discovered by Mr. Mellish at Madison on October 13 was observed by Prof. Hartwig at Bamberg on October 15. Its position at 17h. 0·4m. (Bamberg M.T.) was R.A. = 8h. 26m. 13s., dec. = 8° 45′ 16″ S., and its magnitude 9·5.

The following are a set of elements and an ephemeris calculated by Miss Lamson from places observed on October 15, 16, and 17, and communicated by Prof. Pickering to the Kiel Centralstelle (Circular No. 100):—

Elements.

T = 1907 September 12·47 (M.T. Greenwich).

$$\left.\begin{aligned} \omega &= 291^\circ\ 42' \\ \Omega &= 55^\circ\ 32' \\ i &= 118^\circ\ 53' \end{aligned}\right\} 1907 \cdot 0$$

$q = 0·973$

Ephemeris 12h. (G.M.T.).

1907	α	δ	Brightness
		° ′	
October 19	8 14·1	−7 0	1·15
,, 23	7 57·7	−4 38	—
,, 27	7 36·0	−1 30	—
,, 31	7 6·8	+2 39	2·06

The brightness at time of discovery (mag. = 9·0) is taken as unity. On October 27 the comet will be about halfway between γ (26) Monocerotis and Procyon, and on October 31 it will be some 2° north of δ (22) Monocerotis. On the latter date the comet will rise a little to the north of east at about 10.30 p.m.

A BRIGHT METEOR.—Mr. W. F. Denning informs us that a fine meteor = ♀ was seen by Miss Irene Warner of Horfield Common, near Bristol, on October 19 8h. 50m. It disappeared close to the star δ Aquarii, near the planet Saturn, and was directed from the north-east region of Cygnus, near α and ε. It was of a fiery yellow colour and formed quite a conspicuous object even in the presence of the nearly full moon.

THE SPECTRA OF SUN-SPOTS AND MIRA CETI.—In the September *Astrophysical Journal* (vol. xxvi., No. 2, p. 123) Father Cortie compares the spectra of Mira Ceti, taken at Stonyhurst during the maxima of 1897 and 1906, with the sun-spot spectrum, and infers therefrom that the temperature of the spot vapours is lower than that of the photosphere, thus confirming the results previously obtained by Sir Norman Lockyer, Profs. Hale and Adams, and others. There are strong reasons for believing that the spectrum-producing vapours of Mira were at a higher temperature during the 1906 than during the 1897 maximum. In the first place the star was brighter, and therefore presumably hotter. Again, the changed intensity of the hydrogen lines and of the characteristic absorption bands also indicates, according to our present knowledge, an increased temperature in 1906. Concurrently, the titanium-oxide bands in the spectrum of Mira were weaker in 1906 than in 1897, and, as these bands are *stronger* in the spot spectrum than in that of the photosphere, it seems reasonable to conclude that the spot vapours are therefore cooler than those of the general photosphere.

The evidence thus afforded by the temperature, and the accompanying spectral, changes of Mira from one maximum to a higher one agrees with Sir Norman Lockyer's temperature classification of the stars wherein similar changes, from type to type, are held to determine the relative positions of the Antarian and Aldebarian groups.

RECENTLY DISCOVERED MINOR PLANETS.—In No. 4205 (October 10) of the *Astronomische Nachrichten*, Prof. Bauschinger gives a list of thirty-four recently discovered minor planets showing the permanent designatory number that has been allotted to each. The last date of discovery given is June 9, 1907, and up to that time six hundred and thirty-five of these objects had been allotted permanent numbers. The present list also gives the provisional designation, the name of the discoverer, the date of discovery, and, where it has been allotted, the proper name by which each asteroid is to be known. A second list gives the elements for the orbit of each minor planet where they have been determined. Fifteen of these objects, which were allotted provisional numbers in 1906–7, have been found to be identical with previous discoveries.

ELEMENTS OF COMETS 1907*a* AND 1907*d*.—A set of parabolic elements for the orbit of comet 1907*a* is published by Signor E. Tringali in No. 4205 of the *Astronomische Nachrichten* (October 10).

The same journal also contains a set of parabolic elements for comet 1907*d*, calculated by Prof. E. Millosevich from observations made on June 16, July 18, and August 22. The results of a number of observations of the latter comet made at the Kremsmünster Observatory during the period July 4 to August 28 are given by Prof. F. Schwab in the same issue. On August 18 the comet was of 2·5 magnitude, and its tail was seen to extend 16° in the direction from λ to γ Geminorum.

THE LIVERPOOL ASTRONOMICAL SOCIETY.—We have received the annual report of this very active society giving a brief *résumé* of the work done and papers read during the session 1906–7. Among the latter, reference may be made to the president's address delivered at the opening meeting by Mr. W. E. Plummer, who, in a most interesting paper, directed attention to a few of the more urgent problems at present facing the practical and the theoretical astronomer.

An excellent photograph of Mr. George Higgs is reproduced as a frontispiece, and that observer contributes a short paper dealing with recent advances in the absolute wave-length measurements of solar radiation. Some curious phenomena were described by Mr. C. T. Whitmell, who supposed the observer to be located on the sun, and from that standpoint surveyed the solar system. Of more practical interest were the papers by the Rev. R. Killip, on the planet Jupiter; Mr. H. Waters, who presented a few notes to beginners in stellar photography; and Mr. F. W. Longbottom, on work with a $12\frac{1}{4}$-inch reflecting telescope of 24-inch focus. The two last-named papers are illustrated by reproductions of photographs, that of the vicinity of γ Cassiopeiæ having been taken by Mr. Waters with a $3\frac{1}{4}$-inch Voigtlander portrait lens of 8 inches focal length mounted on a rough equatorial stand and driven by hand.

A MODERN SUN-DIAL.—The August number of the *Bulletin de la Société astronomique de France* (p. 360) contains an interesting illustrated description of a sun-dial which the author, Vicomte d'Aurelle Montmorin, thinks may suit the modern requirements of the general public. The usual gnomon is replaced by a wire stretched across a rectangular frame, its shadow being cast on to a semicircular dial at the back. The frame is adjustable on pivots to any latitude, and curves engraved on the instrument give the equation of time for every fifth day. Setting screws are provided to adjust for longitude, once for all, and for the equation of time, so that no calculation is necessary, the time being read off directly from the dial, which is divided into divisions of five minutes each. The instrument is very portable, and the author suggests an ingenious arrangement of selenium cells whereby the hours and quarters might be struck on one or two gongs.

FLEAS AND PLAGUE.

SIR LAUDER BRUNTON, F.R.S., delivered the inaugural address at the opening of the twenty-fifth session of the London School of Tropical Medicine on Monday, October 25, Mr. R. L. Antrobus, C.B., Assistant Under Secretary of State for the Colonies, presiding. He described the campaign against mosquitoes in relation to malaria and yellow fever; sleeping sickness, its spread along the lines of commerce in Africa and its transmission by a tsetse-fly; and then proceeded to discuss plague. The ravages of this disease in Europe in the fourteenth century under the name of the "Black Death" were described, and quotations from contemporary writers were given illustrating the terrible condition to which the countries attacked were reduced by the pestilence.

In India at the present moment the ravages of plague, though not so great as those of the Black Death or of the Great Plague in London, are nevertheless dreadful. During the first six months of this year no less than 1,060,000 deaths from plague occurred in India, and out of these 632,000 occurred in the Punjaub, which has a population of only twenty-five millions, that is to say, one in every forty inhabitants in this district has died of plague between January and June.

It has long been observed that great mortality in rats is apt to precede pestilence, and Mr. Hankin suggests that the story of the Pied Piper of Hamelin is a legendary account of a plague epidemic. Simond first suggested that fleas transmitted the virus, and the most convincing experiments have been made by Captain W. Liston, I.M.S., who found that 61 per cent. of white rats and 52 per cent. of Bombay rats contracted plague from fleas which had fed upon infected rats. He then found that fleas would infect guinea-pigs. He further showed that guinea-pigs did not catch plague if they were protected from fleas in various ways, *e.g.* by wire gauze, adhesive fly-paper, &c. His experiments have been confirmed and extended by the Advisory Committee appointed by the Secretary of State for India, the Royal Society, and the Lister Institute, who concluded from their experiments that:—

(1) Close contact with infected animals does not give rise to plague epidemic among guinea-pigs when fleas are excluded.

(2) If fleas are present, epidemic starts at once.

(3) An epidemic may be started when no contact with a plague-infected animal is allowed, when fleas from infected animals are introduced.

(4) Infection can take place without the animal being in contact with the ground. Thus a guinea-pig put in a wire cage and suspended 2 inches from the ground contracted disease.

(5) Aërial infection did not take place if the cage was 2 feet (that is, more than fleas jump) from the ground.

(6) In all the animals thus naturally infected the large proportion, 90 per cent. (nearly), of the buboes were in the neck; 179 animals were examined, and in obtaining fleas from animals 65·3 per cent. were obtained from head and neck.

The great difficulties in the way of preventive measures are ignorance and apathy, to which superstition is often superadded. In some parts of India there is great prejudice against taking life of any kind, but this is not universal, because in some parts goats are offered to Kalee, the Goddess of Destruction. If the Brahmins could persuade the natives that the sacrifice of a dead rat as often as possible to Kalee would avert pestilence, rats would very soon be destroyed, and plague would be at an end.

Cases of plague from time to time arrive at the Port of London, and rats might therefore become infected and start a pestilence in our midst. We are pursuing a foolish policy in allowing rat- and flea-infected districts to exist in the East End of London and other similar places.

THE THIRD "PREHISTORIC" CONGRESS OF FRANCE.

THE third Congrès préhistorique de France was held at Autun (Saône and Loire) from August 12 to August 18, and attracted some 350 adherents, about fifty more than did the congress held at Vannes in 1906. More than 150 archæologists attended the scientific meetings and excursions held at Autun.

The congress was opened in the town theatre, where an address of welcome was delivered by the Mayor of Autun. Then Dr. A. Guébhard and Dr. Marcel Baudouin, the president and general secretary respectively of the congress, made the usual statements, and were followed by the official delegate of the Minister of Public Instruction, Prof. Matruchot, of the Faculty of Paris and director of *Pro Alesia*. Prof. Matruchot congratulated the Société préhistorique de France on the success it has attained, and conveyed to it the compliments of the Government.

On Monday evening, August 12, the congressists attended a reception at the Town Hall at the invitation of the learned societies of Autun, a group of bodies held in high respect in France. The brilliancy of this gathering was enhanced by the presence of numerous professors and men of science from other lands, the list of those present including the names of M. Rutot (Brussels), Prof. Cossina (Berlin), MM. O. Montelius (Stockholm), Valdemar Schmidt (Copenhagen), Count Zeppelin d'Arlehausen (prefect of Lorraine), M. Wassre (Switzerland), MM. Lewis and Dickins (England), M. Peabody (U.S.A.), &c. In addition to several German professors who assisted in the meetings of the congress, there were also present Profs. Adrien de Mortillet (Paris), P. Girod (Clermont-Ferrand), Dr. Henri Martin, M. Edmond Hue, M. Gustave Chauvet (Ruffec), Dr. Baudon, deputy of Beauvais, &c.

Among the subjects discussed should be mentioned that which treated of the prehistoric features of the Eduen country, in which the congress was held, and which was celebrated in the Roman history of Gaul. In the environs of Autun itself is situated the "Champ de la Justice," a Neolithic station which has furnished a number of "finds," and formerly included a fine megalithic alignment, which to-day is totally destroyed. This was visited by those who attended the congress, and there is indubitable evidence that it was formerly an ancient fortified camp, of which only the eastern side of the vallum, which has been investigated by M. Déchellette, remains.

Part of another evening was devoted to each of the walls of the town, and groups of the congressists also visited the Roman remains of Autun, which is surrounded on all sides by primitive ramparts dating from the time of Augustus; the temple of Janus, the sepulchral pyramid of Couhard, and the principal gates, such as La Porte St. André and La Porte d'Arroux, were amongst the sites visited. Then another place of great interest was found in the Roman theatre, at one time an important structure, now a mass of ruins, which, however, forms one of the chief attractions to tourists in Autun.

The principal question on the agenda of the congress was that of prehistoric camps and fortifications, which have been thoroughly examined by the learned president of the meeting, M. Guébhard. These were clearly described and discussed by the president before a large meeting of the whole congress held in the theatre on the evening of August 13. The exposition was rendered more enjoyable by the lantern-projection of more than 130 slides, and was so enthusiastically received by the large audience present that another afternoon was devoted to this complex subject.

Another lantern lecture was delivered, on the afternoon of August 14. by Mr. Lewis (England), his subject being the principal megaliths of England, whilst Mr. F. V. Dickins (England) exhibited a number of photographs of Japanese megaliths taken by M. Goodhan. These photographs were greatly appreciated by the audience, and, in the subsequent discussion, Dr. Marcel Baudouin, the great French authority on the study of megaliths, insisted upon the great interest of the English cromlechs and of the Japanese *allées couvertes*, which belong to a more recent epoch, and of which the funeral ornaments singularly recall those of the Gaulish sepultures.

This meeting concluded with a lantern demonstration given by Dr. Henri Martin, who dealt with the remains, showing traces of utilisation, found at stations of the *Moustérienne* epoch in Charente and Dordogne.

It is not advisable to describe here all the communications discussed at the congress, but it should be recorded that, concerning the megaliths, it seems to be generally admitted in France that the monuments were unquestionably oriented for a set purpose. Dr. Baudouin, who, following Gaillard (of Plouharnel) and many others, scientifically defends this theory in France, stated that the orientation varies from N.E. to S.S.E. in Brittany and Vendée, and clearly refers to the rising sun if one takes into account the latitude of the place and, an important factor, the momentous seasons.

The variation of the orientations indicates that in erecting these monuments all the seasons were considered, although the alignments to the winter sun predominate, as in Brittany, where the most frequent direction is S.S.E. This is in good accordance with the results of the work recently prosecuted in England concerning this important problem. The author also insisted upon the relations between menhirs and dolmens, and showed by an example, *apropos* and indisputable, that the menhirs were really indicators of megalithic sepultures, or of the limits of the necropolis of this epoch. By using two certain holed stones as indicators, he was enabled to discover an *allée couverte* which was buried under the soil, and had until then remained undiscovered. This "find," made with remarkable scientific precision, was received by numerous foreign congressists as a striking example of the value of a theory which many of them still ignore.

The question of the place the Aurignacien stratum should occupy in the classification of Palæolithic industries was also discussed at length, first at Autun by Prof. Girod, then at Solutré itself by Dr. Arcelin, jun., and M. Adrien de Mortillet. One sees that the excavations of Solutré should afford the much-desired solution of this problem, but it is not there, for the stratigraphy of that classical station is very intricate owing to serious landslides, and the consequent over-running, which detracts all meaning from the disposition of the layers laid bare by the recent work of M. Arcelin, jun. This worker believes, however, the *sous-solutréenne* layer to be re-mounted; but M. de Mortillet holds the opposite opinion, and believes that the over-running is real.

The question of forgeries was also discussed, and it was decided that it is necessary to warn prehistorians concerning "finds" in the Charollais country, near Autun. Possibly some of the Neolithic arrows of bizarre shapes are genuine, but it is certain that others are the work of clever forgers.

"Eoliths," the fruitful source of much debate, also came up for discussion. The subject seems threadbare in spite of the frequent writings of M. Rutot. He apparently admits that there are "eoliths" of every epoch of the "Stone age," but the true "eoliths" are those which correspond to the Tertiary deposits and suddenly appear in the Lower Quaternary. This is what may be called, with Dr. Baudouin, the *Préchelléen*, without entering into the detail of the layers.

Four days, instead of three, were this year devoted to the final stages of the congress, the session being augmented by one day for this purpose. In this time all the camps were visited, special attention being paid to the stations of the Iron age. Thus, in the days devoted to the more extensive excursions, the congressists visited Mont Beuvray, near Autun, which, under the name of *Bibracte*, was formerly the central Oppidum of the Aedui. Here are carefully preserved the precious remains of brave Gaulois, of which other specimens were also seen in the

Musée de l'Hotel Rolin. The toilsome journey to an altitude of 810 metres was amply repaid by a good lunch, and, in spite of the rain, by the more artistic pleasure of the grand panorama of surrounding plains and hills which is to be seen from the summit.

This visit to Mont Beuvray, a hill well known to the whole world, since it has justly given its name to an important epoch—the Iron age—recalled the fact that Cæsar once visited this Oppidum, and shortly after protected the Aedui from the Helvetian attack, and also from that of Ariovistus. It was here, too, that the Gauls held the famous general assembly, after the Aedui abandoned the Roman cause, and proclaimed Vercingetorix, the proclamation no doubt taking place near the *Pierre de Vibre.*

The ancient importance of this fortified Eduen camp is also attested by the fact that Cæsar, after the triumph at Alesia, established himself there. After this, Gaul was completely submitted to the Eastern civilisation, and *Bibracte* (with its *Beuvraysien, i.e.* its *industrie du Fer*), some years after the commencement of the Christian era, was completely obliterated by a forest fire. Vestiges of the town have been found by a modern Eduen, Bulliot, and a room in the Musée de l'Hotel Rolin is devoted to the results of the gigantic excavations. These were shown to the congressists by his worthy successor, M. Déchelette, who also exposed, for the congress, several Gaulish habitations, and prepared an exposure laying bare part of the old ramparts of the Oppidum, thus affording the visitors a view of a good example of the constructions of that epoch.

On August 16 an excursion to the boundary of the Côte d'Or and Saône and Loire occupied the attention of the congress, and a number of dolmens in the neighbourhood of Nolay and Decize were examined, but these do not recall anything of those well-known monuments on the borders of the Gulf of Morbihan. This visit showed what becomes of monuments in the centre of France, as those of the Field of Justice, in Saint Pantaléon, near Autun, had already appeared as an ultramicroscopic reduction of those of Menec and of Kerlescant at Carnac.

The evening was devoted to an enjoyable visit to the camp of Chassey, a typical Neolithic fortification occupied later by the Gallo-Romans. In the hands of the late director of the Musée Rolin, Dr. Loydreau, this camp furnished a valuable collection to the museum, and, thanks to the enthusiasm of M. R. Gadant, the room devoted to the collection was solemnly declared open during the visit of the congress. The subject of this second excursion was restricted entirely to the two principal periods of the polished stone epoch.

Looking south from Chassey, the far-away plateau of Aluze may be seen, considered by the Eduens as being the only Alesia possible. This supposition has not, however, prevented M. Etienne Bonneau from preparing his modest work, in spite of many difficulties, on the Siège d'Aluze par J. César.

At the camp of Chassey, of which the northern and southern parts of the vallum remain intact, excavations had been specially preserved, and furnished the visitors numerous fragments of Neolithic pottery and remains of Bovides, &c.

The third day was devoted to the Palæolithic age, to the period of the *pierre taillée*, and to this end the congressists visited the very fine collection made by Arcelin *père* from the classical beds of Solutré, and now to be found in the Musée de Mâcon. The son of the inventor of Solutré, Dr. Arcelin *fils*, was the guide, and had prepared a new cutting of the *Clos du Charnier*, which showed *in situ* the exact stratification of the beginning of *Solutréen*. As has already been mentioned, this visit did not give the key to the thorny question of *Présolutréen* or *Aurignacien*, on which sides are taken by the leaders of the Belgian and French brigades.

But the old school of prehistoric France showed that the Solutré bed has been greatly modified by the earth displacements, and so rendered little assistance to the solution of the Aurignacien problem. Against this the few facts have shown that the layers, as known, of horses, which form the base of the station, appear to be contemporaneous with the *Mousterien*. In fact, it appears, *a priori*, that one such place which had been frequented by the Palæolithic workmen had also been inhabited by the Solutréens. Certain flints, and remains of horses, apparently prepared on the Mousterienne model, have been found by Drs. Arcelin and Baudouin.

On the last day of the excursions a visit was made to the Oppidum d'Alesia, where there are rare traces of the Gaulois (huts, &c.). The epoch appears to be completely the Gallo-Roman, *i.e.* at the end of the Iron age. Here is to be seen the result of two years' assiduous labour, and one sees that if Faith is not able to raise mountains, Science of to-day is able to dig out from their foundations the majestic ruins of several successive Roman civilisations. In face of these works, the question which suggested itself was, "If by some unlikely chance this was not the true Alesia, how is it that a town, having presented such elaborate monuments, has left no trace of itself in the primitive history of France?"

This visit, with that to the two special walls which were seen at *Alise Sainte Reine*, worthily brought the congress of Autun to a close.

As a proof of the enthusiasm aroused, it may be stated that the last excursion attracted more than 100 participants. In spite of the complexity of the excursion programme, and in spite of the large number of adherents, the congress programme was carried out punctiliously.

The splendid organisation of this Congrès préhistorique de France may henceforward remain a model for others. It is to be hoped that its success will be repeated upon the occasion of the fourth congress in 1908, and that a still greater number of foreign workers, more especially the specialists of Great Britain, will be present.

ECONOMIC BIOLOGY AND AGRICULTURE.

A CONFERENCE to mark the inception of a new department of economic biology at University College, Bristol, was held on Thursday, October 17, in the Bristol Museum, the Right Hon. Henry Hobhouse, P.C., taking the chair.

Mr. A. D. Hall, director of the Rothamsted Experimental Station, speaking upon the experimental work at Rothamsted, directed attention to the part played by bacteria in the fixation of nitrogen in the soil. Mr. E. S. Salmon (Agricultural College, Wye) referred to the destructive character and prevalence of fungus pests, and the beneficial results following the use of various spray solutions. Mr. F. V. Theobald (vice-principal Wye College), in dealing with the investigations upon insect pests, urged the importance of each worker making his own observations upon their life-history and habits within the district in which he worked, otherwise much mischief would result from the repetition of misstatements. It has been found, for example, that the winter moth, the wingless females of which are supposed to emerge in the middle of October and ascend tree trunks to lay their eggs, does under certain conditions and in some districts appear earlier, so that grease banding of the trees is in such cases carried out too late, and much damage results.

Prof. J. R. Ainsworth Davis (Aberystwyth), speaking upon economic biology in relation to fisheries, urged a much closer connection between educational work and trade. He also pointed out the need of a fuller knowledge of the movements of food fish, and the importance of organising systematic investigations upon the fisheries of the Bristol Channel and the rivers flowing into it. Mr. T. H. Middleton (Board of Agriculture and Fisheries), speaking upon the public and departmental aspects of economic biology, stated that it is the policy of the Board to subsidise institutions establishing departments of agriculture, recognising that the work of economic biologists is of public benefit, in that all are consumers. The result of disease and unscientific management leads to dearer foodstuffs. The Board has a special interest in the work of biologists, and can be made an effective intermediary between the scientific man and the grower. It is possible that a time will arrive when the Board will be able to do more in support of applied science, and when that time comes consideration will be given to those institutions which have actively worked for the benefit of agriculture, forestry, and fisheries.

Mr. W. R. Barker, chairman of the Museum and Art Gallery Committee, said the committee of that institution recognises the beneficial effect of active cooperation with the University College of Bristol, and to that end is rapidly developing a special section of economic biology for the exhibition of insect and plant pests, and of material damaged by them. Prof. A. F. Stanley Kent explained that the new department has been called into existence by the needs of the west of England, and that applications for help and inquiry have come in rapidly. Valuable research work has already been carried on at the college in matters relating to economic biology, and important results have been obtained in connection with ciders, black-currant disease, and the development of lobsters on the coast of Devon and Cornwall. It was announced that Mr. Richardson Cross has offered land for an experimental station, where investigations upon various crops, manures, &c., can be carried on; additional land has also been offered by Mr. James Sinnott at St. Anne's Park. It is intended that the teaching side of the work shall be kept subsidiary to the advisory, and that the real function shall be to supply information and render help wherever required. Prof. Lloyd Morgan pointed out that academic and national interests in these matters are one, and that the department will directly benefit the community. Mr. W. E. Collinge (Birmingham) described the work of his department in the University of Birmingham, instancing as an example of the work done the yield from two orchards of the same acreage, and only separated by a road. One left unsprayed produced fruit worth 122*l.*; the other, that had been sprayed, produced fruit worth 497*l.*

SYNTHETICAL CHEMISTRY IN ITS RELATION TO BIOLOGY[1]

IT is easy to understand why in its early youth organic chemistry was so closely connected with biology; the materials which the chemist was called upon to investigate were mostly products of animal or vegetable origin. Indeed, carbohydrates, proteins, and vegetable acids served Lavoisier, Gay-Lussac, Berzelius, and Liebig as materials in elaborating the methods of elementary analysis.

The isolation of urea from animal urine by Rouelle, the recognition of uric acid, lactic acid, malic acid, and glycerine by Scheele, the isolation of asparagine by Vauquelin and Robiquet, of morphine by Serturnier, together with many other similar discoveries accomplished during the first ten years of the nineteenth century, are admirable examples of the manner in which the living world was drawn upon and made to yield up its treasure of chemical compounds. The many hundreds of natural organic compounds enumerated in the text-books of animal and vegetable chemistry are proof of the rich harvest since gathered in this field of investigation; but how small is their number when compared with the 130,000 carbon compounds which organic chemistry can boast of to-day. All these, it is known, are either products of the artificial transformation of organic matters occurring naturally or have been completely synthesised from their elements. The accumulation of this huge material, including the elaboration of the necessary methods, has been the main occupation of organic chemists during the past sixty years; and as their discoveries gave rise to much happy speculation, for the time being they took the lead in developing chemical theory.

It is not to be denied that, in the latter half of the last century, owing to the growth of the subject in importance, organic chemistry became separated from biology. It cannot be mere chance that the most famous of Liebig's pupils, A. W. Hofmann, A. Kekulé, and A. Wurtz, did not follow the example of their great teacher, whose chief triumphs were won by the use he made of chemical methods in solving biological problems. Perhaps they were restrained by the feeling that, mainly through his influence, physiological chemistry had been developed into a separate discipline, which should be cared for by men who could devote themselves entirely to its service. Such subdivision of labour undoubtedly has many advantages; the disadvantages would have outweighed these had it precluded interchange of experiences and friendly co-operation of workers in the two fields; the history of both sciences, however, affords ample proof that such has not been the case.

Physiologists have ever been ready to avail themselves of the latest developments of chemical analysis and synthesis, whilst organic chemists have not only been stimulated in many ways by biologists, but their studies have derived much practical aid from biological science. I may instance the modern development of the chemistry of fermentation, which began with the pioneer work of Pasteur, and was greatly favoured by the introduction of Koch's refined bacteriological methods; also the flourishing industry to which the manufacture of medical remedies prepared by synthetic methods has given rise.

But organic chemistry will certainly never be content to act as the mere handmaid of biology. This is impossible, as the theoretical and technical problems which she is already called upon to consider are too numerous, and they cannot fail to increase in number and importance in the future; but I do consider it not only possible, but desirable, that the close connection of chemistry with biology which prevailed in the days of Liebig and Dumas should be re-established, as the great chemical secrets of life are only to be unveiled by cooperative work. I will therefore attempt to indicate the part chemistry can play by reference to cases of which I can claim to have personal experience.

We know that in nature the construction of organic matter begins in the leaves of plants with the conversion of carbon dioxide into sugar, from which many physiologists suppose the complex substances contained in the living cell are formed by further changes in which nitrogen, sulphur, and phosphorus take part.

These transformations are for the most part enveloped in mystery. We know nothing definitely even of the assimilation of carbon dioxide. Of the various hypotheses advanced to explain the change, that advocated by A. von Baeyer has gained most support, namely, the view that the initial product is formaldehyde, glucose being formed from this by a process of polymerisation. Actually both changes have been effected artificially. After it had been shown by Butleroff that on heating formaldehyde with lime water a sugar-like, syrupy product is formed, and O. Loew had improved the method of effecting the condensation, I was able to adduce proof that the complex mixture contains a small quantity of an α-acrose which can be transformed into glucose. As it was known that carbon dioxide could be converted into formaldehyde by more or less drastic means, the preparation of glucose from carbon dioxide thus became a possibility. Recently, Fenton has succeeded in carrying out the reduction of carbon dioxide to formaldehyde at a low temperature in aqueous solution, so that it is now possible to effect the complete synthesis of sugar at temperatures such as prevail in the living plant. But how thorough is the work of the plant in comparison with our laboratory practice; usually when such questions are discussed, the poor yields which our methods give rise to are forgotten!

I need only allude here to recent apparently successful attempts, on the one hand, to effect the reduction of carbonic acid to formaldehyde by means of light, and, on the other, to detect formaldehyde in green leaves, as Prof. Meldola dealt exhaustively and critically with these questions in his presidential address eighteen months ago. I may be allowed, however, to dwell somewhat on one peculiar feature of the natural change, namely, the asymmetric character of the synthesis; according to present experience, and especially the brilliant investigations of H. Brown and Morris, the optically active hexoses of the *d*-series, glucose and fructose, are alone formed.

But from the experience gained in effecting syntheses in the sugar group, as I showed some time ago, it is possible to give a fairly satisfactory explanation of this change. It is only necessary to assume that the condensation is preceded by the formation of an additive compound of

[1] Abridged from the Faraday lecture delivered by Prof. Emil Fischer, F.R.S., at a meeting of the Chemical Society held at the Royal Institution on Friday, October 18.

formaldehyde with some optically active constituent of the chlorophyll granules. I shall give a more precise form to this hypothesis if I say that I consider it probable that the carbon dioxide itself enters into combination in this manner, as there is reason to suppose that the proteins offer sufficient opportunity for its fixation; according to Siegfried, even the simple amino-acids are capable of combining with carbon dioxide. I am inclined to think that this compound with carbon dioxide undergoes decomposition into oxygen and a reduction product, probably a derivative of formaldehyde; the condensation to sugar takes place either in the original asymmetric complex or in one produced from it by a secondary change involving the separation of the formaldehyde and its re-association in some other manner. It may be that the condensation takes place directly or that intermediate compounds, biose or glycerose, are formed. Thanks to the researches of Marckwald, and especially those of Mackenzie, we are acquainted with a whole series of asymmetric syntheses; no one of these, however, is half so complete as that involved in the formation of sugar under natural conditions. Indeed, it is obvious that if the natural process is to be imitated *in vitro*, it will be necessary to alter the methods hitherto adopted in every single detail; difficult as this may appear, it is not altogether impossible.

But even if this be done successfully, the precise nature of the assimilation process will not be finally elucidated. It is to be expected that this will only be accomplished when biological research, aided by improved analytical methods, has succeeded in following the changes which take place in the actual chlorophyll granules.

The carbohydrates elaborated by the plant undergo combustion to carbon dioxide and water in the animal body. The change is easily effected by means of powerful oxidising agents at the ordinary temperature; the natural process, however, must be a very different one, as in the organism oxygen is conveyed to the carbohydrate by oxidising enzymes, and doubtless many intermediate products are formed of which we know little at present.

It would be easy to multiply examples; but these two are sufficient to demonstrate the incompleteness of the explanation of biochemical processes deduced from the data of organic chemistry. The service rendered to biology by chemical analysis and synthesis, which will be rendered by it in even greater measure in the future, is to be sought in other directions.

The ultimate aim of biochemistry is to gain complete insight into the unending series of changes which attend plant and animal metabolism. To accomplish a task of such magnitude, complete knowledge is required of each individual chemical substance occurring in the cycle of changes and of analytical methods which will permit of its recognition under conditions such as exist in the living organism. As a matter of course, it is the office of organic chemistry, especially of synthetic chemistry, to accumulate this absolutely essential material. The chemical constitution of hundreds of carbon compounds which occur naturally has already been determined, and their more important properties have been established; but far more remains to be done. In proof of this, let me briefly direct your attention to the three great classes of substances which predominate in the living world: the fats, the carbohydrates, and the proteins.

It was established at least ninety years ago by Chevreul, in the course of his celebrated investigations into the process of soap-making, that the fats can be decomposed into the glycerine discovered by Scheele and into fatty acids; but the relationship of these latter to one another could not be understood until the conception of homologous series had been evolved in organic chemistry. The classical researches of Berthelot and the discovery of glycol by Wurtz were necessary preliminaries to the establishment of the constitution of glycerine; the final proof that the fats are neutral glyceric salts of the fatty acids was first provided by Berthelot's synthesis. Synthetic methods have made us acquainted with the mono- and di-glycerides and also with mixed triglycerides such as have frequently been met with of late in nature. Nevertheless, the group in which the natural fats are ranged is one in which there are still many lacunæ and many misstatements to be corrected.

The problems afforded by the fats are simple, however, in comparison with those connected with the carbohydrates. The original subdivision of the group into mono-, di-, tri-, and poly-saccharides has been justified in practice. Up to the present time only the monosaccharides have been studied satisfactorily from the point of view of their spatial structure. The growth of our knowledge of the monosaccharides has proved in many ways to be of importance in connection with biological inquiry, especially in enabling us to penetrate the mystery of enzyme action somewhat further.

On contrasting the effects which emulsin and the enzymes in yeast produce on the various glucosides prepared by synthetic methods, I was led to conclude, not only that there was a difference between the two series of optical antipodes similar to that discovered by Pasteur in the course of his studies of moulds, but that very slight changes in configuration were sufficient to inhibit the action of enzymes entirely. I was led by these observations to apply the simile of *lock* and *key* as an expression of the close inter-relationship in configuration which obtains between the enzyme and the substance which it attacks. Similar results were obtained on investigating the behaviour of the stereoisomeric hexoses with yeast, the fermentative power of which we now attribute to an enzyme—E. Buchner's zymase.

The experience gained with the glucosides became of service in studying the polysaccharides. Another outcome of the investigation has been the discovery of distinct enzymes capable of attacking di- and tri-saccharides. As the result of these inquiries, I was able to formulate a rule of general biological significance, namely, that the alcoholic fermentation of a polysaccharide is necessarily preceded by its hydrolysis by some particular enzyme. It was shown, especially in the case of the invertase of *Monilia Candida*, that it is not essential that the enzyme should even be soluble in water.

Unfortunately, but few successful syntheses of polysaccharides have been effected. It is most desirable, therefore, that better methods should be devised, as it is probable that the attack on the dextrins, gums, and similar undeciphered substances is most likely to be successful if made from the synthetic side. It is to be expected that biology would gain much by the discovery and utilisation of such materials; more, perhaps, than it has from the study of the monosaccharides and of the glucosides prepared by artificial means.

The carbohydrate group is that in which use was first made of enzymes as synthetic agents. Such syntheses fascinate the imagination, as they approximate closely to natural processes; but I may point out that they cannot take the place of purely chemical methods, as these latter are so much more under our control and can be varied in so many ways that we are in the position to produce materials which it is quite impossible for the organised world to furnish. Laboratory synthetic methods will be indispensable for a long time to come, not only for preparative purposes, but also as the means of elucidating the structure of complex substances of natural origin.

This contention is applicable to the proteins even more than it is to the carbohydrates; as they are among the most complex substances produced in the living world and are concerned in all the vital activities of the cell, a complete comprehension of their nature must obviously precede the full development of biological chemistry. We distinguish to-day some forty to fifty natural proteins, discovered by the joint labours of chemists and physiologists; but it is to be expected that as the methods of differentiating and separating them are improved, their number will be largely increased.

At present the majority are known only in an amorphous form; some important terms of the group, however, such as oxyhæmoglobin, egg albumin and the albumin of horse serum, excelsin from the Brazil nut, and the edestins from other plant seeds, have been obtained in definite crystals; but, unfortunately, it cannot be decided from their crystalline appearance whether these products are definite substances, as the tendency to form mixed crystals is the greater the more complicated the molecule. Examples in point are afforded by the aniline dyes, the higher fatty acids, and the purine compounds;

and those who have studied the chemistry of the natural silicates will be aware of the extension which mineralogists have been compelled to give to the conception of isomorphism. It would therefore be altogether surprising if the crystallised natural proteins should turn out to be single substances.

Of the numerous attempts to unravel the constitution of the proteins by analytical means, the only method which has given useful results hitherto is that of hydrolysis. Hydrolysis can be effected by acids or by alkalis, and also by digestive enzymes; the products, it is well known, besides ammonia, are albumoses, peptones, and ultimately amino-acids. The wide range of variation in composition of these amino-acids is shown by examining a list of all the substances hitherto prepared from the proteins.

The proportions in which the various amino-acids are obtained from the different proteins vary very considerably. In some cases they are altogether lacking, as may be proved by application of the definite tests for tyrosine, tryptophane, or glycine; but it is worthy of note that, as a rule, the amino-acids isolated from the mixtures produced by subjecting albuminous substances to hydrolysis all occur almost without exception, especially is this true of the important proteins which play the chief part in animal or vegetable metabolism, so that the conclusion must be drawn that none of them can be dispensed with in organic life. With the exception of diaminotrihydroxydodecanoic acid, they have all been so thoroughly investigated that their structure is well established. The majority also have been synthesised, proof of their structure having, in fact, been given in this way. Only oxyproline, histidine, and diaminotrihydroxydodecanoic acid remain still to be synthesised.

With the exception of glycine, all the amino-acids derived from natural sources are optically active; but when prepared by ordinary synthetic methods, as is well known, they are obtained in the first instance in the racemic form. The resolution of the racemoids into their optically active components has been effected quite recently in most cases. Asparagine, however, which is closely related to aspartic acid, had been resolved into the two active forms by recrystallising the inactive synthetic product from water and separating the two constituents mechanically. Moreover, in the case of some other amino-acids, for example, leucine, the antipode of the natural form had been obtained by partially fermenting the synthetic product with moulds. The complete synthesis of the active amino-acids which are obtained from natural sources was first accomplished by the method I introduced based upon the use of the acyl derivatives. The method has been applied with success to the majority of the synthetic products; its extension to the remaining cases, proline, lysine, tryptophane, and cystine, is not likely to be attended with any difficulties.

As the amino-acids are formed from the proteins, not only when these are subjected to the action of hot acids and alkalis, but also at moderate temperatures by the agency of the digestive enzymes, they are to be regarded as the true foundation stones of protein molecules. Opinions adverse to this hypothesis are only occasionally met with; they centre round the arbitrary supposition that complicated atomic re-arrangements may take place during hydrolysis.

Were one inclined to regard such objections as of moment, all the experiments on the determination of the constitution of organic compounds by degradation methods would be useless; moreover, the conclusions which have been drawn in other cases from the results obtained by the dissection of compounds have been too frequently confirmed by their synthesis. It is now possible to make this claim on behalf of the proteins, as it has been found to be possible, by a process the reverse of hydrolysis, to associate amino-acids in such a manner that substances are produced which, in the case of the simpler terms, closely resemble peptones, whilst the more complex resemble proteins.

I have termed these synthetic products *polypeptides*, in view of their relationship to the peptones and to facilitate systematic treatment of the group on the lines of the carbohydrates.

No useful purpose will be served by my giving an account of the synthetical methods on the present occasion, especially as I had the honour, six months ago, of describing to you the preparation of an octadecapeptide derived from fifteen molecules of glycine and three molecules of *l*-leucine, a substance which in its external properties closely resembles many natural proteins. I may say that more than one hundred of these artificial polypeptides have already been synthesised.

Many of them, it is true, belong to the lower stages, but all the amino-acids previously mentioned, with the exception of diaminotrihydroxydodecanoic acid, have been made use of in their preparation. The synthesis of the higher terms has been restricted hitherto to the combinations of glycine, alanine, and leucine; there is not a shadow of doubt, however, that all the remaining amino-acids could be associated in complicated systems with the aid of our present methods. The knowledge of the artificial polypeptides thus acquired has opened up new ways of investigating the peptones and albumoses analytically. During more than fifty years, physiological chemists have endeavoured without much success to isolate homogeneous substances from these ill-defined materials; all the products described by them, however, bear indubitable evidence of being mixtures. By making use of new methods based on the study of the polypeptides, it has been possible during the last two years to isolate and detect with certainty quite a number of dipeptides among the decomposition products of the proteins.

In spite of encouraging successes, I am fully aware of the difficulty of discovering the nature of all the components of the various peptones and albumoses; but in preparing the way for the synthesis of the natural proteins this is not even necessary. Probably the work can be restricted to the reconstruction of the original system from the major products of cleavage formed in the process of hydrolytic dissection. I am indeed venturesome enough to cherish the hope that I may be able to solve this problem in the case of silk fibroin, one of the simplest proteins. To deal with the whole of the proteins will be a gigantic task; so large a number of separate investigations will be necessary that nothing less than the life-work of a whole army of inventive and diligent chemists will suffice to complete it. Probably, too, the unpleasant discovery will be made that the natural proteins as we know them to-day are only to be obtained by mixing the homogeneous artificial products.

I have sketched this prospect merely to indicate the manner in which synthesis must play the leading part in this field of work. The nature of the more complicated carbohydrates, as I have already pointed out, will also have to be determined in the future, I imagine, mainly by the application of synthetic methods. Obviously the conditions are very similar in the case of the dextrins and gums to those met with in the case of the proteins, and starch, which has hitherto been regarded as a homogeneous substance, appears also to come into the same category, according to Maquenne's observations.

Not only do the proteins constitute the major part of living protoplasm, but they appear also to be the material from which the organism prepares its most wonderful agents—the ferments or enzymes. In many of the more thoroughly investigated biological processes their cooperation has been demonstrated, and there is good reason to suppose that they take part in all changes occurring within the living cell. So much is certain, the physiological chemistry of the future will be largely concerned with the study of fermentative changes; many indications that this must be the case are to be met with in tracing its latest developments.

The number of the enzymes has been increased to an extraordinary extent during the last ten years. I may allude to the newly discovered enzymes correlated with the carbohydrates: maltase, lactase, mellibase, trehalase, amygdalase, inulase; to the various oxidases: laccase, tyrosinase; to the lipases, erepsin, enterokinase, arginase, the sucroclastic and glucosidoclastic enzymes, and finally to the zymase of alcoholic fermentation. Much valuable information has been accumulated as to the manner in which they act, as to their formation from zymogens, and as to their assistance by co-ferments and their retardation by chemical agents or by anti-ferments. The specific character of their action, in other words, their dependence on the structure and configuration of the object they attack, has been proved beyond doubt, and favours very definitely the assumption that enzyme and hydrolyte enter temporarily into combination, a conclusion to which H. E. Armstrong and E. F. Armstrong have quite recently again very properly directed special attention; but, unfortunately, we know practically nothing of the composition of the enzymes, as the complete isolation of an enzyme has never been accomplished.

From observations hitherto made, it appears in a measure probable that they are derived from proteins and possess a protein-like character. If this be so, it may be hoped that the experience gained with the proteins will be of service in the investigation of enzymes.

In the meantime, there are other directions in which synthetic chemistry can be of service in elucidating the chemistry of fermentation. In the same way that the artificial glucosides have been of use in establishing the dependence of the action of enzymes on configuration, the synthesised polypeptides are now being used by Abderhalden, Euler, and others to define and measure the activity of the proteoclasts. In a like manner, the synthetic exploration of the purine group has served to direct the recent observations on the fermentative de-amination and oxidation of adenine, guanine, and xanthine. Finally, attention may be directed to the use that has been made of stereochemical considerations in the course of Bertrand's interesting studies of the oxidation of polyhydric alcohols by the sorbose bacterium.

Not only have the methods of organic chemistry proved to be fruitful of results in the case of the proteins, but also when applied to complex derivatives of the latter, such as the nucleo-proteins, for example. Thus we are indebted to the brilliant researches of A. Kossel and his school for our knowledge of no less than four bases of the pyrimidine and purine group obtained by breaking down nucleic acids, and the analytical investigation of the latter has already been carried so far that, in the opinion of H. Steudel, it is to be expected that their synthesis will be effected at no distant date. Similar success may be hoped for even sooner in the case of the lecithins. Structural chemistry, moreover, is slowly acquiring the mastery over cholesterin by making use of the experience afforded by the synthetic study of the hydroaromatic substances.

Besides the old well-known constituents of the animal body, new substances having quite unexpected properties have been added from time to time. Such are iodothyrin from the thyroid gland—discovered by Baumann—and crystalline adrenaline—isolated by Takamine from the supra-renal capsule—minute doses of which increase the blood-pressure. Judging from analytical results and the synthesis effected by F. Stolz, adrenaline possesses a relatively simple structure. In the opinion of the discoverers, this is probably true of the "pancreatic secretin" made known by Bayliss and Starling's researches, which has the remarkable property of liberating enzymes from the pancreas. May it not also be true of the toxins of many infectious diseases and of the antitoxins used in serum therapeutics, the discovery and systematic investigation of which by Behring, Roux, P. Ehrlich and others, are to be reckoned among the greatest achievements of modern biology and medicine?

The methods of organic synthesis will certainly serve to throw light on the nature of all such substances of animal origin. Equally numerous problems await solution in the plant world.

The great success with which the alkaloids and terpenes have been studied during the past ten years is known to all, but it is only too obvious that much still remains to be done when such substances as quinine, morphine, and caoutchouc remain to be synthesised.

Alizarin and indigo are prepared artificially in huge quantities, and we are well informed as to the structure of hæmatoxylin and kindred substances; but our ignorance is correspondingly great of most of the blood colouring matters, as well as of many coloured constituents of our own bodies—of the hair, the skin, and the eye.

The fullest recognition must be accorded, however, to recent investigations on the complex colouring matters of the blood and of chlorophyll, which is distantly related to the former, associated with the names of Schunck, Nencki, Marchlewski, Küster, and Willstätter.

In fine, the aid of synthetical chemistry is required in every direction in arriving at a clear understanding of structure and of change. The methods at our disposal in the laboratory are doubtless altogether different from those which come into operation in the living world, but chemists are already trying to effect changes in carbon compounds by means of so-called mild interactions, under conditions comparable with those which prevail in the living organism. It may suffice to refer to the development of a number of catalytic processes and to the comprehensive studies on the action of light on organic substances undertaken by Ciamician. In fact, the effort is already being made to cooperate with biology; it is clear that a section of the forces of organic chemistry is being directed once more towards the goal from which it set out. The separation from biology was necessary during the past century while experimental methods and theories were being elaborated; now that our science is provided with a powerful armoury of analytical and synthetical weapons, chemists can once more renew the alliance both to its own honour and to the advantage of biology. Indeed, the prospect of obtaining a clearer insight into the wondrous series of processes which constitute animal and vegetable life may well lead the two sciences to work with definite purpose to a common end.

In order, as far as possible, to avoid mistakes in this difficult task and to shield ourselves from the disappointment which is the inevitable consequence of exaggerated hopes, we cannot do better than strive to imitate the great example of Faraday, who always, with rare acumen, directed his attention to actual phenomena without allowing himself to be influenced by preconceived opinion, and who in his theoretical conceptions gave expression only to observed facts.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Public Orator, Dr. Sandys, spoke as follows on Thursday, October 17, in presenting for the degree of Doctor in Science *honoris causa* Geheimrath Emil Fischer, F.R.S., professor of chemistry in the University of Berlin:—

Scientiae chemicae professor Berolinensis, purpura nostra (ut videtis) vestitus, ex insperato nobis hodie paulisper affulsit. Novimus tamen quam subtiliter materiam illam investigaverit, quae cum aqua commixta lanam colore roseo pulcherrimo tingit; novimus, via quam admirabili pedetemptim progressus, sacchari genera multa, aut olim nota aut ab ipso patefacta, in elementa sua prima resolverit, atque atomorum de ordine et positura leges novas illustraverit. Peritis saltem nota sunt plurima alia viri huius inventa, quae scientiae intimae ad ipsa penetralia pertinent. Duo vero laboris eius monumenta multorum oculis sunt manifesta atque aperta. Berolinensibus praesertim patet Institutum illud magnum consiliis eius conditum; talium rerum studiosis ubique terrarum patet opus eius eximium sexies saltem in lucem editum. Virum igitur tam insignem et salvere et valere hodie libenter iubemus, qui Faradaii in memoriam orationem inter Londinienses propediem habiturus est, quique, studiorum communium consuetudine nobiscum consociatus, eo artiore nobiscum vinculo coniunctus est, quod filium suum natu maximum Universitati nostrae in scientia chemica erudiendum haud ita pridem commendavit.

Duco ad vos virum in scientia chemica per orbem terrarum totum illustrem, AEMILIUM FISCHER.

On Tuesday, October 15, Mr. A. Henry, the reader in forestry, gave his inaugural lecture before a large audience. The Vice-Chancellor presided. Mr. Henry dwelt upon the causes which had retarded the scientific development of forestry in Great Britain. He then described the various types of forest and their origin, and the several methods of the management of forests. He also described the rapidly approaching depletion of the forests in the United States and northern Europe, and pointed out the necessity of re-afforesting the waste lands of our country. He dwelt at length on the possible introduction of exotic trees, such as the western larch and the Corsican pine. In conclusion, Mr. Henry described the course he purposed to pursue in developing the teaching and research in forestry in the University.

The number of students who have just matriculated is 1099, as compared with 1021 who matriculated in October, 1906. Of these, fifteen are advanced students.

The number of first-year students studying medicine is 130, as compared with 122 last year and 117 in 1905.

Mr. R. P. Gregory has been appointed university lecturer in botany in succession to Mr. Hill, as from Michaelmas, 1907, until Michaelmas, 1912, and Mr. A. M. Smith has been appointed demonstrator in the same subject for the five years ending September 30, 1912.

The general board of studies will shortly proceed to appoint a university lecturer in advanced human anatomy in succession to Dr. Hill. The annual stipend is 50*l*. Candidates are requested to send their applications, with such testimonials as they think fit, to the Vice-Chancellor on or before November 5.

Oxford.—In a Convocation held on October 22, the honorary degree of D.Litt. was conferred upon Prof. E. Meyer, professor of ancient history in the University of Berlin, in recognition of his work on Egyptian hieroglyphs and researches in Egyptian history and chronology, and his general study of history.

The offer of a sum of about 1000*l*. for the foundation of a prize as a memorial of the late Prof. Weldon, and for the encouragement of biometric science, has been accepted by Convocation. The prize is to be awarded every three years for the most noteworthy contribution during the previous six years to biometric science without regard to nationality or sex, biology being interpreted to include zoology, botany, anthropology, sociology, psychology, and medical science.

Mr. A. A. Read has been appointed professor of metallurgy at the University College of South Wales and Monmouthshire.

At University College (University of London) on October 16, the Chadwick medals for municipal hygiene and engineering were presented to Mr. N. G. Dunbar, Mr. W. D. Reynolds, and Mr. J. R. Wade.

The Lord Lieutenant of Ireland will open the new Municipal Technical Institute at Belfast on Wednesday next, October 30. In connection with the opening, a conversazione will be held in the institute on Friday, November 1.

The third annual general meeting of the Association of Teachers in Technical Institutions will be held on November 9, at 3 p.m., in the South-Western Polytechnic, Chelsea, S.W. The annual report of the council will be presented, and other business transacted.

At Bedford College for Women (University of London), Reid fellowships for research have been awarded to Miss Tchaykovsky and to Miss C. Saunders. Dr. W. H. Willcox has resigned the appointment as lecturer in hygiene, and Mr. J. A. H. Brincker has been appointed temporarily to take his place.

The President of the Board of Education, Mr. McKenna, on October 18 laid the memorial stone of a new girls' high school at Gloucester. The cost of the school buildings alone is to be 13,615*l*. Subsequently, Mr. McKenna delivered an address to a large meeting of persons interested in education, and directed attention to a modern tendency in educational administration by which is being realised the American conception of a single type of public school for all classes of the community.

The report read by the principal, Mr. H. B. Knowles, at the distribution of prizes to the students of the Salford Royal Technical Institute on October 18, referred to several points of interest to administrators of technical institutions. Mr. Knowles directed attention to the fact that the Board of Trade requires that a candidate who seeks to qualify as an engineer in the mercantile marine must have served as an apprentice for at least four years. Time spent in a suitable technical school may, however, be accepted as equivalent to artisan service in the ratio of three years in the technical school to two years' artisan service. The Board of Trade has recognised the day mechanical engineering courses at Salford as giving suitable training for this purpose. During last session all applicants for admission to the Salford institute under sixteen years of age were required to give evidence that they possessed a satisfactory preliminary knowledge of English and mathematics, and, failing this, were advised first to attend special courses preparatory to the work of the institute. Sixty per cent. of the applicants for admission were thus rejected. Courses of study are now arranged suitable for persons engaged in the chief industries of the district, based upon attendance at the institute on three evenings per week.

Speaking at Wakefield on October 17 at a public meeting held in connection with the Wakefield Education Guild, Mr. Haldane said that higher education is of great value to those engaged in industrial pursuits, in fact it is of value to the whole nation. Learning for learning's sake is a great text, and it does not shut out the utilitarian side. The profits of industrial enterprise go to the man of brains, to the man with the power of direction. This shows that it is vital to those engaged in industrial enterprises that they should have command of science and as much knowledge as they can get. Unless knowledge is spread among the people there cannot be equality of opportunity. There is only one leveller, only one man who does anything substantial to make people equal, and that is the schoolmaster. Education in this country will never be right until the elementary school, the secondary school, and the university are linked together. The British people perhaps need education more than any other nation. We are very prosperous; we are very self-reliant; we have magnificent energy; if we had not, we should have been distanced in the race. But we are competing against science and the increasing science which science gives. We are being more and more handicapped in the race, and it is our own individual powers that have enabled us still to get to the goal in front of our competitors. Let us learn before science makes still further advances, and before they are appropriated by foreign nations, to bring ourselves at least up to their level.

SOCIETIES AND ACADEMIES.

London.

Entomological Society, March 2.—Mr. C. O. Waterhouse, president, in the chair.—*Exhibits*.—Commander J. J. **Walker**: Living specimens of the heteromerous beetle *Sitaris muralis*, first re-discovered at Oxford in 1903 by Mr. A. H. Hamm on old stone walls in the vicinity of Oxford inhabited by the mason bee, *Podalirius* (*Anthophora*) *pilipes*, on which it is parasitic in its early stages.—G. T. **Porritt**: Black specimens of both sexes of *Fidonia atomaria* from the Harden Moss Moors, Huddersfield, illustrating the melanic tendency of Lepidoptera in the district.—H. St. J. **Donisthorpe**: *Apion semivittatum*, taken at Deal; *Magdalis duplicata* from Nethy Bridge, the first record of the species for Scotland; *Formica sanguinea* from Aviemore and Nethy Bridge, the first record for Scotland; and *Piezostethus formicetorum*, taken with *Formica rufa* at Rannoch, a species not recorded since 1874.—A. H. **Jones**: A case of butterflies taken this year from Herculesbad, South Hungary, including specimens of *Erebia melas* from the Domogled, which bore a remarkable resemblance to *Erebia alecto*, var. *nicholli*, Oberth., from Campiglio, and *Erebia lefebvrei*, Oberth., also shown for comparison by Mr. H. Rowland-Brown. Mr. Jones also exhibited examples of *Chrysophanus dispar*, var. *rutilus*, and *C. alciphron*, from the neighbourhood of Budapest, both species of great size and brilliant colouring.—Dr. F. A. **Dixey**: Specimens from Uganda of the African Pierine genus Mylothris, showing an almost complete gradation between *Mylothris chloris*. Fabr., and *M. agathina*, Cram.—M. **Jacoby**: Several fine forms of the ab. *ceronus* of *L. bellargus* taken this autumn at Folkestone, and one example of the ab. *cinnides*, Stgr.—Norman **Joy**: A specimen of the rare beetle, *Cryptophagus subdepressus*, Gyll., taken near Garva, Ross, on August 4 last.—W. J. **Lucas**: Two specimens of *Deilephila euphorbiae* bred by Mr. Nicholson and Mr. Summers from larvæ found in Kew Gardens. Mr. Lucas also exhibited several examples of predaceous insects with their prey *in situ*.—H. M. **Edelsten**: Specimens of *Sesia andraeniformis*, bred from pupæ taken in Bedfordshire and Kent, and ova of *Nonagria cannae*, giving an account of its remarkable methods of oviposition.—A. **Harrison** and H. **Main**: Four broods from females of *Pieris napi*, var. *bryoniae*, captured on the Kleine Scheidegg Pass, Switzerland, in July, 1906, showing a wide range of variation.—Prof. T. Hudson **Beare**: A specimen of the rare bug *Lygaeus equestris*, Linn., from St. Margaret's Bay, also specimens of *Hypera tigrina*, Boh., taken in some numbers on the wild carrot at the same locality, and *Apion semivittatum*, Gyll., off plants of *Mercurialis annua*, all taken during the same period at St. Margaret's Bay.—*Papers*.—The species of Hesperidæ from the Indo-Malayan and African regions, described by Herr Plotz, with some new species: Colonel Charles **Swinhoe**.—The butterflies of Mauritius and Bourbon: Lieut.-Colonel Neville **Manders**.—The hibernating habit of the lepidopterous genus Marasmarcha: Dr. T. A. **Chapman**.

PARIS.

Academy of Sciences, October 14.—M. A. Chauveau in the chair.—The transits of Mercury across the sun, and, in particular, on that of November 14 next: G. **Bigourdan**. A review of the various phenomena regarding which further information is desirable, including the visibility of the planet outside the sun, the external and internal contacts, the appearance of the horns and the measurement of their distance.—The summation of Laurent's series: A. **Buhl**.—The invariants of differential systems: Étienne **Delassus**.—A theorem on integral equations: Tommaso **Boggio**.—The analysis of mixtures of air and gas or combustible vapours: Jean **Meunier**.—A new improvement allowing of the rapid detection and estimation of methane: Nestor **Gréhant**.—The reactions in the nickel-plating bath: A. **Brochet**. The causes of the favourable effect of the addition of boric acid to the bath are discussed, and also some peculiarities of the way the anode is attacked.—A vinyl alcohol of the type ArR : C : CH.OH: MM. **Tiffeneau** and **Daufresne**. The substance described in a previous note as anisylcyclopropanol has been found to be methylanisylethenol, $(CH_3O).C_6H_4—C(CH_3) : CH.OH$, the first alcohol of this type to be isolated.—A caoutchouc tree at Tonkin: MM. **Dubard** and **Eberhardt**. The principal characters of the tree are given in detail, and prove that it is a new species of the genus Bleekrodea, and is named *Bleekrodea tonkinensis*. This tree is of great economic interest, as it is the first caoutchouc-bearing tree found in Indo-China. It is abundant, and the rubber produced from it is of the highest quality.—The reception of the light stimulus in the compound eyes of insects, particularly the Muscidæ: P. **Vigier**.—The evolution of the carbon, water, and ash as a function of the age in plants: J. **Tribot**.—The psychophysical law; applications to energetics and photometry: Charles **Henry**.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), contains the following memoirs communicated to the society:—

March 9.—Determination of absolute values of magnetisation numbers, especially for crystals: W. **Voigt** and S. **Kinoshita**.—Determination of the elastic constants of aragonite: W. **Voigt**.—Interpolation by means of exponential functions: H. **Burkhardt**.—Some properties of the radium atom: E. **Riecke**.

May 11.—Peculiar cases of vibrating membranes: W. **Voigt**.—The influence of internal reflexions on the interference phenomena in doubly refracting crystal plates: H. **Joachim**.

June 8.—The most general concept of the plane continuous curve (second paper): A. **Schoenflies**.—Vibrations of non-uniformly stretched membranes: W. **Voigt**.

July 20.—The so-called general energy equations of the technical theory of rigidity: J. **Weingarten**.

July 27.—Four new letters of Gauss: P. **Stäckel**.

The business communications, part i. for 1907, of the same society include reports on the progress of the publication of Gauss's works and on the Samoa Observatory, together with a memorial discourse on Ludwig Boltzmann, by W. **Voigt**.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 24.

CHEMICAL SOCIETY, at 8.30.—The Constitution of Phenol- and Quinol-phthalein Salts: a Contribution to the Quinonoid Theory of Colour: A. G. Green and P. E. King.—Poly-ketides: J. N. Collie.—Production of Orcinol Compounds by the Action of Heat on the Sodium Salt of Ethylacetoacetate: J. N. Collie and E. R. Chrystall.—A Simple Gas Generator for Analytical Operations: J. M. Sanders.—Some Double Ferrocyanides of Calcium, Potassium and Ammonium: J. Campbell Brown.—Halogen Determination in Organic Substances: J. Moir.—Racemisation by Alkalis as applied to the Resolution of *r*-Mandelic Acid into its Optically Active Isomerides: A. McKenzie and H. A. Müller.—The Optical Activity of Cyclic Ammonium Compounds: F. Buckney and H. O. Jones.—Keten. A New Anhydride of Acetic Acid: N. T. M. Wilsmore.—The Action of Phosphorus Pentachloride on Hydroxy-trimethyl Succinic Ester. 1 : 2-Dimethyl Trimethylene 1 : 2-Dicarboxylic Acid: H. Henstock and B. E. Woolley.

FRIDAY, OCTOBER 25.

PHYSICAL SOCIETY, at 5.—On the use of Variable Mutual Inductances: A. Campbell.—On Magnetic Oscillators as Radiators in Wireless Telegraphy: Dr. J. A. Fleming.

TUESDAY, OCTOBER 29.

FARADAY SOCIETY, at 8.—On the Electrolysis of Salt Solutions in Liquefied Sulphur Dioxide at Low Temperatures: Dr. B. D. Steele.—Note on the Action of Aluminium Powder on Silica and Boric Anhydride: F. E. Weston and H. R. Ellis.—Reduction of Metallic Oxides by Means of Calcium Hydride: Dr. F. Mollwo Perkin and Lionel Pratt.—A Series-Parallel Lamp Resistance Useful for Electrochemical Work: N. T. M. Wilsmore.

CONTENTS.

THURSDAY, OCTOBER 31, 1907.

THE THEORY OF FUNCTIONS OF A REAL VARIABLE.

The Theory of Functions of a Real Variable and the Theory of Fourier's Series. By Dr. E. W. Hobson, F.R.S. Pp. xvi+772. (Cambridge: University Press, 1907.) Price 21*s.* net.

IT is impossible to read Dr. Hobson's book without reflecting on the marvellous change that has come over Cambridge mathematics in the last twenty years. Twenty years ago Cambridge mathematics was a thing standing by itself, and with its own virtues and defects. Pure mathematics in Cambridge meant Cayley and a few disciples; and Cayley (widely as he read) owed little or nothing to anyone but himself. Certainly he never appreciated the most fundamental ideas of modern Continental analysis. It is probable that he could not have defined a function or a limit in a way which would have satisfied Weierstrass or Dr. Hobson: it is certain that he would have been as incapable as any Senior Wrangler of proving any of the less obvious theorems of convergence. The first signs of the absorption of these ideas are to be found, not in Cayley, but in Stokes.

Now Cambridge has fallen into line. There are no Cayleys, perhaps, but there is quite a flourishing school of pure mathematics, working by what may be called German methods and on German lines, and making up in numbers and soundness for anything that it has lost in distinction. The school of Cayley is dead, and so (what is perhaps even more to be regretted) is the old Cambridge school of applied mathematics: pure mathematics and experiment have combined to kill it, and the Stokes Lecturer in Applied Mathematics writes books like this. We wonder what Clerk Maxwell or even Stokes himself would have thought of it.

However, all this is not Dr. Hobson's fault, and we must not blame him if the reflections which it inspires are not altogether pleasant. And we hasten to congratulate him on the completion of what is, without a doubt, a magnificent piece of work. It would be a fine piece of work even if were a mere compilation; for the subject is one of which there was no systematic account in English, and which no previous English writer had ever really mastered. But the book is far from being a compilation, for Dr. Hobson has made the subject his own, and writes with the air of mastery that only original work can give: and even in French, German, or Italian, there is no book which covers anything like the same ground. Dini (whom Dr. Hobson has obviously taken as his model) has held the field for a long time, and Dr. Hobson can fairly claim to have superseded him.

In taking Dini as his model, Dr. Hobson has made the "theoretically general," rather than what Borel has called the "practically general," his goal. No doubt he had to make his choice, but we must confess that he seems to us to have gone too far. Let us consider his treatment of "double limit problems," for example, problems such as those of the differentiation or integration of an infinite series or an infinite integral (why will he persist in making the uninitiated scoff by his fondness for the word "improper"?). Such problems may be approached from two different points of view. We may ask, "What is absolutely the most general form in which we can state our theorems, when we utilise all the most modern theories of sets of points, Lebesgue integrals, and the like?" This is the point of view of Dini and Dr. Hobson. On the other hand, we may ask, "In what special forms do these problems naturally occur in analysis? What are *the really important cases?* Can we state our theorems in such a way that writers on applied mathematics, or other branches of pure mathematics, when they are confronted, as they continually are, with particular problems of this kind in all conscience difficult enough, will be able to turn to us for a solution of their difficulties?" These questions must be continually before us, if we are aiming at Borel's "practically general" completeness, and even an author who has decided to aim at the other ideal will do well to keep them clearly in sight; and we wish that Dr. Hobson had more often adopted this point of view. He might then have made his book a good deal more useful and attractive for the ordinary worker in the fields of analysis. The latter, as it is, is likely to find himself faced by many theoretical difficulties to which he will not easily find an answer in Dr. Hobson's pages. However, it is perhaps as well that Dr. Hobson should leave something for someone else to do.

But it is time that we said a little of the details of the book. It is needless to say that it is beautifully and almost faultlessly printed. It is a pity, though, that the chapters are so long. Long chapters do not make a difficult book easier to read, nor do they make it easier for the author to arrive at the proper logical arrangement of the subject-matter—as appears very clearly in chapters v. and vi., which had much better have been broken up into half a dozen shorter chapters. We should like to have seen a great many more examples. Summaries of the chapters, too, would have been useful; and the author is too sober in his use of different kinds of type. In a word, he shows too great a contempt for the arts of popularity.

There are seven chapters in all. For the first three, which are of a particularly abstract character, we have practically nothing but praise. The matter is admirably selected and admirably arranged, and Dr. Hobson writes with a lucidity and distinction rare indeed among mathematicians. Nothing could be better in its way, for example, than his terse criticism of the "formal" view of mathematics (pp. 9–10). We cannot entirely agree with the conclusions at which he arrives in the course of the critical discussions of chapter iii, but we can appreciate the clear and temperate manner of his criticisms, advanced, as he says, "with some diffidence, on account of the great logical difficulties of the subject," and in the hope that "they may be of utility as a contribution towards the discussion of questions of great interest which at the present time, cannot be regarded as having been decisively settled."

In chapter iv. we begin for the first time to be bored in places. The four derivatives of a function *are* dull, and no one will ever make them seem anything else; and a good deal of Brodén's work is much more solid than inspiring. Occasionally we do not quite like Dr. Hobson's choice of words—in particular we may instance his use of "indefinitely great," in such phrases as "has indefinitely great values," "the functional value is regarded as indefinitely great," "the lower limit is indefinitely great." Why not, in the last case, simply "there is no lower limit"? Dr. Hobson could reply that he has expressly warned the reader against any such confusion of thought as is sometimes implied in modes of expression such as these; and there is certainly none in his own mind. None the less we wish that he had expressed himself in a different manner.

In this chapter, let us single out for special praise the sections on double and repeated limits (pp. 303 *et seq.*). We particularly like the author's generalisation of the definition of a repeated limit, which enables him to simplify the statements of a number of theorems. We have already said that we do not altogether like the arrangement of the next two chapters. Surely it would have been better to introduce the notion of a series at an earlier stage. As it is, some of the theorems concerning integrals are separated from one another in a rather irritating way. But most of the discussions of particular theorems are admirable. We may mention especially the treatment of the "absolutely convergent improper integral" (pp. 364 *et seq.*), the sections on the transformation of double integrals (pp. 445 *et seq.*), and the account of Baire's theory of the representation of functions (pp. 522 *et seq.*). A few criticisms of details suggest themselves. Is it worth while to define "principal values" if nothing more is to be said about them? There is a curious slip on p. 454, l. 14; obviously the condition stated is not *necessary*: and it is very odd that Dr. Hobson should define *divergence* and *oscillation* in such a way that $1-2+3-4+\ldots$ is a divergent rather than an oscillating series. The last word has not yet been said about Weierstrass's non-differentiable function (pp. 620 *et seq.*). What about $\Sigma a^n \cos b^n x$, where ab is only a little greater than 1? One would expect the function to have no differential coefficient whenever $ab \geqq 1$; but no one seems to have found out whether this is the case or not.

Finally, chapter vii. (Fourier's Series) shows Dr. Hobson quite at his best. The last part, in which he supplies a final touch of rigour to some of Riemann's work, is extremely difficult, but that was inevitable. The remark at the foot of p. 647 is open to dispute. Was not something very much like the theorem, ascribed to Lerch on p. 727, also proved by Stokes? On p. 732, l. 24, for "diminished" read "increased."

A short appendix contains some further critical remarks, in addition to chapter iii. We wish that there had been space for a summary of König's rather watery theories, and the author's neat and convincing reply in the London Mathematical Society's Proceedings. We must confess to a strong temptation to argue with Dr. Hobson concerning the remarks at the top of p. 765, but the temptation must be resisted.

Dr. Hobson has attempted an appalling task. There is no region of pure mathematics (unless it be the theory of numbers) which is quite so difficult as this; certainly none of which the literature is so scattered and so difficult to collate, or in which the writing of a big book requires a greater combination of drudgery and critical insight. All things considered, he has succeeded wonderfully. We can think of no one else who would have done half as well. G. H. H.

LIEBIG AND GÜSSEFELD.

Justus von Liebig und Emil Louis Ferdinand Güssefeld. Briefwechsel: 1862–1866. Herausgegeben von Dr. O. E. Güssefeld. Pp. viii+72. (Leipzig: Johann Ambrosius Barth, 1907.) Price 3 marks.

THIS little book has a twofold interest. To the scientific agriculturist it is interesting as elucidating the history of the introduction of the modern methods of agriculture into Germany, and especially of the introduction of the so-called chemical fertilisers, due largely to the teaching and influence of Liebig; it serves also to throw some sidelights upon the character and habits of Liebig himself, and is therefore of interest to the historian of chemistry. It consists simply of a collection of thirty-eight letters which passed between Liebig and Emil Güssefeld from 1862 to 1866, twenty-two of which are contributed by Liebig, and the whole has been arranged for publication, with explanatory notes and annotations, by the pious care of the son of one of the correspondents.

Emil Güssefeld was a Hamburg merchant, of the conventional type, dealing mainly in coffee and other colonial products. In a fortunate hour he accepted an agency from an American company for the sale in Germany of guano from Baker Island, in the Pacific Ocean, and thereby laid the foundations of a prosperous business in phosphatic manures. Emil Güssefeld indeed stands to Germany in much the same relation that the late Sir John Bennett Lawes stands to this country, and both reaped fame and fortune by the far-sighted enterprise which induced them to give practical effect to the theoretical views of Liebig. As a prudent man, Güssefeld, before undertaking the agency, seems to have consulted Liebig as to the probability that the Baker guano, of the merits of which he was well assured, would find a ready sale among a body of agriculturists who are even more conservative than our own, and Liebig's reply constitutes the first letter in the series. It is in every respect worthy of him—sound, thoughtful, and considerate, and with that note of cautious optimism which the eminently practical mind of the Hamburg merchant could not fail to appreciate. Liebig, as this correspondence abundantly testifies, never spared himself when his interest was aroused, and he was ever ready to give of his best, without fee or thought of reward, when the object commended itself to him. In this large-hearted liberality Liebig resembled Davy, who nearly half a century previously had striven in the same self-sacrificing way to infuse something of the scientific spirit into the oldest of the arts. Liebig's letters are rich in practical advice, business hints, analytical information

—all given with no other thought than of doing what in him lay to further the true interests of agriculture. How greatly Güssefeld benefited by his wise counsel, and what material advantages he gained from Liebig's altruistic interest in the development of the industry of which he was a pioneer in Germany, Güssefeld's letters clearly indicate. His letters, too, indicate his sense of gratitude. He repeatedly pressed upon his distinguished correspondent his earnest desire to make some substantial recompense, but Liebig declined to entertain any thought of pecuniary reward. All Güssefeld could do was to appeal to one of the most characteristic of Liebig's frailties. He was, to quote Dr. O. E. Güssefeld, a "leidenschaftlicher Raucher und wollte schwere und nur gute Zigarren haben." These, we are told, are particularly easy to obtain in Hamburg; and we are assured by Liebig that Güssefeld sent him of the best the city could furnish, and kept him well supplied. There is much virtue in a good cigar; how much German agriculture owes to it may be plainly discerned in this interesting correspondence.

T. E. T.

BOTANICAL WORKS.

(1) *Botanisches Jahrbuch.* Edited by Dr. A. Engler. Vols. xxxvi to xxxix. (Leipzig: W. Engelmann, 1905–7.)

(2) *Das Pflanzenreich.* Edited by Dr. A. Engler. Vols. xxii to xxvi, xxvii and xxix. (Leipzig: W. Engelmann, 1905–7.)

(3) *Recueil de l'Institut botanique.* Edited by Dr. L. Errera and Dr. J. Massart. Vols. i, ii, and vi. (Bruxelles: H. Lamertin, 1906.)

(1) ENGLER'S "Botanisches Jahrbuch" serves mainly as a repository for information on systematic botany and plant geography. The issue is peculiar, as usually three or four volumes are in progress simultaneously, but the irregular appearance of the parts serves to ensure rapid publication of papers containing new identifications. Vol. xxxvi was begun and completed in 1905, but the three succeeding volumes form a simultaneous triad that date from September, 1905, to March, 1907. Throughout the four volumes there are only four instalments of the "Beiträge zur Flora von Afrika," in which special interest attaches to the Orchidaceæ and Asclepiadaceæ mostly collected and described by Mr. R. Schlechter, two new genera of the Podostemonaceæ founded by Dr. A. Engler, the collation of the Combretaceæ by Dr. L. Diels, and the list compiled by Dr. F. Pax of plants collected by Mr. F. Rosen in Abyssinia. Another monograph of a similar nature is concerned with the plants collected by Dr. A. Weberbauer on a tour of exploration over the highlands of Peru, of which a brief outline was given in vol. xxxii, and a map with the two first instalments of determinations prepared by various workers under the editorship of Prof. I. Urban appears in vol. xxxvii. Dr. Weberbauer also contributes two short articles that may be regarded as preparatory to a volume for the series "Die Vegetation der Erde."

The subject of insular floras is enriched by several papers. To a phytogeographical account of New Caledonia, Mr. R. Schlechter has added a systematic account of the flora, and Dr. E. Lemmermann has compiled a list of algæ collected in the Chatham Islands.

Among the summaries representing recent work on individual orders and genera, a general comparative account of the Cornaceæ is presented by Mr. W. Wangerin. The review of the order Valerianaceæ by Dr. P. Graebner affords an indication of a more elaborate commentary to appear in a future volume of the "Pflanzenreich." The genus Anemone forms the subject of a monograph by Dr. E. Ulbrich.

Two papers of more universal interest are provided in the accounts of myrmecophilous plants by Mr. E. Ule and Mr. H. v. Ihering. The symbiotic hypothesis, as well as the view that the hollow spaces in the stems are the result of natural selection, are refuted. The biology of tropical flowers and fruits is discussed by Prof. H. Winkler, and an ecological study of the vegetation on some newly-formed islands in a Swedish lake is described by Mr. S. Birger.

(2) "Das Pflanzenreich" has attained to twenty-nine volumes, of which eight have been published since November, 1905. The volume on the Primulaceæ has been prepared by Prof. F. Pax and Dr. R. Knuth. The genus Primula is remarkable, both for the beauty of the flowers and its wide distribution. From the map provided it will be seen that centres of distribution occur in Switzerland and in the Himalayas, but the richest source lies in western China. Dr. A. K. Schindler has contributed the monograph on the Halorrhagaceæ, from which he excludes the genus Hippuris. Dr. Fr. Buchenau has summarised the fruits of his researches in the volume on the Juncaceæ. The anatomy of the leaves, the germination of the seedlings, and the numerous hybrids are important features of the order. Prof. L. Diels is responsible for the Droseraceæ, that show many interesting characters in anatomy, regeneration, and growth forms. In dealing with the Polemoniaceæ, Dr. A. Brand pays special attention to the work of American botanists. The latest volume by Mr. O. E. Schulz is concerned with the Erythroxylaceæ.

(3) The papers collected in these volumes of the "Recueil de l'Institut botanique" of Brussels constitute a scientific memorial to the late Prof. Errera, as they represent research carried out by him or inspired by his influence. The first volume contains several papers by Prof. Errera on glycogen in plants, and contributions on the same subject by Dr. E. Laurent and Mr. G. Clautriau. In the second volume is published a series of papers dealing with the cycle of nitrogen compounds, including those by Dr. E. Laurent on the reduction of nitrates, and Mr. E. Marchal's account of ammonia formation in the soil by bacteria. Another important collection of papers relates to alkaloids and proteid substances. This series begins with the paper on the localisation and significance of alkaloids in plants, written by Prof. Errera in conjunction with Dr. Maistriau and Mr. G. Clautriau. The next three volumes are reserved for papers published before the year 1903. The sixth

volume, edited by Dr. J. Massart, opens with a contribution by him on the subject of irritability in the higher plants. It also contains the instructive essay by Prof. Errera on the primrose, an account by Miss J. Wéry on the attraction of bees by flowers, and an investigation carried out by Dr. A. Jacquemin on the localisation of alkaloids in the Leguminosæ.

OUR BOOK SHELF.

Les Observatoires astronomiques et les Astronomes. By P. Stroobant, J. Delvosal, H. Philippot, E. Delporte, and E. Merlin. Pp. vi+317; with one chart. (Brussels: M. Hayez, 112 Rue de Louvain, 1907.)

IN collecting and publishing the information contained in this volume, Prof. Stroobant and his collaborators have rendered a service of inestimable value to all interested in astronomy. The purpose of the publication is to permit astronomers of every class to learn readily what is being done in their own line of work, and by whom and where it is being done, and the arrangement of the matter makes this a very simple task.

In the main list all the known observatories are arranged in alphabetical order, and for each one is given the country wherein it is situated, its latitude, longitude, and altitude, the nature and titles of any publication it issues, the names of the director and staff, and, finally, a brief *résumé* of the observatory's history, instruments, and work.

This is followed by a list of astronomical societies arranged in the order of their foundation, a brief statement of particulars concerning each society, such as its meeting place, subscription, number of members, titles of its publications, &c., being given. The chief astronomical reviews are then similarly treated.

An alphabetical list of some 1500 names of individual astronomers gives page references to the list of observatories, which enables one to refer immediately to any person named, and find at once his specialities and resources. Then follow a geographical list of all the places referred to, and a list of the astronomical societies and publications of each country.

The work concludes with a chart of the world, on which the distribution of observatories is shown, and which should be consulted by those who are desirous of founding new observatories. Whilst western Europe and the eastern States of the U.S.A. are thickly dotted with observatories, only seven are shown in the whole of Africa. The southern hemisphere and the torrid zone are remarkably deficient in this respect.

The whole of the work of compilation and publication has been done by the Comité de bibliographie et d'études astronomiques of the Royal Observatory of Belgium. Their names appear on the title page, and they are to be heartily congratulated upon the efficiency and expedition with which they have performed their self-imposed task.

Lese- und Lehrbuch für ländlich-gewerbliche Fortbildungsschulen. By H. Gehrig, Dr. A. Helmkampf, Dr. Th. Krausbauer, and Fr. Stillcke. Pp. vii+343. (Berlin: B. G. Teubner.) Price 2 marks.

IN Germany, as in England and other industrial countries, there is a growing difficulty in keeping country lads in the country, and attempts are being made to stimulate interest in rural matters by giving definite agricultural instruction in certain of the schools.

The present volume is intended for the Fortbildungsschulen, continuation schools at which attendance is compulsory for two or three years after leaving the elementary school. Like other readers in use at these schools, it contains literary and patriotic sections in addition to the purely technical matter. The book opens with a few poems and short prose pieces in praise of a country life, and exalting the husbandman's calling; towards the end comes the section headed "Deutschland über alles," describing some of the glories of the Fatherland.

The technical part covers a very wide range. Some of the readings deal with economic questions, cooperative societies and banks, liquidation of mortgages, the legal position of the workman with regard to holidays, taxes, &c. Others are hygienic, and give rules for bathing, advice about fresh air and tuberculosis, and first aid to the injured. The purely agricultural part occupies about a quarter of the volume, and is distinctly practical. Useful hints on the management of farm stock are given, together with general accounts of soils, crops and manures. There is also a collection of proverbs dealing with husbandry that will help the pupil fix in his mind the instruction he has received. So far the book is very good, both in conception and in execution. But we are not quite clear why the authors should have attempted accounts of apparently extraneous matters like the metallurgy of copper and steel, the theory of the microscope and of the dynamo. The treatment is necessarily vague and general, and the space might well have been utilised for a fuller development of things falling clearly within the scope of the book.

However, a good deal will depend on the teacher. If he is an enthusiastic countryman he will find the book very useful; if not, it may prove rather dull. Whether a reader of this sort will really attract boys to agriculture remains to be seen; the result of the experiment will be watched with great interest by those in this country who are trying to solve the same problem. E. J. R.

La Houille verte. By Henri Bresson. Pp. xxii+278. (Paris: H. Dunod et E. Pinat, 1906.)

THE title of this work, if literally translated, signifies "green coal," and a word of explanation is necessary as to what this combination of words implies. The word "houille" in this sense is intended to convey the idea of energy, more particularly that due to waterfalls and rivers, and the qualifying adjective "verte," as opposed to "blanche," indicates that the sources of the energy are the rivers and watercourses to the exclusion of snow- and glacial-fed torrents.

A book with such a title might be an engineering work or a statistical record; in the present case the latter is the more correct description. Throughout the volume the scientific information is scanty and very elementary. A large part is taken up with a chronicle of the utilisation of water power in the various departments of France; this part comprises 127 pages out of a total of 278. The first half is devoted to "Généralités et Theories," but it must be confessed that the theories are not very serious, and that the generalities are the more prominent.

A large quantity of statistical information is contained in the last fifteen or twenty pages, in which several tables are given showing the volumes of the various rivers and the numbers of hydro-electric installations. These tables will probably be of more interest to the serious student of the subject than all the rest of the book.

The illustrations are fairly numerous, and consist chiefly of landscape scenes; they help to make the book appear lighter, but hardly serve any other 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 intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Transit of Mercury across the Sun's Disc, November 13-14, 1907.

PREMISING that the times given on p. 451 of the Nautical Almanac for 1907 are the Greenwich mean astronomical times of the several contacts in the above transit as seen from the centre of the earth, it may be useful to the readers of NATURE to record the corresponding Greenwich mean astronomical times of the contacts as seen from Greenwich. These times are deduced by the formulæ printed on the above-mentioned page of the Nautical Almanac:—

		d.	h.	m.	s.
External contact at ingress ...	November	13	22	23	24
Internal contact at ingress ...	,,	13	22	26	1
Internal contact at egress ...	,,	14	1	48	10
External contact at egress ...	,,	14	1	50	50

Angle from north point of sun of contact at ingress, 62°; angle from north point of sun of contact at egress, 345°; measured towards the east in both cases.

A. M. W. DOWNING.

H.M. Nautical Almanac Office, October 26.

Origin of Radium.

IN a letter to NATURE (June 6) I gave the experimental evidence which led me to conclude that in ordinary actinium preparations a new substance was present which was slowly transformed into radium. By a chemical method this substance was separated from actinium, and a solution of the latter was obtained which showed no appreciable growth of radium over a period of eighty days. Observations on this solution have been continued over a total period of 240 days, and there is still no detectable increase in the quantity of radium. The growth of radium, if it occurs at all, is certainly less than 1/500 of that observed in other experiments.

In two recent letters to NATURE (September 26 and October 10) Dr. Boltwood has given the results of his later experiments in this direction. He has confirmed my conclusions, and has, in addition, been successful in devising a satisfactory method of separating this new substance from actinium, and has examined its radio-active and chemical properties. He suggests that the name "ionium" be given to this new body, which is probably the immediate parent of radium. Dr. Boltwood is to be congratulated for his admirable work on this very difficult problem, for, apart from the chemical operations, the radio-active analysis required for correct deduction is unusually complicated and difficult.

Dr. Boltwood has not been able to separate the parent of radium from actinium by the reagent employed by me, viz. ammonium sulphide, but has found the use of sodium thiosulphate effective. In explanation of this discrepancy, he suggests that I employed old ammonium sulphide. As a matter of fact, I did not use the ordinary laboratory solution of ammonium sulphide, but added ammonia to the actinium solution, and then saturated it with sulphuretted hydrogen. The complete separation effected in my experiment was, I think, probably due to an accidental production of finely divided sulphur in the solution.

In a letter to NATURE of last week, Mr. N. R. Campbell raised objections to the name "ionium" given by Dr. Boltwood to the new body, from the point of view that every radio-active substance should be given a name to indicate its position in the scheme of radio-active changes. This system is very excellent in theory, but I have found it extremely difficult to carry out in practice. The continual discovery of new products in very awkward positions in the radio-active series has made any simple permanent system of nomenclature impossible. Besides uranium and thorium, twenty-four distinct radio-active substances are now known to exist in radio-active minerals. The number of products still to be discovered is, I think, nearly exhausted. When there is a general consensus of opinion that this is the case, I feel it will be very desirable for physicists and chemists to meet together in order to revise the whole system of nomenclature. There is not much to be gained in doing so immediately, as the discovery of a new product in the midst of a series would entail the alteration of the names of a possible half-dozen others which follow it. At the same time, I think it will be desirable to retain a distinctive name for those radio-active substances which, like radium, have a long enough life to be separated in sufficient quantity for an examination of properties by the ordinary chemical and physical methods. It is probable that the parent of radium fulfils these conditions, and should thus have a distinctive name like radium.

Personally, I do not much like the name "ionium," but for similar reasons neither do I care for the name "actinium." It is not easy to suggest a name that is at once simple and explanatory. I have for some time thought that possibly "paradium" or "picradium" might be suitable for the new substance. The former name suggests that it is the parent of radium, but I recognise that a possible play on words may make it unsuitable. The name uranium A, suggested by Mr. Campbell, in itself innocuous, is open to the objection that in the case of radium, thorium, and actinium the suffix A is applied to the first product of the disintegration of the respective emanations, while no such emanation has been observed in the initial series of changes of uranium.

E. RUTHERFORD.

University of Manchester, October 27.

The Nature of X-rays.

IN a paper published in the October number of the *Philosophical Magazine* (pp. 429–449), Prof. Bragg, after discussing the properties of various electric radiations, arrives at the conclusion that although a beam of X-rays contains some ether pulses, these may not after all constitute the bulk of Röntgen radiation. In place of the usually accepted theory, he proposes the hypothesis that these rays consist mainly of "neutral pairs" (consisting of a positive and a negative particle) each revolving in a plane containing its direction of translatory motion. This, he considers, affords an easier explanation of the properties of the rays, and is not improbable *a priori*.

I do not intend to discuss more than one point here, for it seems to me that the record of a simple experiment is of more value in deciding between the two hypotheses than a series of comparisons or discussion of probabilities possibly could be.

To explain the phenomena of secondary radiation from light atoms, he supposes that a "pair" striking a light and yielding atom does not suffer disarrangement, but may be returned unchanged and constitute a scattered ray. He also supposes that it is liable to be taken up only by an atom revolving in the same plane as itself, and that if ejected again the subsequent rotation and translation will continue to take place in the one plane. The secondary radiation in a direction perpendicular to that of propagation of the primary will then consist of pairs rotating in the plane of the primary and secondary propagations, and the tertiary will therefore be strongest when in the same plane, thus explaining the polarisation effect.

It is important to notice that this theory can only account for the amount of polarisation which I found to exist in a secondary beam from carbon (Proc. Royal Soc., A, vol. lxxvii., 1906), if the assumed relation between the plane of rotation and direction of propagation is an accurate one.

Now it can easily be shown that, according to the ether pulse theory, when an unpolarised X-ray beam is incident on a substance of low atomic weight, such as carbon, the intensity of secondary radiation is at a minimum in a direction perpendicular to that of propagation of the primary beam, and a maximum in, or opposite to, that direction.

On the neutral pair hypothesis, if we only assume that the chance of ejection from an atom is equal in all directions in the plane of rotation, it may as simply be shown that the directions of minimum and maximum intensity are the same as on the previous hypothesis; but whereas on the ether pulse theory the intensity of the secondary rays in the direction of propagation of the primary is double that in a direction at right angles, on the "neutral pair" hypothesis it varies as the cosecant of the angle which the direction of propagation of the secondary makes with that of the primary, becoming infinite along the direction of propagation of the primary. In other words, the intensity of secondary radiation varies as the density of the lines of longitude (or as the secant of the latitude) on a sphere with the secondary radiating mass at its centre, the direction of primary propagation being along the axis.

I have made experiments to test the two hypotheses, using an electroscope to compare the intensities of secondary radiation as nearly as possible in these two directions. Taking into account the finite section of the beams and consequent obliquity of the rays, the ratios on the two hypotheses would be roughly 1·9 : 1 and 8 : 1, assuming perfect scattering and neglecting the effect of tertiary rays in the first case and assuming the plane of rotation to contain accurately the direction of propagation in the second. If the assumption is only approximately correct in either case, the ratio will be somewhat reduced. It is evident that great accuracy in the experiments was not essential. They, however, leave no doubt as to the conclusion, for the ratio of intensities was roughly 1·6 : 1—one that might be expected on the ether pulse theory, and appears impossible on the other. It is possible that with suitable primary rays and thickness of secondary radiator, results showing more perfect scattering will be obtained.

These preliminary experiments, however, to my mind furnish quite conclusive evidence in favour of the ether pulse theory. CHARLES G. BARKLA.

University of Liverpool, October 26.

On Correlation and the Methods of Modern Statistics.

I do not know that much profit is likely to arise from continuing this discussion further; it appears to me to be merely unwrapping considerable convolutions in Mr. Hinks's mental attitude towards Miss Gibson and myself. The chief charge made at the British Association was that we had overlooked a curved regression line between magnitude and parallax—that now appears to have disappeared into limbo. In his first letter to NATURE Mr. Hinks apparently objected to our finding "a quite significant and important" relation between parallax and proper motion, but one not more than half-way up the correlation scale. He has now discovered that "the point of most general interest" is that of colour. He charged us with stating a far-reaching suggestion on the basis of the Cape stars. It turns out now that the element in our far-reaching suggestion is not the *suggestion* at all, but what I am prepared to assert as a fact, namely, that the magnitude of the stars "is not mainly determined by parallax or distance, but is more closely associated with colour, and thus probably with chemical or physical condition." The colour and magnitude correlation is essentially that determined by Miss Gibson, 0·3; the values for the spectral class and magnitude correlations run up according to the classification used to double this value, and even to 0·7. The colour and spectral class correlations reach, as we might expect, a still higher value. Meanwhile, the magnitude and parallax relation in its best determination is 0·28. I agree with Mr. Hinks that this is a point of "general interest," and I am glad that his last letter enables me to assert it, not as "the vaguest of suggestions," which words had reference to the discontinuity of frequency in star counts, but as a fact which may be slightly modified when more data are reduced, but is substantially correct as I have given it.

KARL PEARSON.

The Interpretation of Mendelian Phenomena.

I AM sorry Mr. Lock should mistake what I devoutly hope is a sense of proportion for a desire to belittle Mendelian work. In science clear ideas are of importance, and I wished to elicit something more definite than the vague notion that Mendelism will someday and somehow furnish a master key to the problems of heredity. I made no complaint that Mendelism "does not immediately lead to the solution of all the most difficult problems which biology affords," as Mr. Lock rather extravagantly asserts, but merely asked what conceivable bearing it can have on any problem save that of sex. By the problem of sex I mean the problem of the function of sex—or of conjugation if Mr. Lock prefers. I confess I cannot imagine what light Mendelism has shed on the question of the alleged transmission of acquirements, and as for the "problems of the actual transmission of characters," these, as dealt with by Mendelians, *are* nothing other than problems of sex. That is, Mendelian experiments demonstrate nothing more than the degree in which certain characters (mutations) are transmitted or distributed under, or affected by, conditions of conjugation. Doubtless it is true that the majority of Mendelian cases have been observed in self-fertilised types, but I am not aware that they have ever been observed unless cross-fertilisation had previously occurred. In parthenogenesis the individual arises from an unfertilised ovum; how, then, is segregation possible? What segregates?

The evidence on which I base my assertion that there is no segregation in the mulatto is that of my own eyes. Mulattoes vary amongst themselves, but the blend is usually very obvious, and is reproduced in subsequent generations when breeding is *inter se*. With every infusion of European blood the negro type—skin colour, hair texture, shape of features, and the like—grows fainter, until at length the "touch of the tar-brush" is hardly if at all perceptible; and this blending, so far as I am aware, occurs, not only in all crossed human varieties, but in other natural varieties as well. There may be exceptions; in fact, I believe there are; but blending appears to be the rule in the vast majority of instances.

How can the fact that human races have crossed more often than any other animal complicate the problem? My statement implied, not that every human race is a chaotic mixture of types, nor even that there are no pure types, but only that we have here a very large and varied mass of material on which to found our judgments. Nor did I imply that mutations are especially frequent under conditions of cultivation. I believe they are quite as common in nature. Our hospitals and asylums are full of them—hare-lips, cleft-palates, club-feet, hæmophilia, colour-blindness, deaf-mutism, feeble-mindedness, and so forth. Their inheritance is usually Mendelian, but I never heard of a human mutation that was useful. I implied merely that artificial selection is founded on mutations, and that the striking difference between artificial and natural varieties indicates that natural selection is not founded on them. We know the past and present of man better than that of any other type, certainly of any natural type. Men are fond of noting wonders, and we have a written history of thousands of years; but never yet has the differentiation of a human variety by mutation been recorded. On the other hand, so surely as a human race separates into sections, between which there is little or no intercourse, gradual differentiation sets in, which, under conditions of savage warfare and very restricted intercourse, may be seen in the inhabitants of quite small tracts of country, as in New Guinea. Amongst plants and lower animals parthenogenetic types are particularly rich in varieties. "Thousands of forms may be cultivated side by side in the Botanical gardens and exhibit slight but undoubted differentiating features, and reproduce themselves truly by seed" (de Vries, "Species and Varieties," pp. 59–60). When reproduction is bi-parental, varieties are few if individuals from distant parts of a wide area are able to mate, and proportionately more numerous if intercourse is more restricted. Thus in every valley of Samoa is found a distinct variety of snails; but species of birds, mammals, and fishes which possess considerable powers of locomotion have few varieties. Is Mr. Lock able to conceive any interpretation of all these facts except that under natural conditions fluctuations are selected and inheritance is blended?

He lays stress on the circumstance that man is not amenable to experiment; but man is not the only species that has natural varieties. May I, in turn, lay stress on the fact that it seldom pays the cultivator to select small differences (fluctuations)? Of necessity he selects mutations. The Mendelian experimenter has practically limited himself to the materials so created. He himself chooses for his experiments, and can choose, only glaring differences. In other words, he has, *qua* experimenter, absolutely no acquaintance with the small differences (fluctuations) which normally distinguish mating individuals in natural breeding. He judges the normal from the abnormal, the rule from the exception, and then appeals to earth to note the precision of his methods and thanks heaven he is not as other men, even as mere observers who seek to take the whole of the facts into consideration. Notwithstanding his parade of exactness, his belief that he reproduces natural conditions "is an assumption which still lacks the support of facts." Once more, therefore, let me challenge Mr. Lock and his comrades. If Mendelism deals with any other problem but that of sex, what is that problem? If no other problem can be named, what is the evidence that Mendelism deals with anything more than those abnormalities of sexual reproduction which occur under conditions of artificial selection? As I say, I do not ask for the solution of any problem. I ask only for an indication that Mendelism has any conceivable bearing on it. If the latter question also cannot be answered, then by all means let Mendelians pursue their very interesting studies; but let it be understood that "the new science of genetics" implies, not the study of heredity in general, but only the study of certain curiosities of artificial breeding.

G. Archdall Reid.

Southsea, October 20.

Pagan Survivals and Christian Adaptations.

It may interest some of the readers of Nature to find that the institution of the "kern-baby" (corn-baby) still exists in our island; and a writer in the *Christian World* for October 3 was present at the bringing home, on the last load, of this Pagan institution, and was present at the harvest supper this year, when the effigy was honoured by being placed on the table. It was, presumably, only a survival of olden time, when our ancestors "ate and drank" with their gods—especially the gods of agriculture (Judges, 9, v. 27).

Again, I received a letter the other day from the rector of Fobbing, Essex (formerly rector in the Scilly Islands), informing me, in reply to an inquiry, that the Beltane fires are, up to the present day, lit there on the highest point of the islands on May eve, just as our ancestors lit them in honour of the rise of Baal (or the sun). My informant, who has only left the islands two years, often witnessed the jumping of the youths "through the fire." I should be very pleased to learn of any ancient customs of this kind still carried out on the eves of "May Day," "Easter," "All Hallows," "Christmas," or other solstitial and equinoctial periods, and not heretofore recorded in standard books on the subject. In trying to ascertain the uses of certain stone circles and monster cromlechs this evidence is of great importance, as the early missionaries purposely "adapted" so many of the Pagan festivals to Christian worship. Wales is the most promising field.

J. W. Hayes.

West Thurrock Vicarage, Grays, Essex, October 16.

The "Quaternary."

In reply to Dr. Wright's comment on my letter (p. 639), I would point out that the restricted use of the word "Quaternary" appears to be confined to anthropologists. Geologists (Sir Archibald Geikie, Prof. Kayser, and Prof. Lapworth, for instance) who employ the term include in it everything from the commencement of the Glacial period to the present time.

John W. Evans.

Imperial Institute, October 25.

THE "MAURETANIA."

The first impression of the *Mauretania* is one of colossal size, the last is wondering amazement at the forethought and design which appear in details, trivial in themselves, but of supreme importance to individual comfort, of the fittings. Only those who saw the ship in the narrow waters of the Tyne can realise her huge dimensions. Eight hundred feet long herself, she floated abreast the builders' yard in a river less than 900 feet wide, which runs in a narrow cleft between low hills. In that narrow valley the great bulk of the ship made a prodigious spectacle, and over the valley before the start on the maiden voyage the smoke from her four great funnels moved like a pall.

In the brief voyage from the Tyne to the Mersey which took place last week, some of the peculiar features of the great ship were revealed. The Tyne is winding and narrow, and on the Tuesday afternoon its course was obstructed by crowds of steamers laden with sightseers. In this difficult passage the handiness of the vessel was at once apparent. Proceeding under her own steam, steered by propellers and the rudder, she was easily manœuvred at the sharp bends. To the writer, who was on the bridge at the time, it was obvious that the great turbines, which in the aggregate can develop 70,000 h.p., can be stopped or started with ease and certainty.

At sea, though the recurrent shocks characteristic of vessels fitted with reciprocating engines are absent, vibration is noticeable, though relatively slight. Generally speaking, it is maximal in the after part and diminishes thence to the bows. The distribution, however, is erratic, regions of maximal vibration often being close to regions of minimal vibration. In the great dining saloon at 22 knots the tremors were barely noticeable, being something like the passage of a vehicle in a street outside. On the other hand, a region of marked vibration was forward of this, about the level of the second funnel.

The cause of the vibration in turbine-propelled ships is not at all obvious, and experts at present seem to be unprovided with a satisfactory hypothesis. The turbines themselves are singularly free from it. Leaning against their great steel shells one is not conscious of a movement. In the shaft tunnels, however, it is very marked. The vibration has been referred to the impact of the water thrown by the blades of the wing propellers against the sides of the ship, to the unequal thrusts which each blade exerts in the course of each revolution, and to the formation of twisting couples between the propellers when they synchronise in certain ways. Inequalities in the thrust arise from the fact that owing to skin friction the water near the side of the ship is dragged bodily along with it. Each blade, therefore, as it revolves, passes through water moving in the direction of the ship to water which, relatively speaking, is still.

The vibrations themselves are markedly periodic, mounting by a long crescendo to a climax, followed usually by complete quiet. This periodic nature unquestionably suggests a dependence upon synchronism between propellers on opposite sides of the ship, and it was found in the case of, I believe, the *Deutschland* that vibration was much lessened when her twin screws were set to rotate respectively at 70 and 80 times a minute instead of both being at approximately the same rate. The whole subject is being investigated on the *Mauretania* by means of the pallograph, which registers at the same time the shaft movements and the vibrations.

As it is not possible to get an indicator diagram of a turbine, the work done is measured on the

Mauretania by torsion meters directly applied to each shaft. Two wheels are fitted on the shaft at some distance apart, each of which in its rotation makes an electrical contact. The contacts are exactly in line, and therefore are coincident in point of time when the shaft is at rest. When the shaft is rotated it suffers torsion, and the aft contact lags behind the forward one. The angle of the lag measures the torsion. The instrument is calibrated by determinations made in the shops of the twist which the shaft suffers from couples of known magnitude. In the navigating house of the *Mauretania* are four dials, on each of which a hand revolves in the direction and at the speed of the particular propeller shaft to which it is attached. It is obvious that the torsion meter might be so adjusted as to give direct records on the bridge of the work of each turbine from moment to moment.

The two most impressive parts of the machinery are the controlling platform, already mentioned, of the engine-room, where a few small levers control the gigantic forces pent up in the long polished barrels of the turbines, and the small, easily manipulated wheel in the wheel-house, which, by means of a small hydraulic motor, controls the enormous steering engine sunk below water level some 650 feet distant!

The plates of the *Mauretania* were delivered rolled to a guaranteed thickness. This is, I believe, a new departure in the building of English merchant ships, and it enabled the builders to save 500 tons of dead weight. The use of silicon steel in the boilers effected a further saving of 500 tons, making a total of 1000 tons, which, reckoned as cargo, represent a gain to the Cunard Company of about 22,000*l.* a year in the earning power of the vessel. An interesting saving in dead weight was also effected in connection with the decoration. The lifts in the well of the main staircase are enclosed by a beautiful piece of metal work adapted from existing sixteenth-century wrought-iron work. It is carried out in aluminium instead of iron, and thereby 20 tons weight is saved. One wonders whether the high affinity of the metal for chlorine and the presence of chlorides in sea air have been adequately taken into account.

The engine-room of the *Mauretania*, despite the absence of the main reciprocating engines, is very closely packed, and the greatest ingenuity is manifested in the arrangements. The four main turbines, each of 15,000 h.p., are controlled from a tiny platform by six small levers. Over the great engine-room steam pipes arch large enough for a boy to walk through, and the exhaust from each low-pressure turbine passes through a "pipe" 14 feet by 16 feet! The distinctive noise of the engine-room is the continuous roar of the steam passing through the main steam pipes. The engine-room, counting main turbines, turbo-generators, and auxiliary engines, holds machinery capable of developing something over 80,000 h.p., and the rotating mass of the main turbines amounts to about 600 tons, and rotates about 200 times a minute.

The gigantic low-pressure turbines receive the steam at nearly atmospheric pressure, which falls to a condenser pressure of about minus 27 inches of mercury. Ingenious gauges are fitted on each turbine, which record the pressure at different steps in the expansion, so that, should some of the blades become stripped, the injury can be at once located.

The stokeholds are so efficiently ventilated by powerful fans as to be cool save when the furnace doors are actually opened, in spite of the presence of 192 furnaces.

The magnitude of the strains which a ship nearly the length of the Houses of Parliament must experience in a heavy head sea is brought to mind by the provision which has been made for bending. The boat deck, together with the deck houses on it, which contain the long suite of public rooms, are cut completely through in three places, so as to allow the ship to give longitudinally.

No description can give the effect of the stately progress of so great a ship down the narrow Tyne. The grey autumn day, the cheering crowds piled on the hill-sides to their summits, and the anxious pilot striving to make his orders heard amid the clamour of steam whistles and fog signals, are vivid recollections. So, too, are the raucous blasts of welcome flung to us from the great headlands as we passed them by. The sombre cliffs of the Pentlands in the grey dawn, Cape Wrath under the autumn sun, lonely light vessels, tiny fishing craft, and liners, each after its own fashion wished us the freedom of the seas.

W. B. HARDY.

THE GEOLOGICAL SUCCESSION IN SOUTH AFRICA.[1]

EVERY year our knowledge of the geological succession in South Africa becomes more extended as a result of the labours of the Geological Commission of the Cape, the Geological Survey of the Transvaal, and the host of private workers who contribute to the Transactions of the Geological Society of South Africa. The newly published Report of the Cape Commission for the year 1906, and the Transactions of the Geological Society for the period January to June of this year, are full of interesting matter. The Cape surveyors have been working in Bechuanaland and Griqualand West, and have thus come into close contact with the work of the Transvaal geologists; for although the operations of the official Survey of the Transvaal have as yet been confined to the Pretoria and Middelburg districts, the Marico district and the neighbourhood of Mafeking have been explored by unofficial geologists in the employ of big land companies. Pioneer work of this nature, although unsanctified by official publication, is not to be contemned, since in many cases it is done, under conditions of considerable difficulty, by enthusiastic geologists and keen observers whose labours have often laid the foundation for the detailed work of the Government surveyors.

The earliest work in Griqualand West was by Mr. G. W. Stow, who communicated some of his results to the Geological Society of London (Q.J.G.S., vol. xxx., pp. 581–680, 1874). Unfortunately, a considerable proportion of his observations was embodied in reports to the Griqualand West Government, which since they were handed in have never emerged from their pigeon-holes. However, his classification of the Griqualand West rocks has, with the exception of the Keis series, been adopted by the Cape Survey. It is as follows:—

Matsap Series...	Quartzites and conglomerates
(unconformity)	
Griquatown Series ...	Magnetite-jasper rocks
Campbell Rand Series ...	Limestone and quartzite
Keis Series	Quartzites and mica schists

[1] Eleventh Annual Report of the Geological Commission of the Colony of the Cape of Good Hope, 1906. (Capetown, 1907.)
Geological Map of the Colony of the Cape of Good Hope. Sheet xlvi. (Published by the Geological Commission, 1907.)
Transactions of the Geological Society of South Africa. Vol. x., January to June, 1907. Pp. 1–68. (Johannesburg, 1907.)

The next step was the tracing by Mr. E. G. Holmes in 1904 from the Transvaal into Bechuanaland of the Black Reef, Dolomite, and Pretoria Series (Trans. Geol. Soc. S.A., vol. vii., p. 130). He followed these well-known Transvaal formations near enough to the original localities of the Keis, Campbell Rand, and Griquatown Series described by Stow to suggest the correlation which was proposed in the following year by Hatch and Corstorphine in their "Geology of South Africa" (p. 311), namely, in the following manner:—

Griqualand West		Transvaal
Matsap Series	=	Waterberg Series
(unconformity)		(unconformity)
Griquatown Series	=	Pretoria Series
Campbell Rand Series	=	Dolomite Series
Keis Series	=	Black Reef Series

Mr. Rogers appears to doubt whether Stow, by his Keis Series, referred to the quartzites which succeed the Campbell Rand Series in downward succession. He therefore substitutes the Transvaal name—Black Reef Series—and with this modification accepts the correlation; but he points out that the Matsap and Waterberg Series present marked points of difference, especially in regard to their volcanic rocks, which are of a more acid character in the latter than in the former.

The Matsap Series is subdivided by Mr. Rogers as follows: an *upper* group of quartzites and sandstones, developed in the Langebergen proper; a *middle* group of quartzites, lavas, and fragmental rocks of volcanic origin; and a *lower* group of quartzites, slates, and conglomerates forming the foothills east of the Langebergen, north of Pad Kloof. The basal bed contains many boulders and pebbles of quartzite, quartz, and red jasper in a quartzite matrix which is sometimes highly ferruginous.

In the Transvaal, Mr. Mellor has recently shown (Trans. Geol. Soc. S.A., vol. x., p. 44) that while the base of the Waterberg System is often marked by the presence of coarse conglomerates, in the Middelburg district a series of acid and intermediate lavas, interbedded with tuffs, agglomerates, shales and sandstones, underlies the usual sandy types of sedimentation. The whole volcanic series attains a thickness of approximately 8000 feet.

The Griquatown Series is divided by Mr. Rogers into an *upper* group, consisting largely of slaty rocks, together with some brown and red jasperoid rocks and thin beds of chert and limestone; a *middle* group, consisting for the main part of the Ongeluk volcanic beds, together with some banded jasper beds; and a *lower* group, comprising banded jaspers, quartzites and mudstones. The conglomeratic rocks that occur at or near the top of the lower group in the Hay district contain "striated and flattened pebbles and boulders," which, according to Mr. Rogers, "certainly owe their characteristic shape and scratches to glacial action" (Rep. for 1905, p. 162). Seeing that these beds belong to a geological period considerably older than the Dwyka Glacial Series (they occur at least 15,000 feet lower down in the succession—even more if the Matsap Beds are considered to be older than the Table Mountain Sandstone), this is an interesting contribution to the fast-growing history of glacial action in the remotest periods of geological time.

The Campbell Rand Series occupies practically the whole of the Kaap plateau. As in the Transvaal, this formation consists mainly of dolomitic limestone with which cherts are often associated. The shales which occur near the bottom of the series were searched by Mr. Rogers without success for fossils. Conformably underlying it is the Black Reef Series, consisting of quartzites, grits, felspathic quartzites, conglomerates, shales, &c. An exact divisional line between the two formations cannot be drawn owing to the alternation of beds of quartzite and limestone near the junction.

The three series—Black Reef, Campbell Rand, and Griquatown—are grouped together by Mr. Rogers as the Transvaal System, a term introduced by Molengraaff for the corresponding series in the Transvaal. The name is scarcely a happy one; but since it has also been adopted by the Transvaal Geological Survey, it will probably remain. Below the Black Reef Series is a basic series of amygdaloidal lavas—the Pniel series of Stow—and this is succeeded by an acid volcanic series to which the Cape geologists have given the name Zoetlief Beds. There is an unconformity between the two series; but Mr. Rogers has decided to include them in one group under the name of the Ventersdorp System, which name is used for the equivalent formation in the Transvaal.

The Ventersdorp, Transvaal, and Matsap Systems lie on a floor of granite and schists, and have been folded during pre-Dwyka times into arches and troughs, the axes of the folds embracing a wide area of low mountains, the principal range of which is the Langebergen. The underlying schists are grouped as the Kraaipan Series; they are equivalent to the Swaziland Series of the Transvaal, and consist largely of magnetitic schists and thin quartzites. The Cape geologists have found no evidence of the granite being intrusive into the schistose formation, although this has been clearly proved in the Transvaal (Abelskop, Monte Maré, &c.). In this connection it is interesting to note that the Geological Survey of the Transvaal has recently recognised that the granite mass which lies north of Johannesburg is younger than the schists of the Swaziland Series (Moodies Series), while it also admits the correctness of the view that it constituted an older floor on which the basement beds of the Witwatersrand Series were deposited (Trans. Geol. Soc. S.A., vol. x., pp. 55 and 57; *cp.* also "Geology of South Africa," p. 93).

Summarising, there is in South Africa, lying on an old floor of schists and granite (which is almost certainly of Archæan age), a succession of sedimentary rocks, older than the Devonian, and including the Waterberg or Matsap, the Transvaal, the Ventersdorp and the Witwatersrand Systems, all separated by strong unconformities. In this accumulation of sediments, which is estimated to have a thickness of between 50,000 and 60,000 feet, not a single fossil has as yet been found.

With regard to the Karroo rocks of the Transvaal, a further step in their elucidation is marked by the conclusion arrived at by the Survey, that the Bushveld Sandstone Series (a succession of red marls, shales, and fine-grained sandstones), together with the overlying amygdaloids, are the equivalent of the Red Beds, Cave Sandstone, and Volcanic Group of the Stormberg Series of the Cape, the Orange River Colony, and Natal (Kynaston, Trans. Geol. Soc. S.A., vol. x., p. 34). The recent discovery by Mr. J. Mitford Bowker, in the Zoutpansberg district near the Limpopo River, of fossil bones, which Dr. Broom has determined to be of Stormberg age, shows that the Bushveld Sandstone Series extended far to the north; for it is found to cross the Limpopo River into the Victoria district of Mashonaland, where coal-seams have been reported to occur in it (Proceedings of the meeting of the Geol. Soc. of S.A. held on June 24, 1907).

F. H. Hatch.

THE ROMANCE OF PHOTOGRAPHY.[1]

ALL phenomena are wonderful in the measure that we are unaccustomed to them, and if quite strange to us they are incredible. The romantic character of the details of any subject is therefore an individual matter, but the author in this particular case assumes no exact, and very little general, knowledge on the part of his readers, and so he is justified in his repeated asseverations of the marvellous character of the various details of the discovery and achievements of photography. We take it that the duty of the writer of such a volume is very largely to rob his subject of its atmosphere of romance by showing its gradual development and the reasonableness of its results. In this the author is successful. He gives no "instructions," but merely tells his story in a readable form and illustrates it well, for every one of the sixty or more illustrations has a definite and sufficient reason for its presence. He treats it in an easy and sometimes, perhaps, rather too discursive manner, giving many apt analogies of the development of photography and of its applications in instantaneous work and kinematography, the making of book illustrations, the photography of the invisible as by means of Röntgen rays or the ultra-violet of the spectrum, and the reproduction of colour.

Telegraphed Photographs. These photographs are just as they were received by the electric telegraph. The left-hand portrait is that of the Crown Prince of Germany, and the other is a portrait of Prof. Korn. From "The Romance of Modern Photography."

One of the most interesting chapters deals with the detection of crime and the identification of criminals, for it is seldom that those who are not engaged in the work itself have the opportunity of seeing examples of photographs taken for these purposes. There is also a chapter on telegraphic photography, described in NATURE of August 19 (p. 445). The accompanying illustration from this chapter is reproduced by the courtesy of the publishers. In another chapter we learn how "the largest photograph in the world," 40 feet long by 5 feet wide, was developed by mounting it face outwards on the periphery of a large broad wheel made for the purpose, and rotating it in a comparatively shallow tank that contained the developer, and find details of many other cases in which great difficulties were successfully overcome. The number of examples given of extraordinary methods of work is considerable, and they cover so wide a field that probably no one who reads the book will fail to find something new to him.

When an author sets out with the avowed purpose of dealing with the romantic side of such a subject, the critic naturally looks for a little exaggeration here and there, and when so many branches of the subject are dealt with he expects to discover a few inaccuracies. It may be true to a certain extent to say that kinematography will enable our descendants to see the incidents in our great battles, but it is a mistake to state, concerning a picture of a group of men in the act of diving, that "the whole detail of this living scene was recorded by the great artist, Light, in one five-hundredth part of a second" by means of a focal-plane shutter, as the narrow slit in the shutter probably took thirty or forty times as long as this to pass over and so expose the surface of the plate. It is also incorrect to state that a Lippmann photograph "must have its mercury background" to view it properly. But the slips of this kind are not very serious and they are very few.

C. J.

[1] "The Romance of Modern Photography." By Charles R. Gibson. Pp. 345. (London: Seeley and Co., Ltd., 1908.) Price 5s.

M. MAURICE LOEWY.

"RIEN ne saurait exprimer la consternation et l'affliction que la mort foudroyante de Tisserand a répandues autour de lui, car l'amitié, l'estime et l'admiration entouraient comme d'une auréole l'illustre astronome qui s'est éteint dans la nuit de mardi." These words, which M. Loewy spoke at the graveside of his friend and predecessor, Tisserand, may very well be remembered when expressing our sense of the loss which France and science suffer in the sudden removal of the director of the National Observatory of Paris. Even the painful suddenness, which added an increased bitterness to the grief we experienced in the loss of Tisserand, is repeated again with depressing emphasis, for we understand that M. Loewy was struck down while attending a meeting of the Conseil des Observatoires astronomiques.

The director of a great National Observatory does not usually enjoy unfettered discretion in the selection of the lines of investigation to be pursued. In such institutions large pieces of work are not unfrequently undertaken, for the conduct of which both ample time and funds are needed. Too often he who plans does not see the full fruition of his work, and loyalty to the reputation of predecessors and the influences of tradition alike restrict the direction along which activity is possible. The long connection of M. Loewy with the Paris Observatory, previous to his occupancy of the director's chair, would make him particularly anxious to complete, if possible, certainly to forward, two very heavy legacies of work bequeathed to him by former astronomers. One of these was the great Paris catalogue of stars, depending upon meridian observations made within the period 1837–1881, including the re-observation of all Lalande's stars. The complete work, published in four sections, furnishes the places of nearly 35,000 stars, based upon 387,000 single measures. This heavy piece of work was brought to a very satisfactory conclusion under the supervision of M. Loewy, and by its completion the observatory staff is relieved of an oppressive incubus. The other is the International Star Chart, which had its origin under Admiral Mouchez. Not only has this work been prosecuted with ardour at the observatory, but encouragement and assistance were given to all who participated in the scheme, by means of conferences that have been held from time to time in the observatory at the suggestion of the regretted director. To both these projects M. Loewy gave as generous and consistent support as though he were responsible for their introduction.

M. Loewy's more immediate influence on the conduct of the observatory is shown in the steady prosecution of another piece of work, the chart of the moon derived from photographs taken with the equatorial coudé, a form of telescopic mounting with which M. Loewy's name is closely connected. The long focal length, which is one of the advantages secured in this class of telescope, giving an image of the moon more than seven inches in diameter, made this instrument peculiarly suitable for the investigation. The admirable reproductions made from the negatives justify the time and attention that have been bestowed on the enlargements. Concurrently with the issue of the maps there have been published acute dissertations on the physical constitution of the moon, founded on a minute critical study of the lunar surface. This close and detailed examination led the director to conclude that there were evidences of a permanent elongation of the moon's figure towards the earth, and of a surface action tending to diminish the angular velocity of rotation.

But besides the study of the moon's surface, the equatorial coudé has served another purpose. The principle of construction is so well known that it is not necessary to describe it here. But in designing this instrument M. Loewy had in view the possibility of obtaining greater stability than is attainable with ordinary equatorials, and by taking advantage of this stability to measure large angular distances on the celestial sphere. Having determined, by a thorough examination of the theory, the sources of error inherent in the instrument, M. Loewy proceeded to use it for obtaining a new value of the constant of aberration by an entirely novel method. For this purpose he placed a double mirror, formed by silvering two faces of a large prism of glass, in front of the object glass. The double mirror was capable of rotation about the axes of the telescope, so that by reflection from the two silver surfaces the images of two stars in different parts of the sky could be brought into the field side by side, and the distance between them measured in the common plane of reflection. By choosing suitable stars and making the necessary measures six months apart, the quantity measured could be made four times that of the constant of aberration. For greater accuracy the stars selected had the same altitude so as to reduce the effects of refraction to a minimum, but by changing the plan of observation it was possible to investigate the effects of refraction separately. The instrument lent itself to methods of great beauty and ingenuity, displaying both the mechanical ability of the inventor and the varied resources of the mathematician and astronomer. The Royal Astronomical Society fittingly acknowledged its appreciation of the important services M. Loewy had rendered to astronomy by awarding him the gold medal. Needless to say, he was an honorary member of that society as of many others, both in his own country and abroad.

It would not be possible, even if it were desirable, to record all the varied occupations in which M. Loewy was engaged in the course of his scientific career. His position made him frequently the adviser of his Government in many important matters. His services to the Bureau des Longitudes, in his capacity of director of the Connaissance des Temps, will be readily acknowledged. The part he played in various conferences, such as those which arranged the scheme for observing the planet Eros and for securing uniformity in the employment of astronomical constants, has been already mentioned. We can only deplore, in company with the whole guild of science throughout the world, the loss of one who ornamented a dignified position and worthily supported the traditions of the National Observatory. Within the last few years the continuity of its direction has been too frequently interrupted by the loss of its distinguished chiefs. Among these brilliant memories the name of Maurice Loewy will hold an honoured place. Round his grave in respectful sympathy were grouped the representatives of many learned societies. In addition to those of France, there were present members of the Academy of Sciences of Vienna, of the R. Accademia dei Lincei, while the Royal Society of London, as well as the Royal Astronomical Society and the British Association, were represented by Sir David Gill and Major MacMahon.

NOTES.

It is reported that at Monday's meeting of the Paris Academy of Sciences Prof. Lapparent described some experiments by Prof. Bordas upon the conversion of corundum into precious stones by the influence of radium. It is stated that when fragments of corundum were placed in contact with a tube containing radium for a month they changed colour entirely, and were transformed into crystalline varieties of the mineral, some pieces becoming yellow, like topaz; others purple, like amethyst; blue, as sapphire; and red, as rubies. The gems thus produced were submitted to a jeweller, who was unable to distinguish them from precious stones. We shall await with interest the appearance of the *Comptes rendus* of Monday's meeting for particulars of these experiments and results.

The death is announced of Prof. Gustav Adolf Zeuner, the distinguished authority on applied mechanics. Born at Chemnitz in 1828, he was the founder, and editor from 1853 to 1857, of the German journal the *Zivilingenieur*. In 1855 he was appointed professor at the Zurich Polytechnic, of which institution he was director from 1865 to 1868. From 1871 to 1875 he was director of the Freiberg School of Mines, and from 1873 to 1890 he was also director of the Dresden Polytechnic. He retired in 1895. His works included treatises on valve gearing and on the mechanical theory of heat.

Dr. Elis Strömgren, private tutor at the Kiel University, has been appointed professor and director of the Copenhagen Observatory in succession to Prof. T. N. Thiele, retired.

Sir Herbert Maxwell has been appointed chairman of the council of the National Association for the Prevention of Consumption in succession to the late Sir William Broadbent, and Dr. C. Theodore Williams has been elected vice-chairman.

The cup for the winner of the International Balloon Race, to be awarded to the aëronaut landing furthest from St. Louis in a measured straight line, has been won by Herr Erbsloh (Germany), who descended at Annapolis Junction, Maryland, having covered a distance of 874·4 miles.

The death is announced of Mr. T. F. Brown, a recognised authority on the geology of the South Wales coalfield. Mr. Forster Brown was a member of the Institute of Civil Engineers, a Fellow of the Geological Society and of the Surveyors' Institute, and past-president of the South Wales Institute of Engineers.

We are asked to announce that the annual "fungus foray" of the Essex Field Club will take place on Saturday, November 2, at Loughton and Theydon Bois, Epping Forest. The director will be Mr. George Massee, of the Kew Museum. Botanists wishing to be present should communicate with the secretary, Mr. W. Cole, Buckhurst Hill, Essex.

Referring to his letter in Nature (October 3, p. 568), the Rev. Dr. Irving writes to state that his assignment to the Upper Eocene or Oligocene of the fossiliferous limestone discovered in a well-sinking at Thorley, near Bishop's Stortford, was erroneous. The bed in question is probably Lower Eocene, of the age of the Oldhaven beds.

Count G. N. Plunkett, who has just taken office as director of the Dublin Museum of Science and Art, initiated the system of museum "demonstrations" about ten years ago, and has lectured on the arts and artistic crafts, and also on Irish archæology. In the Cork Exhibition of 1903 he organised a nature-study section, the work of more than a hundred schools. He is known outside Ireland through his book on Sandro Botticelli.

The list of lectures to be delivered at the London Institution during the present winter session is varied and comprehensive. Prof. G. S. Boulger takes for his subject the Andes of Peru; Prof. W. M. Flinders Petrie, F.R.S., will describe ancient Egyptian houses; Mr. E. S. Bruce is to explain the coming of the aëroplane, with the aid of experiments and illustrations; Mr. A. R. Hinks will discuss the evidence for life on Mars; Mr. I. S. Scarf takes up the subject of flames; Mr. L. E. Hill, F.R.S., researches on deep-sea diving; Prof. W. B. Bottomley, soil inoculations; and Mr. P. Chalmers Mitchell, F.R.S., ruminating animals. The lectures for juveniles will be delivered during the Christmas vacation by Prof. Grenville A. J. Cole, his subject being three days of open-air geology.

Calabria was subjected to a severe earthquake shock during the evening of October 23. The disturbance, which occurred at 8.30 p.m., seems to have followed the same line and to have been felt throughout the same districts as that of 1905. The centre of the disturbance was located in Monteleone, and its effects seem to have been noticed from Catanzaro to Reggio di Calabria. Reports of varying amounts of damage have been received from Gerace, Sinopoli, Pizzo, Tropea, and other places, which also suffered two years ago. Secondary shocks were felt on October 24; but from observations which have been recorded it is believed that the earthquake of last week was less severe than that of 1905. The shocks on both days were recorded by Prof. Milne's instruments at Shide, in the Isle of Wight, and by Prof. Belar at Laibach, in Austria. The number of victims is variously estimated, Reuter putting the number at 600. The damage is extensive and widespread. Shortly before 6 p.m. on October 28 a violent shock was experienced at Monteleone, Santa Eufemia, Bagnara, and Sinopoli.

Mr. Balfour on October 25 opened the new administrative buildings and two new wards at the Royal Victoria Hospital for Consumptives at Craigleith, Edinburgh. During the course of an address, Mr. Balfour said it is impossible to withhold wonder at the enormous strides which scientific medicine has made in the treatment of consumption in less than thirty years. Referring to future work in this direction, he remarked:—"If we cannot destroy and expel the tubercle bacillus from among us, we can reduce its power to do evil to a degree which may seem to us at the moment to be almost incalculable. We have an example before us of what has been done with regard to typhus. I doubt whether there is a single case of typhus in Edinburgh at this moment; and it may be that our children will live to see the time when consumption will be as little known in their midst as typhus is at this time. We have made the conditions of infection with regard to typhus so small that the power of resistance of the community at large is amply adequate to prevent its making any lodgment of a serious kind in our midst. That is the ideal to which we look forward with regard to tuberculosis." Continuing, Mr. Balfour pointed out that it is a great responsibility resting upon every person to see that the doctrines of modern scientific medicine penetrate, not merely among the well-to-do, but to every class in the community.

According to *Museum News* for October, a figure of a native Australian, carefully modelled by an eminent Washington sculptor, has been placed in the Brooklyn Museum alongside stuffed specimens of the man-like apes, in order to illustrate the wide differences between the latter and the lower races of mankind. Silk-worm-culture and silk-manufacture are now illustrated in the museum by cases of living silk-worms, as well as by exhibits of the more important descriptions of raw silk.

Total prohibition of the use of the plumage of wild birds as articles of dress is regarded by Prof. T. H. Montgomery (Bull. Univ. Texas, No. 79) as the only effectual remedy against what he regards as a mischievous fashion. "It will not do," he writes, "to prevent the killing of our American birds and to allow the importation of foreign ones, for this would be injuring another country, and in the long run, for the sake of greater cheapness, would result in the killing of our native species."

The additions to the Zoological Society's menagerie during September were 149 in number, of which sixty-eight were acquired by presentation and two by purchase, while sixty-five were received on deposit, four by exchange, and ten were born in the gardens. Amongst these, special attention is directed by the secretary to the following, viz. a female giraffe, born on September 20; a male gayal, born on September 6; three harnessed antelopes (*Tragelaphus scriptus*); a nagor antelope (*Cervicapra redunca*); and two side-striped jackals (*Canis lateralis*), from Gambia, presented by Sir George Denton; and a Cayenne kite-falcon (*Leptodon cayennensis*), deposited.

Vol. lxxxviii., part i., of *Zeitschrift für wissenschaftliche Zoologie* contains an exhaustive article on the morphology and life-history of the vine Phylloxera (*Phylloxera vastatrix*), by Mr. H. Stauffacher, of Frauenfeld, Switzerland, illustrated by a coloured plate showing the chief developmental stages and the dimorphic phases of the winged adults. At the conclusion of the article special attention is directed to the origin of these dimorphic phases, which include a larger and a smaller form; diagrammatic illustrations being given of the various theories proposed. According to the author's view, trimorphic nymphs are developed, from which are produced what he terms the α form, β form, and γ form, which in turn respectively give rise to the parthenogenetic generation, to males, and to females.

To the July issue of the Proceedings of the Philadelphia Academy, Mr. E. G. Conklin contributes a paper on the embryology of the gastropod Fulgur, from the point of view of the influence of the yolk on development. The eggs of this genus are remarkable for their large size, the bulk being almost wholly due to the quantity of yolk; and one of the problems to which special attention was devoted is the effect of large or small yolks on the development of the organs of the embryo. For the author's conclusions our readers must be referred to the original paper; but it may be mentioned that after a certain stage the elements of the Fulgur yoke cleave irregularly, a feature which may foreshadow the "meroblastic" eggs of birds and reptiles, in which only a portion of the yolk undergoes cleavage.

We have received copies of a circular issued by the Vigilance Committee of the Fur and Skin Trade Section of the London Chamber of Commerce directed against the alleged practice of certain retailers in wrongly marking, naming, and advertising furs for sale, in violation of the Act of Parliament against "false trade descriptions." The action taken by the committee has already led to satisfactory results, but there appears reason to believe that the illegal practice still continues. Among the scheduled items are musquash and nutria (coypu) fur, sold, "when pulled and dyed," as seal; and nutria, when "pulled natural," sold as beaver. Dyed rabbit fur sold as sable, white rabbit as ermine, and dyed white rabbit as chinchilla, also appear in the list. It is added that purchasers who may have any doubt as to whether furs sold to them are correctly described can obtain expert opinion, free of charge, by forwarding the articles to the offices of the London Chamber of Commerce, Oxford Court, Fleet Street, E.C.

In the introduction to his report on the diatoms collected in the Pacific Ocean on the voyages during the years 1898 to 1904 of the steamer *Albatross*, belonging to the United States Bureau of Fisheries, Dr. A. Mann claims that, as owing to their minuteness diatoms can be transported by slow currents or surface drifts, a tabulation of the species found at different stations would provide useful data for determining the direction and extent of ocean currents. He also quotes several instances to show how different species are confined to, and therefore typical of, distinct localities. The systematic enumeration contains a careful digest and sifting of previous nomenclature. The genera Navicula, Biddulphia, and Coscinodiscus are richest in species, and also provide the larger number of new species. The report is published as vol. x., part v., of the Contributions from the United States National Herbarium.

We have received the annual report of the medical officer of health (Dr. Seaton) of the administrative county of Surrey for 1906. The prevalence of enteric or typhoid fever in the administrative county is the subject of a special report. The incidence of 2093 cases occurring during the last twelve years has been reviewed, and the opinion is expressed that it is doubtful whether even 10 per cent. of the cases can be attributed to the drinking of a polluted or infected water supply, and there seems to be no evident relation between the rainfall, and consequent floods, to typhoid prevalence. Dr. Seaton believes that polluted and infected foods are a much more frequent source of typhoid illness than is even now generally supposed. He also refers to the occurrence of cases which it is impossible to connect with any other case, and suggests the possibility of new origin (*i.e.* apart from human infections) through bacilli other than those which are regarded as the invariable specific causes of typhoid. With regard to this, it may be mentioned that recent German researches have shown that patients may harbour the typhoid bacillus for months after they have recovered from an attack, and that even well persons may occasionally be the hosts of the organism; it seems hardly necessary, therefore, to suggest a *de novo* origin.

Under the title of "The Tuna as a Food for Man," Mr. R. F. Hare and Mr. D. Griffith have provided in Bulletin No. 64 of the Agricultural College, New Mexico, an illustrated account of the varieties of fruit—commonly called prickly pear—grown to a considerable extent in Mexico. The fruits described are species of Opuntia; they have a thin skin more or less covered with spicules, under which is a rind enclosing the pulp and embedded seeds. The pulp alone is generally eaten, but sometimes part of the rind is included. The fruit is relished by the peons and poorer classes, and is harvested for shipment. There is also a local manufacture of products of the nature of honey, sugar-paste, and toffee.

The Quarterly Journal of the Liverpool Institute of Commercial Research in the Tropics, vol. ii., No. 5, contains excellent illustrations of some African fibrous plants from photographs by Mr. J. A. Alexander, formerly of Portuguese East Africa. Dr. E. Drabble furnishes notes on the synonymy, morphology, and fibres of leaves of *Sansevieria guineensis* and *Agave rigida*, also on the seeds of *Myristica angolensis* and fruits of *Lophira alata*. From the latter the natives of West Africa obtain a cooking oil, and the fat of Myristica is suitable for soap-making. Dr. D. Spence contributes articles on the analyses of latex and rubbers, the most important being a discussion of the methods of analysing raw rubbers.

A second hundred of the leaflets published by the Board of Agriculture for free distribution has been completed. They deal with farm and garden crops, insects and fungal pests, and the breeding and management of farm animals. Among recent issues are two containing information on the winter rot of potatoes caused by the fungus *Nectria solani*, and the black rot of cabbage attributed to the bacterium *Pseudomonas campestris*. The Nectria appears on stored potatoes, forming white, and later pink, patches, from which arise crops of spores that spread the disease and reduce the tubers to a fœtid mass. The ascospores developed in the following season can infect growing crops. The cabbage rot is readily distinguished by the black appearance of the vascular bundles along which the bacteria travel. The Sycamore leaf-blotch, caused by species of Rhytisma, so familiar by reason of the black patches produced, is described in another leaflet. An account of the coltsfoot, *Tussilago farfara*, and a note on the Fertilisers and Feeding Stuffs Act, 1906, have also been published.

The King has instituted a new medal for bravery in mines. The Royal Warrant states that the King is desirous of distinguishing by some mark of Royal favour the many heroic acts performed by miners and quarrymen who endanger their own lives in endeavouring to save the lives of others. The new medal will be of two classes, which are to be designated the Edward medal of the first class and the Edward medal of the second class. The ribbon will be dark blue with a narrow yellow stripe on either side.

The *Engineering Magazine* for October is a special number of great interest, devoted exclusively to mining. There are articles on the copper situation in the United States, the production of gold, the mechanical engineering of the mine, the manufacture of steel and wrought iron, asbestos, excavations for the foundations of a modern tall building, electrometallurgical progress, steam production from the cheaper grades of anthracite, underground workings in New York City, and the unwatering of mines in the anthracite region. All these articles are written by leading authorities and are admirably illustrated, and the whole forms a trustworthy review of current practice.

At the first meeting of the new session of the Institution of Mechanical Engineers, Prof. Bertram Hopkinson read an important paper on the indicated power and mechanical efficiency of the gas engine, describing an investigation made with the object of finding whether the indicator power of the gas engine does, in fact, vary so much and is so difficult of determination as the report of the committee of the Institution of Civil Engineers on the efficiency of internal-combustion engines suggests. The conclusions reached were as follows:—(1) If precautions are taken to keep the pressure of the gas supply constant, the diagrams given by the engine are remarkably regular, and whether the engine be missing ignitions or not, it is possible, by the use of a sufficiently accurate indicator, to obtain the indicated power from diagrams within 1 per cent. or 2 per cent. It seems probable that the difficulty experienced by the committee was due either to the essential defects, for this purpose, of the ordinary form of indicator, or to casual variations in the gas supply per suction due perhaps to variation in the gas pressure at the engine. (2) The difference between indicated horse-power and brake horse-power is rather less than the horse-power at no load under the same conditions of lubrication, mainly because of the difference in the power absorbed in pumping. In the particular engine tested by Prof. Hopkinson the error from this cause in obtaining the indicated power would amount to about 5 per cent. The friction is substantially constant from no load to full load, provided that the temperature of the cylinder walls is kept the same, but the influence of temperature is very great.

The current number of the *Quarterly Review* includes an important article, by Mr. Urquhart A. Forbes, on the water supply of the United Kingdom. The importance of treating water supply on broad lines was pointed out by the 1869 Commission on Water Supply, when the adoption of the watershed area as the administrative unit for water supply was recommended. Since the water supply for purposes of navigation is derived from the various watersheds traversed by canals and river navigations, it is desirable that the authority in each watershed should be empowered to exercise some control over canal companies and river trustees with respect to the amount of water to be abstracted from it. Such watershed boards with the powers indicated would be able to carry out the scientific regulation of all water from its first arrival as rain to its disappearance in the ocean. It has been suggested that the staff of the central authority, which would be a department under the Local Government Board, would, in addition to the administrative head, comprise (1) an engineer and assistants, with a special knowledge of geology and water supply, charged with the duty of collecting and digesting for use all the facts requisite for the scientific treatment of our water system; (2) a bacteriologist and a chemist, with a special knowledge of the bacteriology and chemistry of sewage, trade effluents, and water supply, who should be provided with a laboratory for experiments; (3) a staff of inspectors for carrying out its supervisory work with respect to both pollution and waste of water. In addition to the facilities it would provide for the treatment of our water system on scientific principles, the establishment of a central water department offers the best means of restoring order in the present chaotic condition of things.

The great changes wrought by the eruption of April, 1906, necessitated a re-survey of Mount Vesuvius, which has been effected by the Italian Military Geographical Institute. The extreme height of the mountain was determined as 1223 metres above sea-level, as compared with 1335 metres before the eruption; the height of the crater rim has become more irregular, dropping to only 1103 metres on the E.N.E., with a diameter of 725 metres from N.N.E. to S.S.W., and 645 metres from N.W. to S.E. At lower levels the contours have everywhere been enlarged from those of the survey in 1900, and in the Atrio del Cavallo and Valle dell'Inferno the depression has been filled up to the extent of from 5 metres to 50 metres.

In travelling by rail, or still better by steamer, from Lyons to Avignon, a marked narrowing of the Rhone Valley is noticed after Valence, between the pre-Alps of Dauphiné on the left and the singular dark ridge of Coirons on the right. This easterly spur of the central *massif* of France is capped by a thick sheet of basalt, which affords a striking instance of inversion of topography. There is no doubt that, at the close of the Miocene, when the molten rock issued from a vent located near Mount Gerbier des Joncs, it followed one of the channels of the river system of that period. Since that time the eastern border of the central *massif* (Cévennes) has been subjected to strong erosion, increased by the subsidence of the lower part of the Rhone Valley, and the consequent lowering of the base-level. The surrounding Cretaceous and Upper Jurassic limestones have been easily worn down and reduced to gentle slopes. The basaltic flow, about thirteen miles in length and three miles wide, resisted much more successfully the subaërial disintegration. In consequence of this very unequal weathering, what was once a valley is now a long ridge standing 2200 feet above the level of the Rhone. The history of the Coirons may be compared to that of the Scuir of Eigg in western Scotland. Unfortunately, a portion of the sheet of lava of Coirons rests upon the Oxfordian, easily undermined by the head-waters of the lateral torrents; the edges of the volcanic table are liable to break away and to creep down the slopes upon the clayey substratum. The landslip which occurred on October 11 above Moulin-Artige is only an episode in this process of slow undermining, which has reduced the formerly continuous basaltic plateau to the shape of a fish-bone. As a consequence of the torrential rains which occurred in southern France during the first part of October, nearly one million cubic metres of rocks has moved a distance of 900 metres, threatening to block a valley and to form a lake. Such incidents are bound to occur again on both sides of the Coirons, and the suggested re-afforesting of the district will tend to diminish, but not to prevent, all future danger. Perhaps it would be wise to restrict the construction of villages to safer ground.

MR. W. ERNEST COOKE, Government astronomer at the Perth Observatory, West Australia, directs our attention to an exhibition of globe lightning, or a fireball of some sort, which was noticed by two observers on September 7. Mr. Cooke did not himself see the display, but he can certify that about the time mentioned by the observers there was a blinding flash of lightning in the vicinity, followed almost immediately by a heavy crash of thunder. The observers who reported the matter to Mr. Cooke are stated by the *Daily News* of West Australia (September 9) to have described their experience as follows:—In the middle of the reverberation of the thunder a tremendous explosion about 6 feet from the ground was heard, and a momentary flash of blinding intensity was seen. Both saw a lurid red ball, estimated by them as about 4 inches in diameter with a circle of bright yellow flame, with a diameter which seemed to be 18 inches, which graduated in colour until it faded at the edges. As there are only a few authenticated instances of similar displays, it is desirable to place each new instance on record.

MESSRS. GEORGE PHILIP AND SON, LTD., have sent us a specimen of their "New Standard Time Dial" designed by Prof. R. A. Gregory for the determination of the local mean time at any place on the earth's surface, corresponding to the time at the place where the dial is being used. This simple and useful device consists of a stout wooden board on each side of which is printed a clock face showing the hours from noon to midnight and midnight to noon. Within each dial is a rotating disc on which is printed, on the one side, a map of the northern, and on the reverse side a map of the southern, hemisphere. Meridians of longitude are drawn at intervals of 15° on each map, and where a meridian marks a commonly used standard time, such as Greenwich, mid-Europe, or inter-Colonial, it is so designated; the meridian where the date changes from the American to the Asiatic date is also marked. By simply rotating the inner disc until the meridian of a place is opposite to the actual time, as shown on the dial, the corresponding local time at any other place may be read off directly. The device will be found serviceable; and its low price (3*s*. 6*d*. net) should ensure its appearance in all places, especially schools, where the longitude-time problem has to be solved frequently.

Le Radium for September contains an important article by M. Jean Becquerel on the influence of temperature on the absorption of solids. It appears from M. Becquerel's researches that increase of temperature of a solid displaces the absorption bands towards the red end of the spectrum by two or three units of the fifth figure of the wave-length per 100° C., while the bands at the same time increase in width and change in intensity, the width being proportional to the square root of the absolute temperature.

THE communication to the Physical Society of Berlin in which Dr. E. Goldstein announced his discovery of the existence of two independent spectra of each of the elements cæsium, rubidium, and potassium has been reproduced in full in the *Physikalische Zeitschrift* for October 15. The new spectra are produced by powerful condenser discharges, and have not a single line in common with the old, or as Dr. Goldstein names them, the arc spectra. The new lines do not appear to fall into series, and the author suggests that they constitute the "fundamental spectra" of these elements, the arc spectra being due to polymerisation in the metal vapour, which is impossible in the powerful sparks necessary to produce the former.

IN the June number of *Terrestrial Magnetism and Atmospheric Electricity*, Mr. Y. Homma calculates the rates of change of the electrical potential at different distances above the earth's surface on various assumptions as to the distribution of positive charges in the atmosphere, the earth being taken as a sphere. None of the calculated rates of change agrees with the somewhat meagre observations which have been made, and the author points out the importance of further work in this direction.

IN the report of the third Prehistoric Congress of France in NATURE of October 24 reference was made to some photographs of Japanese megaliths, which were said to have been taken by M. Goodhan (p. 649, col. 2, line 3), Prof. W. Gowland writes to say that the photographs were taken by him, and were lent to Mr. F. V. Dickins for exhibition at the conference. The name was printed exactly as it was given by the secretary of the conference, who furnished the report of which a translation appeared in NATURE.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN NOVEMBER:—

Nov. 4. 15h. 33m. to 19h. 14m. Transit of Jupiter's Sat. III. (Ganymede).
10. Saturn's major axis outer ring $=43''\cdot00$, minor axis $=0''\cdot64$.
12. 4h. 11m. Moon in conjunction with Mars. (Mars 0° 58′ S.)
13. 22h. 23m. to
14. 1h. 47m. } Transit of Mercury across the Sun.
,, 10h. 24m. Moon in conjunction with Saturn. (Saturn 2° 26′ N.)
14–16. Epoch of the Leonid meteors. (Radiant 150° + 22°.)
17. 10h. 1m. Minimum of Algol (β Persei).
20. 6h. 50m. Minimum of Algol (β Persei).
,, 4h. 25m. to 5h. 4m. Occultation of δ^1 Tauri (mag. 3·9).
,, 4h. 44m. to 5h. 35m. Occultation of δ^2 Tauri (mag. 4·7).
21. 17h. 6m. to 17h. 54m. Occultation of ζ Tauri (mag. 3·0).
23. 15h. 41m. to 17h. 1m. Occultation of δ Geminorum (mag. 3 6).
25. 20h. 34m. Moon in conjunction with Jupiter. (Jupiter 1° 57′ S.)
29–30. Mercury rises 2h. 2m. before the Sun.
30. 18h. 49m. to 23h. 39m. Transit of Jupiter's Sat. IV. (Callisto).

COMET MELLISH, 1907*e*.—Three observations of Mellish's new comet are reported in No. 4207 of the *Astronomische Nachrichten* (p. 111, October 17). Prof. Hartwig's observation on October 15 showed that the comet was round, with a diameter of 3′ and a central condensation. The magnitude at 15h. 52m. on October 15, as estimated by Prof. Becker at Strassburg, was 9·3.

THE TRANSIT OF MERCURY.—In view of the approaching transit of Mercury (November 14), Mr. W. T. Lynn publishes a letter in No. 388 of the *Observatory* (p. 382, October) in which he directs attention to earlier observations of this phenomenon and to its periodicity. He states that the first authentic observation of the transit was made in 1631 by Gassendi, and was followed by an observation by Jeremiah Shakerly, an Englishman who went to Surat, India, in 1651, for the purpose of observing the transit. Halley observed the 1677 transit at St. Helena, and this led him to suggest that transits of Venus would afford a peculiarly advantageous means of determining the solar parallax, a suggestion that was first carried out officially in 1761.

Mr. Lynn also directs attention to the peculiar commensurability existing between the orbital periods of the earth and Mercury, the former completing forty-six in nearly the same time that the latter completes 191 revolutions; the periods are 16,801 and 16,802 days respectively, and thus transits of Mercury must occur every forty-six years at the same node.

THE PERSEID METEORS.—In No. 4206 of the *Astronomische Nachrichten* (p. 81, October 16) Herr W. Milowanov, of the Kasan University Observatory, Russia, gives an account of the Perseid observations made at Kasan in August, 1906. Two hundred and seventy-two meteor-paths were recorded, by three sets of observers, on August 11, 12, and 13, forty-nine of which were not Perseids. The horary rate on August 11 was 21·5, and on August 12 25·4. The time of observation, the path and the magnitude of each meteor are given, together with a list of the variously estimated radiants; the centre of the radiant for 1906 is given as $\alpha = 43°·5$, $\delta = +55°·0$. The heights of twenty-four meteors are also given, the mean heights of appearance and disappearance being 111 km. (sixty-nine miles) and 73 km. (forty-five miles) respectively.

A RICH NEBULA REGION.—On a plate exposed in the Bruce telescope for three hours on July 10, 1906, Prof. Max Wolf found an extensive nebulous cloud having its centre some $1\frac{1}{2}$ degrees north-east of ϵ_2 Sagittarii. Later observations show that the region is very rich in small nebulæ, a plate exposed on July 16 showing a large number of such objects over a region of forty-eight square degrees. Most of these nebulæ are of Prof. Wolf's class I_1, being round objects with central condensations (*Astronomische Nachrichten*, No. 4207, p. 109).

RAIN-GAUGE EXPOSURE AND PROTECTION.

WHEN during the nineteenth century rainfall observations by means of gauges began to be carried out upon an extensive and scientific system, it was soon discovered that gauges which stood in situations much exposed to the wind invariably indicated a smaller amount of rain than such as were protected from the wind.

The greater part of our knowledge regarding the effects of wind exposure upon the indications of rain-gauges was derived from a careful study of the diminution of recorded rainfall with the elevation of gauges, either upon buildings or poles, above the ground, and an abundance of experimental work carried out during the nineteenth century in many European countries, notably, perhaps, in England, as well as in the United States of America, left no doubt but that this indicated decrease of rainfall with height above the ground was only apparent, and due to the more imperfect catch of rain by the gauges consequent upon their increased exposure to wind.

The well-founded conclusion is that wind interferes with the proper catch of rain by eddying around the mouth of the rain-gauge, and that consequently a rain-gauge should on theoretical principles be protected from wind disturbance if we would know the true quantity of rain that falls upon the ground in its vicinity. Nothing is known as to the mode of formation or of the complexity of these wind eddies, and information respecting these questions could only be suggested through laboratory experiments. When a gauge is elevated above the ground upon a thin pole there is merely the augmented wind velocity to be considered in explanation of the decreased amount of rain it will receive as compared with a similar one upon the ground, but when a gauge is placed upon an edifice or close to the edge of a steep cliff or bank the case is far more complicated through new disturbances introduced by such obstructions themselves to the wind, which has the effect of causing a deficit of rain upon the windward side of buildings and a relative surplus upon the leeward side.

The whole subject, however, of decrease of recorded rainfall with height above the ground has been thoroughly investigated, as mentioned above, in its several relations, so that there offer themselves for discussion, more particularly the methods that have been adopted for protecting rain-gauges from, or of correcting their readings for, wind error.

It was about the year 1889 that Prof. Cleveland Abbe,[1] of the United States, made an exhaustive study of the data

[1] *Monthly Weather Review*, vol. xxii., 1894, p 25, "The Reliability of the Rain-gauge"; *American Meteorological Journal*, vol. vi. p. 241, "The Determination of the Amount of Rainfall.'

at that time available from different parts of the world with reference to the apparent decrease of rainfall with elevation above ground, and relating his data to a law known to meteorologists as Archibald's, connecting increase of wind velocity with square root of altitude for small altitudes above the surface of the earth, showed that the deficit of rain indicated by an elevated gauge was proportional to the square root of its altitude above the ground. From these results Abbe deduced for a rain-gauge in a free, open situation a numerical wind correction which may be explained as follows:—

If a second gauge, in all essential respects similar to the one for the readings of which the correction is to be applied, be placed twice as high above the ground as the latter, the quantity $E \times 2·414 + R = C$, where E is the excess of the reading of the lower gauge above that of the upper, R is the reading of the lower gauge, and C is the corrected reading of the lower gauge; to state this in words, add to the reading of the lower gauge 2·414 times its excess above that of the upper, and the result is the amount of rain which the lower gauge would have caught in the absence of wind disturbances. The validity of this correction, which depends, of course, upon the extent to which for any particular occurrence of wind and rain the necessary assumption of Archibald's law is trustworthy, is doubtless such as to enable at least a close approximation to the true rainfall to be reached. But two conditions must be complied with before the records of two gauges placed at different heights above the ground can thus bear a simple relation to differences of wind velocity corresponding to different amounts of error through eddy action at the mouths of the gauges:—(*a*) the two gauges must be of the same form and dimensions; (*b*) if the lower gauge rests upon the ground, the upper one must be supported on a somewhat thin pole as may not induce, by offering an obstruction to the wind, other disturbances operating at the mouth of the rain-gauge in addition to those due to the gauge itself.

Of the various types of wind-shield for rain-gauges that have been suggested or tried, by far the most serviceable is the protecting funnel jacket[1] originally devised about the year 1879 by Prof. F. E. Nipher, of the United States. This is screwed on to the cylinder of the rain-gauge at such a height that the rim of its broad upper portion lies level with that of the mouth of the gauge, and consists usually of copper gauze for the purpose of preventing or minimising the splashing of water into the gauge from the inner surface. The efficiency of such a protector has been tested, not only by Nipher himself, but by Prof. R. Börnstein in Germany and Dr. H. Wild in Russia, with the result that the contrivance may, on the whole, be regarded as an appropriate means of eliminating, or at all events reducing, injurious wind eddies around the mouth of a rain-gauge, as will be shortly seen. Since the protecting jacket was invented by Nipher it has been improved in various ways, a comparatively recent modification, as used at some of the Russian rainfall stations under the direction of the Central Physical Observatory at St. Petersburg, being capable of being taken to pieces so as to facilitate packing for transport.

Another type of protection contrivance, more accurate than the Nipher jacket, was established about 1880 in St. Petersburg by Dr. H. Wild. This took the form of a rectangular fence enclosure composed of wooden slabs, 2·5 metres in height, at certain equal distances on each side from the rain-gauge, the mouth of which was 1 metre above the ground, and provided with a door for the entry or exit of the observer. A comparison of anemometer observations within and without such an enclosure shows that even during the prevalence of high wind the conditions within approximate nearly to those of a calm, so that a fence enclosure of the dimensions adopted by Wild may be taken as the standard of accuracy for wind-protection contrivances.

[1] *Zeitschrift der Osterreischischen Gesellschaft für Meteorologie*, Band xiv., 1879, s. 250, "Ueber die Bestimmung der wahren Regensmenge mittelst hochaufgestelltes Regensmesser, von F. F. Nipher: *Meteorologische Zeitschrift*, Band i., 1884, s. 381, "Ueber den von Nipher vorgeschlagenen Schutztrichter für Regenmesser," von R. Börnstein; *Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg*, v^{e} série, vol. iii., 1895, p. 193, "Kritische Untersuchung der Angaben freier und geschützter Regenmesser,' von Emil Berg.

Respecting the relative efficiency as protecting agents of the Nipher jacket and the Wild fence, experimental observations have been, and are apparently still being, conducted in Russia, a country, be it noted, where, owing to the large quantities of snow that fall during the colder months of the year, the sources of error in rain-gauge records through wind assume greater magnitude than they do, for instance, in England, where the winter precipitation consists largely of rain. It may be said that, while the Nipher protector is generally well adapted to its purpose for ordinary situations of rain-gauges, it may be with advantage replaced by the fence enclosure in the case of gauges which are unduly exposed to the full force of the wind in unsheltered locations. If the accuracy of the Wild fence be taken as 100, that of the Nipher jacket may approximate to 100 in more sheltered positions, but may be as low as 80 or even lower in such as are quite open to the violence of the wind. It should be added that a Nipher gauge ought to be fitted with some form of heating apparatus adequate to prevent accumulations of snow in winter upon the protecting jacket, from which into the rain-gauge portions of such accumulated snow are liable to be blown.

This brief abstract of the chief methods of diminishing or eliminating the wind error due to rain-gauges would be incomplete were it omitted to mention a process of calculation [1] by which the rainfall figures for a sufficiently long period, as indicated by a gauge at a place which suffers undue exposure to the wind in comparison with another gauge in the neighbourhood, say a few miles distant, at a more sheltered spot that may be regarded normal, may be corrected. The method depends upon the relation subsisting between the amounts of discrepancy in the records of two such gauges during periods of rain and of snow. If the rainfall for a specified time at the sheltered station be represented as 100, and that at the exposed station as $100-A$ for periods of rain and $100-A-B$ for periods of snow, the equation $K=\frac{x+A}{B}$, when solved for x, affords the correction required. The value of K, which for a few localities in Germany has been found to range from 0·13 to 0·22, must be empirically determined for a particular district by establishing two similar rain-gauges close together, or, if possible, side by side, one of which is fitted with an efficient wind-protection contrivance, the other being left free; for a pair of gauges in such close proximity x may be considered to vanish, so that K becomes $=A/B$. The value of K for the locality being thus found, x is solved $=KB-A$, which will, of course, be a *plus* or *minus* quantity according as the true rainfall is slightly greater or less at the exposed than at the sheltered station. This method of calculation, which is applicable in many instances, has been tested by another more direct one involving anemometer readings, whereby the measured quantities of precipitation could be reduced to equal mean wind velocities, and as the two have given most concordant results, it may be concluded that the one briefly delineated above is correct.

Thus at Karzig, in Neumark, the rainfall at an open, wind-swept spot on the outskirts of a forest, though indicated by a rain-gauge as considerably less than that of a glade more than 2 kilometres distant, was found by both processes of calculation to be actually 2 per cent. greater.

To summarise the contents of this article:—

(1) Experimental observations extensively carried out during the nineteenth century in many countries have established the fact that in the measurement of rainfall errors of considerable magnitude accrue from the presence of the rain-gauge during the prevalence of wind, and point to the conclusion that such errors arise from the eddying or rebounding of wind about or from the mouth of the rain-gauge.

(2) The readings of a rain-gauge in a free, open situation may be corrected by means of a method involving their comparison with those of another similar gauge placed at twice the height above the ground.

(3) The most efficient wind-protection contrivances for rain-gauges are the Nipher jacket and the Wild fence enclosure; the latter, though more accurate and advantageous in special circumstances, is generally less used than the former.

(4) The corrected rainfall for a sufficient length of time of a wind-swept spot may in many instances, if the rainfall for the corresponding period of a sheltered spot in the same neighbourhood, say a few miles distant, be known, be determined by means of an equation involving as known data (*a*) the relative amounts of discrepancy in the records of the gauges at the two places during periods of rain and of snow; (*b*) an empirically determined constant K.

L. C. W. Bonacina.

[1] *Meteorologische Zeitschrift*, Band xxiii., 1906, s. 444, "Wald und Niederschlag in Westpreussen und Posen und die Beeinflussung der Regen und Schnee-messung durch der Wind," von J. Schubert.

RECENT DEVELOPMENTS IN THE THEORY OF MIMICRY.[1]

The remarkable resemblances that exist between certain insects belonging to widely different orders have long been known to naturalists. Wasps and hornets are imitated by the "clear-wing" moths, the resemblance being so close that it has sometimes deceived for the moment a skilled entomologist. Certain two-winged flies that inhabit the nests of humble-bees are scarcely to be distinguished from their hosts, and the handsome Xylocopas, or carpenter-bees, familiar objects in the tropics, are deceptively copied by two-winged flies found in the same regions.

But it is not only the bees and wasps that are so imitated, nor are the imitating insects to be found only in the ranks of moths and flies. An ichneumon fly in Borneo, belonging to the same order as the bees and wasps, though not in the same sense a stinging insect, is closely copied by a Reduviid bug.

Other instances are numerous. So long ago as the year 1836, the French entomologist Boisduval directed attention to the extraordinary resemblance that exists between certain butterflies which are not at all closely related to each other, belonging, indeed, to groups which are widely distinct. One of these butterflies is a member of the Danainæ, a group of which we have no resident representative in this country; a second is nearly related to our familiar "swallow-tail" of the Cambridgeshire fens; while the third is a Nymphaline, not far removed from our British "White Admiral." The structural differences between these butterflies show the want of real affinity between them in spite of their superficial resemblance. The "cell," for example, of the hindwing is open in the Nymphaline, while in the other two it is closed by a transverse vein. This illustrates the point that these resemblances affect only obvious characters; they are independent of affinity or blood relationship, and leave untouched such morphological features as do not readily meet the eye.

An insect thus resembled by another is spoken of as its "model," the imitating insect is called a "mimic," and the combination of model and mimic or mimics is known as a "mimetic pair" or "mimetic assemblage," as the case may be.

What is the meaning of these resemblances? Many of them were well known to the older naturalists, who, however, had nothing to offer by way of explanation but vague talk about "repetition" and "analogy" in nature. The well-known entomologists Kirby and Spence got so far as to suggest that in some cases the resemblance might be of advantage to the mimic, but in their day it was not likely that the subject should be treated from the evolutionary point of view, and the first really scientific explanation of the matter was given by Bates on his return from his famous visit to the Amazon, now nearly fifty years ago.

Bates had observed that in these cases of deceptive resemblance between butterflies, one member of the pair or of the group was often characterised by abundance of individuals, while the whole group was marked by slowness of flight, conspicuousness of appearance, and immunity from the attacks of insect-eating birds. On these grounds he put forward the suggestion that the mimicking species enjoyed protection from attack by their

[1] An evening discourse delivered at the Leicester meeting of the British Association on August 5 by Dr. F. A. Dixey.

resemblance to their more abundant models, the immunity of which, he thought, was due to the possession of some distasteful quality—probably a scent or flavour disliked by the birds.

Accepting Darwin's view of evolutionary process, he attributed the formation of these resemblances to the accumulation by natural selection of variations in the mimicking species that happened to point in the appropriate direction; so that these mimics had gradually put off the general aspect of the group to which they properly belonged, and had become more or less completely assimilated in outward appearance to the members of an entirely different assemblage; thus sailing, as it were, under false colours, as if a peaceable merchantman were to disguise itself under the rig and ensign of a man-of-war. This is the well-known Batesian theory of mimicry. It was at once, and cordially, accepted by Darwin; while the array of facts from South America on which it was based was soon afterwards shown to be paralleled by corresponding phenomena in the Malayan Archipelago and in South Africa. This was the work of two great naturalists happily still with us, Alfred Russel Wallace and Roland Trimen.

An objection was raised in early times to Bates's view on the ground that it was difficult to account for the first advances towards the formation of a mimetic pattern. This objection was felt in some degree both by Darwin and by Fritz Müller, of whom we shall hear more presently. Darwin and Müller thought that the objection might be met by supposing a considerable original likeness between mimic and model; it can, however, quite easily be shown from forms actually at present existing that a complete series of gradations may occur between the ordinary type of a mimetic genus and its very distinct-looking model or models. The transitional forms, even those exhibiting the earliest stages of mimetic assimilation, are evidently able to maintain themselves (how they do it we shall see later), and they in many cases form a perfect succession of links between extreme forms of the utmost divergence in aspect. Hence it is unnecessary to suppose that a considerable initial resemblance must exist between mimic and model, while the initial stages of the mimetic pattern, however we are to account for them, are not only theoretically possible, but are found to be in actual existence.

The beauty and simplicity of Bates's theory commended it strongly to public acceptance, and it is probable that to this day, when the subject of mimicry is mentioned, it is the Batesian theory that presents itself to most people's minds.

But notwithstanding the immense value of Bates's contribution to knowledge, it is now evident, as we shall see, that he only touched the fringe of a great subject, and that a much wider view is necessary before the facts observed by him, and subsequently by others, can be fully explained.

Those who read Bates's classical paper cannot avoid remarking that he himself was not thoroughly happy about all the facts there recorded. He directs attention to the circumstance that not only do the mimics resemble their models, but that the models themselves often show an extraordinary resemblance to each other. He speaks of "a minute and palpably intentional likeness which is perfectly staggering."

To take an instance: two species of the Ithomiine genus Dircenna, *D. epidero* and *D. rhaeo*, structurally distinct, but almost indistinguishable on the wing, were noted by Bates as being always found together where they occur in the Amazonian region. A moth, *Hyelosia tiresias*, was regarded by Bates as a mimic of *Dircenna epidero*, but it did not escape him that his theory failed to account for the resemblance of the two Dircennas to one another, the subfamily Ithomiinæ, to which they belong, being on good grounds supposed to be generally distasteful. The difficulty becomes still greater when it is realised that not only members of the same presumably distasteful genus, but also members of different genera, all with the same habits and denizens of the same region, bear the same extraordinary likeness to each other. There are, for example, some twenty species of Ithomiines, belonging to no less than seven different genera, all with the same, or very nearly the same, external appearance. But this is not all, for the same mimetic assemblage will be found to include, not only these Ithomiines, but also butterflies belonging to the group of Danaines (genus Ituna) and Pierines (genus Dismorphia), as well as moths of the two widely separated groups of Hypsidæ and Castniadæ, all with a common facies.

If it were merely a case of resemblance between two or more species of the same genus, such as the Dircennas that have just been mentioned, we might be tempted to say that the resemblance was merely due to affinity, and to explain, as Bates did, the circumstance of the constant companionship of the two species by appealing to the "social and gregarious instincts of the group." When, however, we see that not only Dircennas, but Ithomiines generally, Danaines, Pierines, and moths all come into the same mimetic assemblage, the explanation from affinity breaks down. Affinity, no doubt, may help mimicry, but there is no necessary connection between the two. Some members of the company are closely related; others are widely distinct. Bates himself saw clearly enough that his theory of one distasteful and immune form sheltering others which would be attacked if detected would not apply to cases of this kind. If all the species but one of a "homœochromatic" group are to be considered as edible mimics, we should have to account for the fact that they vastly outnumber the model, in which case the mimicry would be more harmful to the model than beneficial to themselves; we should also have to face the improbability of one species of a genus being distasteful and immune, while other species of the same and allied genera were edible and liable to attack. It was plain that the distasteful models did really imitate each other, but why?

All that Bates could do in the face of this difficulty was to fall back, somewhat doubtfully, on the hypothesis of some local or climatic cause acting equally upon the forms of different groups, and in some unexplained way bringing about this strange resemblance between them. In this supposition he was for a time followed by Wallace.

It is not to be denied that there is a certain plausibility at first sight in this view concerning the direct action of external conditions. It is, for example, a striking fact that the members of a mimetic group of very diverse affinities will, as Bates says, every few hundred miles all change their hue and pattern together, "as if by the touch of an enchanter's wand."

There is a well-marked assemblage of this kind, generally characterised by a pattern composed of the three colours red, yellow, and black. It contains, besides moths, butterflies of many diverse groups, Ithomiines, Heliconiines, Danaines, Nymphalines, and Pierines—in some of the latter the female only taking part in the mimetic cluster, a point to which we shall return later on. The members of this assemblage as it occurs in the northern part of Central America—Guatemala to Nicaragua—present in common a remarkable streakiness of pattern, a feature that makes them easily recognisable among the corresponding forms from other regions of the same continent. Passing on to Venezuela, we find among the geographical races, or, if we like to call them so, the representative species, that there replace the Central American forms, a tendency to the breaking-up of the streaks, and a slight encroachment of the red ground-colour upon the yellow of the apex. In Trinidad there occurs a general paling of the ground-colour, due to an increase of yellow pigmentation, and running, as before, through the entire group. Next, taking the corresponding Guiana forms, we find a further breaking-up of the streaks into spots, and also a general darkening, especially of the hindwings, which gives a most characteristic aspect to the whole assemblage. In East Brazil we have a modification which somewhat recalls the Trinidad facies, though here the yellow streak on the hindwing is better defined, and the black of the apex is less broken up. At Ega, on the Upper Amazon, a curious dark chestnut tinge pervades the group, while in Peru a characteristic spottiness takes the place of the streaky pattern we saw elsewhere, and the apex becomes more uniformly dark. Finally, in Ecuador the streaks have all but disappeared, and even the spots have become almost blocked out by a dark infusion which now occupies, not only the apex, but also a large part of the base of the forewing, and the whole, or nearly so, of the hindwing. After a little study of some of the typical members of each of these geographical groups, it becomes easy to pronounce, with a considerable degree of confidence, upon the local habitation of a species that we may never have met with before.

If facts of this kind were the only ones with which we had to deal, there might be some justification for adopting the theory of the direct effect of geographical conditions, but it is now incumbent on us to consider whether this hypothesis of common surroundings producing a common aspect will bear further examination. We will take the instance of a group of ant-like insects caught by Mr. Guy Marshall in Mashonaland on one day on a single plant. All were to outward appearance ants; but while the first four were veritable ants, the next two were bugs, and the last was a locustid, belonging, that is to say, to the order of crickets and grasshoppers. If a common environment has of itself produced the ant-like appearance of the bugs and the locust, why has it not done something towards assimilating the points of structure that do not meet the eye? As a matter of fact there is no such approach. In internal organisation each member of the group preserves the exact characters of its own order.

There is a certain ant-like locustid, possibly of the same species as that last mentioned, in which the body of an ant is, as it were, painted on that of the locust. The constriction between thorax and abdomen, real in the ant, is in the locustid only apparent. Can the external conditions which are supposed to have caused the characteristic shape of the ant actually paint a copy of the ant on the otherwise unaltered body of the locust?

Again, there are cases where the supposed external influence must have acted, if at all, as sculptor instead of painter. In a certain ant-like Membracid (an insect allied to our common "cuckoo-spit") the body of the insect is concealed beneath a shield, which grows backward from the fore part of the thorax. This shield or screen, which is quite separated from the body except along one line of attachment in front, is hewn or moulded, so to speak, into the form of an ant, reproducing even the small swelling in the peduncle which is characteristic of some ants of the region that this insect inhabits.

Another instance, probably familiar, but so much in point that I cannot refrain from mentioning it, is that of the immature form of a Membracid found by Mr. W. L. Sclater in Guiana among a number of leaf-cutting ants. The flat green body and brown head and legs of the Membracid make a very fair copy of the ant engaged in its occupation of carrying home the cut leaf, the picture including, not only the ant, but the leaf as well. Ants are avoided by some enemies, though not by all, and in a procession of ants of this kind it is not likely that an enemy, however sharp-sighted, would readily pick out the Membracid from among its leaf-carrying companions. The idea that external conditions can produce in another insect a copy, not only of the ant, but of the leaf which it carries, needs, I think, only to be mentioned to be dismissed.

Looking at the matter from a slightly different point of view, we may take the instance of the wonderful African butterfly *Papilio dardanus*, no very distant relative of our English "swallowtail." The male of this insect is non-mimetic, while the female occurs in three or four different forms, each of which is a palpable mimic of a separate model. On the theory of direct external causes we have to explain why these external conditions have brought about a resemblance between each form of the female and a separate model of different affinities, while these causes have not been able to prevent individuals of the same species from going off in four or five different directions.

The facts here have been questioned, but as all the diverse forms have been found among the offspring of one individual, there is no longer any room for doubt that they are all really conspecific.

We can get more light on the subject if we return for a moment to our assemblage with transparent wings, the assemblage, that is, which contains the two Dircennas, *rhaeo* and *epidero*.

Now if the effect of transparence, which is common to the entire group, had been the direct result of an external cause, we should expect it to have been brought about in all cases by the same means; but whereas in the Ithomiines the transparence is due to an alteration in shape and diminution in size of the minute scales which normally clothe the wing, in the Pierines the same effect is produced by a mere diminution in size, the shape remaining unaltered. The Danaines of the group owe their transparence to a reduction in the *number* of the scales, not to any alteration in shape or in size; while in the associated moths the effect results, not from any change in size, shape, or number of the scales, but from the fact that the individual scales themselves become transparent, and are sometimes set up vertically, so as to let the light pass between them.

In view of these facts, the investigation of which we owe to Prof. Poulton, it is difficult, if not impossible, to imagine any direct agency which will produce the same visual effect by all these different means. The likeness is superficial; the real difference is profound. The common features, if we may so express it, are only meant to be looked at. They must stand in relation to vision of some sort; and to whose vision, we may well ask, if not to the vision of would-be enemies? Natural selection will attain the desired end by any means that come to hand, and these observations of Poulton seem to put every other explanation in this case out of court. If we may be allowed to use, without prejudice, teleological language, we may say that these resemblances have been brought about by natural selection for a mimetic purpose. Any variation, whether in size, shape, number, transparence, or position of scales, which leads in the required direction, will be preserved; and the final result, though to ordinary vision identical in all cases, will bear evidence, on close examination, of the manner, different in each individual case, in which it has been effected.

But, it may be said, many of your instances are simply cases of Batesian mimicry, and for them we can allow the sufficiency of natural selection; it is the other cases which want explaining. This is quite true, but a great point is gained if we have shown that, in many of these cases, neither affinity nor the direct agency of external conditions will account for the facts, while natural selection will do so if only we can find out why it should be an advantage for these distasteful types to form themselves into groups. If we *can* bring both kinds of mimicry under one cause, we are bound to do so. The old logical canon, the "razor of Occam," applies here. "Entia non sunt multiplicanda praeter necessitatem"; in other words, having found an adequate cause for one case of a given phenomenon, we are not at liberty to go out of our way to seek another cause for a second case of the same phenomenon. We must first try if the cause already established will not meet the requirements of the situation.

What we have to do, then, is to prove, if we can, why it should benefit these *distasteful* forms of various affinities to fall into homœochromatic groups, groups, that is, essentially similar in outward aspect. For a long time the key to the puzzle eluded discovery; it was at last found by Fritz Müller.

This admirable naturalist, working, like Bates, in South America, put forward in the year 1879 a suggestion which, when developed into its full consequences, has revolutionised our conception of the whole subject.

His suggestion rested on the assumption (since shown, mainly by Lloyd Morgan, to be correct) that birds have no instinctive knowledge of what forms would be suitable for food and what should be avoided, so that each bird has to gain its knowledge by experience. Hence a certain number of distasteful forms must be sacrificed by each generation of birds until these enemies have learned to leave such forms alone. In other words, each distasteful form has to *pay a tax* for its immunity.

Now if two distasteful species resemble each other so closely that birds or other enemies do not distinguish between them, the disagreeable experience gained by tasting an individual of one species will be applied to the benefit of the other, and so each of the two species will only need to contribute a portion of the tax, instead of each paying the whole—a consideration which, I think, will go home to most of us. And what is true of a combination of two species will be equally true of a larger assemblage; the greater number of forms that can be got to share the tax, the better for all. Hence the formation of these large "inedible associations," or, as they might be called, Müllerian groups. I do not wish to be understood as saying that the Batesian and Müllerian theories are mutually incompatible. They are *supplementary* to each other, and there is ample room for true mimicry beside or within the ranks of the Müllerian associations.

Though the theory of which I have just given an account is really quite simple, it has never been so generally understood and appreciated as that of Bates. May I, at the risk of being tedious, try to illustrate the relation between the two?

Imagine a large box of sugar-plums, and a schoolboy given *carte blanche* to help himself from it as he likes. Imagine, further, that the sugar-plums are of different colours and flavours, and that some of them are flavoured with an essence which the boy does not like—we will say aniseed. Further, let all the aniseed sugar-plums be coloured pink. The boy will soon find out that the pink sugar-plums are unpleasant to his taste, and *after a trial or two* they will be left until all the others have been disposed of, or, if sufficiently disagreeable, they will be refused altogether. The pink colour is here an *aposeme*, to use Prof. Poulton's term, or the visible mark of a distasteful character.

Suppose a few pleasantly flavoured sugar-plums to be coloured pink like the aniseed sugar-plums. These, if there are not so many of them as to destroy the impression of nastiness associated with pink, will also be left. This represents Batesian mimicry. The few pleasantly flavoured sugar-plums share in the protection afforded by the pink aposeme.

Now for Müllerian mimicry. Let us suppose that there are *two* flavours disliked by the boy, say aniseed and peppermint, and that the sugar-plums with these flavours are coloured pink and green respectively. The boy would have to try both pink and green before he learned to avoid them. Perhaps two of each, two of the pink and two of the green, *i.e.* four in all, would be sufficient to complete his education in this respect; but if *both* kinds of disagreeable sugar-plums were coloured pink, a trial of two only, instead of four, would be sufficient to protect all the rest, of both flavours, aniseed and peppermint, from the boy's depredations. In other words, the tax paid by each would be halved, and so with larger numbers. Hence the advantage of a common aposeme for *distasteful* objects, whether sugar-plums or butterflies.

This illustration refers only to the relation between the two theories. It says nothing, of course, as to the means by which the sugar-plums originally became coloured and flavoured; but what we *have* done is to show the advantage to be gained by Müllerian association, and therefore to supply the required motive power for natural selection.

Müller's suggestion was brought to the notice of British naturalists by Prof. Meldola in the year of its first publication, and in its further developments at the hands of Meldola himself and of Poulton it was accepted both by Wallace and by Trimen, the two naturalists who had done most by their own observations to confirm the validity of the supplementary (though earlier-devised) theory of Bates.

Fritz Müller had spoken chiefly of the resemblance between two butterflies, Ituna and Thyridia, belonging to distinct subfamilies, but it was soon pointed out by Prof. Meldola that the general likeness between members of the same distasteful family groups came easily under the same principle.

In order to appreciate this point fully, let us consider the common European Vanessas, the Peacock, Red Admiral, large and small Tortoiseshells, Camberwell Beauty, &c., several of them familiar objects in our own country. We see at once that though there is certainly a family likeness between them, they are distinguishable from one another at a glance; no one would think of taking one of them for another. Contrast this with a similar group of closely allied species, known to be distasteful, from a part of the world where competition is keen, for instance, the Acræas of Africa. Of these, four or five species may be taken on the same day, looking all alike while on the wing, and practically indistinguishable from one another without close examination. Or take a group of Euplœas, another distasteful genus, from the Oriental region. Here again we may have some five separate species, all quite distinct, but so much like one another that it needs much more than a casual glance to distinguish between them.

These and similar cases were shown by Meldola to be easily explicable on the basis of the Müllerian theory of mutual protection by the adoption of a common scheme of warning colours on the part of inedible forms, and the possibilities of the theory were still further expanded by Poulton, who pointed out that in any given region the fewer independent schemes of warning coloration there were to learn, the better chance there was of the protection they afforded being effective; so that the same simple warning badge, such, for instance, as the alternate black and yellow rings on the body of a wasp, might be employed by insects, like the caterpillars of the Cinnabar moth, which are widely separated from the wasp in point of affinity. The aposeme, or signal to an enemy to keep his distance, may be recognised and obeyed even when hoisted by insects which have little else in common between them. A great part of the significance of the facts that we have noticed depends, of course, on the circumstance that the members of each of these closely assimilated groups inhabit the same geographical areas. We do not find an Eastern Euplœa resembling an American Heliconius, or an Ithomiine from Brazil recalling an African Acræa. As a further illustration of what Poulton has aptly named "synaposematism," or the adoption of a common warning badge on the part of distasteful forms, we may take the wonderfully diverse assemblage that centres round the conspicuous and distasteful beetles belonging to the genus Lycus. This assemblage, in South Africa, contains wasps, Braconids, moths, a bug, and a two-winged fly, besides beetles belonging to three or four different families. I have myself seen several members of this group, heterogeneous in affinity though wonderfully similar in hue and pattern, on or about one tree at East London, in South Africa. Be it remarked that they were all conspicuous insects, and exposed themselves freely, so that there could be no question of a common cryptic coloration. The assemblage, beyond doubt, is mainly if not entirely synaposematic.

We have now reached what may at any rate rank as a preliminary generalisation, that is to say, that the resemblance between distasteful forms is to their advantage, and is an adaptation brought about by natural selection. Following the approved logical method of Mill and Jevons, we ought next to see what consequences are involved in the hypothesis we have formed, and then to make a fresh appeal to the facts for verification or the reverse.

(1) It is obvious that in Batesian, or true mimicry, the advantage is all on the side of the mimic. Experience gained by tasting the mimic would be used to the injury of the model. While, therefore, there is every inducement for the mimic to seek safety by approaching nearer and nearer to the aspect of the model, there is no reason for the model to assimilate itself to the mimic, but rather the contrary.

In a Müllerian association, on the other hand, the benefit is mutual. Each fresh accession to the group is a source of strength, not of weakness. Everything is in favour of the formation of such groups as rapidly and on as large a scale as possible; hence there is nothing to impede, and everything to promote, the free interchange of characters all round, each member being able to act, so to speak, *as both mimic and model*. This, we saw, could not happen in the case of Batesian mimicry.

Now does this interchange of characters, as a matter of fact, ever take place? If it does, it will be, of course, a confirmation of our theory.

One of the most characteristic features in the subfamily of Pierines, or "white butterflies," is the possession of red or yellow spots, streaks, or patches on the underside of the hindwing, near the base. These marks reach a high state of development in some members of the Eastern genus Delias, and relics of them are to be seen in the common white butterflies of our own country.

Now no one who accepts mimicry at all will be inclined to doubt the existence of a mimetic relation between *Heliconius guaricus* and the Pierine *Pereute leucodrosime*. How has it been brought about? The dark colour and red band are not at all characteristic of Pierines, and have no doubt been copied from the Heliconius; but the Pierine red spots have passed the other way, being taken up by the Heliconius from the Pierine. This, I believe, was the first case of mimetic interchange noticed.

Another instance. White is not an ancestral colour in Heliconius; it *is* ancestral in the Pierines. The Pierine *P. locusta* falls by its undersurface into mimetic association with the group of Heliconius represented by *H. alithea* and *H. galanthus*. The white colour has passed from Pieris to Heliconius; the dark, in great measure, from Heliconius to Pieris.

Much the same has happened in the case of *Heliconius leuce* and the female of *Pieris noctipennis*. These two have undergone reciprocal change. The white comes from the Pieris, the black from the Heliconius.

There is another case where two species belonging to widely separated sections of the same subfamily are in question. The hindwings of the island form of the Pierine *Huphina nerissa* have been drawn away into imitation of the hindwing of *Ixias baliensis*, also a Pierine; while the forewing of the Ixias, leaving the usual aspect of its genus, has been assimilated to the forewing of Huphina.

Another good example of interchange is afforded by the "swallowtail" *Papilio rex* from Uganda, which is in undoubted mimetic relation with the Danaine *Melinda formosa*. The brown at the base of the forewings is a Danaine character adopted by the Papilio; the pale areas at the base of the hindwings are a Papilionine character adopted by the Danaine. Each has in one of these respects acted as a model to the other. The two African genera Mylothris and Phrissura, the species of which form a parallel series of mimetic pairs analogous to the Ithomiines and Heliconiines of tropical America, furnish what is probably another instance of the same phenomenon. For this mutual approach by a process of give and take on both sides, Prof. Poulton has proposed the apt term "diaposematism," the idea of reciprocity being conveyed by the Greek particle "dia."

Let us now look at the working of this reciprocal principle in another direction.

It is well known that where the sexes differ in the extent to which they are protected, whether by power of concealment or by other means, it is almost invariably the female that has the advantage. This was pointed out long ago by Dr. Wallace, and was, no doubt rightly, attributed by him to the fact that the continuance of the life of the female, as the guardian of the early stages of the future brood, was of greater importance than that of the male to the welfare of the species. So we find many cases in which the female alone is mimetic, not the male. Shall we say that "Nature abhors the unprotected female"?

We have already noticed the case of *Papilio dardanus*, with its non-mimetic male, and three or four different forms of female, each form in mimetic relation with a Danaine model.

The case of the Pierine *Leuceronia argia* is in many respects parallel to that of the Papilio. Again we have a non-mimetic male, and several different forms of female, each being in mimetic relation with another butterfly of quite different affinities.

Once more: the female of the Nymphaline butterfly *Hypolimnas bolina* falls into mimetic association with Danaines and with a Papilio, leaving its own male outside the group. It will be remembered, also, that much the same thing occurs with certain of the South American Pierines which we considered in an earlier part of the present lecture.

These instances are sufficient to show the readiness of the female, as distinct from the male, to enter a mimetic combination.

Bearing these facts in mind, when we look at such a combination as that of *Papilio iphidamas* with *Euterpe approximata*, we shall have little or no difficulty in recognising that here we have an analogous case. The sexes of the Euterpe (a Pierine) and the female of the Papilio all resemble each other, while the male of the Papilio stands apart. We have just seen how readily the female of a given species may be drawn away into a mimetic relation apart from its own male, and we have every reason to suppose that the same has occurred here, only that in the case of *P. dardanus*, *L. argia*, and *H. bolina* the pull has been mainly or entirely away from the *dardanus*, *argia*, and *bolina* standard, while here there is no doubt that the female Papilio has pulled the Pierine away from the usual Pierine standard, though it has in turn been pulled away from its own male. The male, it is true, belongs to a synaposematic group of its own, but the female has joined the stronger combination. The pull has been mutual between female Papilio and Pierine, and the association must therefore be Müllerian.

(2) Here is one more piece of evidence. We have seen that from the nature of the case the attraction (so to call it) in a Müllerian assemblage acts, or may act, in all directions, for each member of a Müllerian group is potentially both mimic and model.

It ought then sometimes to happen, if the Müllerian theory is correct, that although one dominant species, distinguished perhaps for its hardiness and distasteful qualities, may act as the centre of a group, influencing all the other members, yet that these other (subordinate) members of the group should show signs of having influenced each other, apart from the dominant species.

Does this ever happen? Certainly it does.

Limnas chrysippus, a Danaine, is one of these dominant forms, numerous in individuals, hardy, conspicuous, proved to be distasteful, and accompanied by mimics wherever it goes. Among its mimics in Africa are an Acræa, and a Lycænid (allied to our common blues). Now it is quite evident that there is a mimetic relation between the Acræa and the Lycænid apart from that which exists between them both and the Limnas. In short, they resemble each other in some respects more than either of them resembles the common model. Hence one or other of these two, or perhaps both, must be distasteful, and therefore there must be a Müllerian element in the whole group, if, indeed, it be not entirely Müllerian.

It has been pointed out by Prof. Poulton that many beetles, belonging to different families, are all in a sense mimics of the hymenopterous group of the Mutillidæ, and yet they have become assimilated to each other in non-Mutilloid points.

Facts of this kind prepare us for a further consideration of great importance, with which I shall conclude.

(3) We find that it is impossible to regard the mimetic assemblages of a given region as so many isolated groups. As a matter of fact, though there are certain dominant forms which act, so to speak, as centres of attraction, we often find that the mimetic forms constitute a nexus, models of the most dissimilar aspect being held together, as it were, by a kind of connection which runs from group to group, gradations from one group to another being formed in the most unexpected ways. From the nature of things this point is difficult to illustrate within the limits of a lecture like the present; a few examples may suffice.

Starting from a white Pieris of ordinary aspect like *P. phaloe*, we can pass by easy stages through *P. calydonia* ♀ and *P. demophile* ♀ into a well-marked distasteful group of which the Ithomiine *Aeria agna* is a good example. From *P. demophile* ♀ we can also pass through *P. viardi* ♀ to the pattern of *Heliconius charitonia*, or in yet another direction by way of *P. tithoreides* ♀ to *Heliconius atthis* and *Tithorea pavonii*. *P. calydonia* ♀, again, gives us a fresh starting point from which to proceed by way of *P. kiçaha*, *P. pandosia*, and *P. leptalina* up to a well-marked Ithomiine group typified by *Napeogenes inachia*. We have already seen how *P. locusta* ♂, which presents the Pierine characters of *P. phaloe* in an intensified form, comes into association with another group of Heliconii, while the same butterfly forms an early link in the chain which leads up by easy gradations through both sexes of various species of Perrhybris (another Pierine genus) to the red, black, and yellow Müllerian assemblage we have already considered. From an intermediate stage in this latter series, exemplified on the undersurface of *Perrhybris lorena* ♀, we get a passage to yet another Heliconiine scheme of coloration, that shown by *H. aranea*. Here, then, we have groups centring round protected Heliconiines and Ithomiines of the most varied aspects, all held together and linked up with white butterflies of the ordinary Pierine facies by a network of almost imperceptible gradations.

As a final illustration, let me direct your attention to the series formed by *Papilio iphidamas* ♀, *Euterpe approximata*, *E. bellona*, *E. nigrina* (underside), and *Heliconius venusta*.

We have only to examine a gradated series like this to see how difficult it is to account for it on Batesian lines. There is the common aposeme, the yellow patch on the dark forewing, running right through; but if the Papilio is the model for all the rest, why should these Euterpes, which are Pierines, mimic a mimic (the Heliconius) instead of going to the model itself (the Papilio)? If, on the other hand, we regard the Heliconius as the model, we are met by exactly the same difficulty, only that it is reversed. Now we know that some at least of these intermediate forms are numerous in individuals, and as soon as the Müllerian principle is admitted we can see how easily forms protected by distastefulness can arrange themselves into a gradational series of this kind. For every distasteful form tends to protect other forms on each side of itself; hence the existence of these transitional stages is just what we should expect. This group represents in miniature what is everywhere to be found when we examine a tropical butterfly fauna from the point of view of mimicry, and I think we have here discovered the answer to an objection that met us at the outset, namely, the difficulty of accounting, on the principle of natural selection, for the existence of these intermediate forms, including the initial mimetic stages. Whether or no the difficulty is a real one in the way of the Batesian theory, in view of the Müllerian principle it is non-existent.

The comparison may perhaps be allowed between these mimetic groups, each with its own type of coloration, and the solar and stellar systems. Sometimes, as in the solar system, there is one central member of the group dominating the whole and influencing its attendant planets to an extent in comparison with which the force they themselves can exercise is insignificant. At other times, as in the systems of double and multiple stars, there are bodies more nearly equal in mass and importance bound together by mutual attraction into a single combination, where each one effectively controls and is controlled by the rest. Could we imagine irregular wanderers through cosmic space which from time to time get drawn within the limits of some established system, we might in them find an analogy to certain species which seem to hover on the outskirts of mimetic groups, undecided, as it were, whether to throw in their lot with one association or another.

What result have we been able to reach to-night? Starting from the fact, long recognised by naturalists, of the wonderful likeness borne to each other by certain insects of widely different affinities, we have found that the first rational explanation of the phenomenon was given by Bates, who nevertheless did not conceal from himself that his interpretation left many of the observed facts unaccounted for. The fertile suggestion of Fritz Müller went far to supply what was still wanting. Expanded by Meldola and by Poulton, accepted by travelled naturalists like Wallace and Trimen, the Müllerian generalisation has proved a powerful means of interpretation of many complicated relationships. We have seen reason for concluding that such rival attempts at explanation as those which allege affinity, or geographical and climatic conditions, as adequate causes for the phenomena before us, break down on serious examination; and we have applied the final test of arguing deductively from the premises, and finding, on a fresh appeal to the facts, that our results are in accordance with expectation.

This verification, we saw, is concerned with the three chief topics of (1) the interchange of characters, or diaposematism; (2) the influencing of subordinate members of mimetic groups by one another; and (3) the nexus of protected conspicuous forms which may overspread a whole zoological continent.

I think no one who has paid attention to the facts that have been before us can fail to recognise that here, as everywhere in organised nature, the principle of adaptation is paramount. No scientific explanation of adaptation that really meets the case has yet been offered except natural selection. Whatever bearing the principle of adaptation by selection may have on the question of the origin of species—I for one venture to think that it has a very important bearing—it is a principle which cannot in fairness be ignored.

In what has been said I have tried to be explanatory rather than controversial, though it has not been possible to avoid altogether points that have given occasion for dispute. Those who are conversant with the subject will know that many questions of interest have been left unnoticed; but I trust that in this survey, necessarily brief, I have said enough to show how much of biological importance and interest is involved in the really great subject of mimicry.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. R. C. Punnett has been re-elected to the Balfour studentship for one year from Michaelmas, 1907.

A grant of 50*l*. from the Balfour fund has been made to Mr. W. E. Agar in furtherance of his expedition to the Paraguayan Chaco.

A proposed change in the Previous Examination, which may be of far-reaching importance, will be voted on by the Senate next week. At the suggestion of the Board of Examinations, a paper on elementary heat and chemistry will be set in part ii. of the Previous Examination as an alternative to the papers on Paley's "Evidences" and elementary logic. The Board also proposes the substitution of a single combined paper on arithmetic and algebra for the present separate papers on these subjects in the same examination.

The Special Board for Mathematics has issued an important report with reference to the constitution of the board. Owing to the new regulations, the examiners and moderators will in future be nominated by the board. The representatives of the college on the board given them in past years by the nomination of the moderators will thus disappear. The board considers it advisable that there should be direct representation of the mathematical lecturers of the University and of the colleges; it is therefore suggested that two members be nominated each year at a meeting held of the lecturers in subjects for the mathematical tripos.

The reforms which the board of mathematics have introduced into the University in the last four years are numerous and far-reaching. They include a complete revision of the mathematical tripos, the recognition that the teaching of mathematics should be correlated with that of physics and engineering, the establishment of a qualifying examination in mechanical sciences, re-casting of the mechanical sciences tripos, and reforms in the mathematical special examination for the ordinary degree.

Dr. Hobson has been re-elected president of the Cambridge Philosophical Society. The new vice-presidents are Prof. J. J. Thomson and Mr. S. Ruhemann. The new members of the council are Prof. T. B. Wood, Prof. B. Hopkinson, Dr. Searle, and Mr. W. E. Dickson. Mr. H. F. Newall has been re-elected treasurer, and Mr. A. E. Shipley, Dr. E. W. Barnes, and Mr. P. V. Bevan secretaries.

OXFORD.—The Romanes lecture will be delivered by the Chancellor of the University, Lord Curzon, All Souls' College, on Saturday, November 2, at 2.30, in the Sheldonian Theatre. The subject of the lecture will be "Frontiers."

Mr. J. S. C. Douglas, Christ Church, Radcliffe travelling fellow, has been elected to the Philip Walker studentship in pathology.

The London Day Training College, Southampton Row, W.C., will be opened by the Earl of Rosebery on Saturday, November 2, at 3 p.m. The ceremony will be conducted by Mr. H. Percy Harris, chairman of the London County Council.

Dr. W. Goodwin has been appointed head of the chemical department of the South-Eastern Agricultural College (University of London), and Mr. B. N. Wall head of the agricultural department. A new department of soil bacteriology is being established under the charge of Mr. C. T. Gimingham. A conference of hop-growers will be held on November 27 under the chairmanship of Mr. E. C. Lister-Kay, when papers on fertilisation of hops, eel-worms, and hop-drying will be communicated.

At the annual general meeting of the Old Students' Association at University College (University of London), Dr. Tempest Anderson was elected president of the association for the year 1907–8. The annual dinner of the association will be held on Thursday, December 5. The new wing that has recently been added to the college will be completed by that time, and will be open to inspection. Former students of the college who desire to be present should communicate with Mr. George A. Aitken at 42 Edwardes Square, Kensington, W.

Prof. L. F. Vernon Harcourt, who died on September 14, bequeathed 1000*l.* to the Institution of Civil Engineers in memory of the many advantages he had derived from its library and lectures, to found a yearly or biennial (in the discretion of the institution) lecture, medal, premium, or prize, in connection with river, canal, or maritime engineering. The residue of his property he left to his wife for life, and after her death to the University of Oxford, if there shall have been founded there in the lifetime of himself and his wife a school of engineering or mechanical science, 1000*l.* for the promotion of the teaching of engineering science there. He also bequeathed 200*l.* to University College, London, for a yearly prize in civil engineering.

The new laboratories of the scientific departments of the College of Liberal Arts of Boston University have now been opened in the building formerly occupied by the Harvard Medical School. We learn from *Science* that the top floor is occupied by the departments of astronomy, physics, and mathematics, and comprises large and small lecture-rooms, laboratories, and offices; a large part of the basement is also given over to physics. The chemical and biological departments occupy the second floor, and consist of large, well-lighted class laboratories, private laboratories and store-rooms, professors' rooms, and an amphitheatre for the larger classes. The two domes for the telescopes of the astronomical department are situated on the roof, and are not quite completed. The equipment of all the laboratories is new, and was purchased in part by special funds given to the University for that purpose. The scientific departments are under the same directors as last year.

The report for the year 1907 on secondary education in Scotland, prepared by Dr. J. Struthers, the permanent secretary of the Scotch Education Department, has just been published. It appears that instruction in experimental science continues to make headway steadily. The schemes of study submitted to the department for approval often show a tendency to attempt a larger volume of work than can be accomplished satisfactorily in the time allotted to the subject, and teachers find difficulty in treating inductively the more advanced subjects included in the school course of physics and chemistry. The chief examiner reports a large increase in the number of candidates presented at the examination for leaving certificates. It is exceedingly satisfactory, the report continues, to know that in more than 50 per cent. of the schools the examiners were able to accept the teacher's list without change or modification of any kind. This is a sure sign of the growth of that mutual confidence between teachers and examiners which is essential to any really healthy system of examination.

The scientific training of the pharmacist was the subject chosen by Prof. Meldola, F.R.S., for the inaugural address upon the occasion of the opening of the present winter session of the School of Pharmacy. From the lecture we gather that for the two examinations of the school the passing of which qualify the student as a pharmacist, a period of fifteen months' training is all that is required. The standard of the examinations themselves is unquestionably high, and too high, in the opinion of Prof. Meldola, for so short a period of training, creating the danger of the instruction of the school degenerating into a "cram." It appears, however, that at present no knowledge of the action of drugs is demanded of the pharmacy student, although a most intimate acquaintance with the methods of physical and chemical analysis is demanded of him. There can be no doubt that legally great responsibility rests upon the pharmacist, in that if he cannot make his own preparations he is expected to know how they are made and how to assure himself that the products he dispenses are of the nature and substance demanded. In Germany a more thorough and a more prolonged scientific training is necessary before a legal qualification in pharmacy can be obtained, and in this country certain universities have, after a prolonged and thorough curriculum, granted degrees in pharmacy. In conclusion, Prof. Meldola suggested that the Pharmaceutical Society should demand of those students entering the school a higher standard of general education and some specific scientific training either in addition to or in the place of the present three years' apprenticeship, or, in other words, that more attention should be given to the scientific status of pharmacy, even if this has to be done at the expense of its commercial aspects.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, October 21.—M. H. Becquerel in the chair.—The transits of Mercury across the sun, and in particular on that of November 14: G. **Bigourdan.** A discussion of the various phenomena which have been observed in connection with the transits of Mercury, together with suggestions regarding instruments, &c., for use in the coming transit.—Some formulæ relating to the minima of classes of quadratic forms, binary and positive: G. **Humbert.**—The spawning of the cod in the south of the North Sea: Alfred **Giard** and C. **Cépède.** The authors criticise the views put forward by T. Wemyss Fulton in a recent paper on the same subject. The spawning of the cod in the Pas-de-Calais, the south of the North Sea, and the Baltic takes place in winter, the maximum being produced towards the middle of February, or a month earlier than indicated by Fulton. There is no indication of there being two spawning seasons in certain localities.—The installation of a large astronomical instrument at the summit of the Pic du Midi: B. **Baillaud.** This was carried out in 1906 and 1907 with the assistance of officers and men of the French artillery. Observations will be commenced in August, 1908.—Observation of the Mellish comet (1907*c*) made with the bent equatorial of the Observatory of Lyons: J. **Guillaume.** The comet appeared on October 17 as a diffuse nebulosity of about 35″ diameter, with a faint central nucleus. Its lustre is about that of a star of the tenth magnitude. The apparent positions of the comet and comparison stars are given.—Observations of the new comet (1907*e*) made at the Observatory of Marseilles with the Eichens 26 cm. equatorial: M. **Borrelly.** Similar observations made on October 17 and 18.—Integral equations: E. **Goursat.**—The integrals of the differential equation $y' + A_2y^2 + A_3y^3 = 0$: Pierre **Boutroux.**—The variation of the mass of the electrons in the interior of the atom: H. **Pellat.**—The formation and preparation of aluminium carbide: Camille **Matignon.** Four methods of preparing this carbide without the use of the electric furnace are described: heating a mixture of aluminium powder and lampblack in a Perrot gas furnace for twenty minutes, inducing the reaction to start at a point in the same mixture by the addition of iodine or sulphur, the use of the oxy-acetylene blow-pipe, and by the interaction of aluminium and hexachlorobenzene. In the first two cases the purity of the product was tested by treating with water and analysing the methane produced.—A delicate method for the detection of nickel in the presence of cobalt: Z. **Tchougaeff.** A direct comparison of the dimethylglyoxim reagent suggested by the author some years ago with the reagent recently proposed by M. Pozzi-Escot (ammonium molybdate) shows that the latter is much inferior in delicacy, and under certain conditions may also give rise to a precipitate with cobalt.—Syntheses in the camphor group. The complete synthesis of campholene: G. **Blanc.** The starting point of this synthesis is ethyl malonate, and the sodium derivative of this, treated with γ-bromodimethylbutyric ester, $CH_2Br.CH_2.C(CH_3)_2.CO_2C_2H_5$, gives the ester of 1:1-dimethylbutane-1:4:4-tricarboxylic acid. This is saponified and the acid heated, giving ααδ-trimethyladipic acid, the anhydride of which, slowly distilled at the ordinary pressure, is converted into 1:1:4-trimethyl-*cyclo*pentanone-5. This with magnesium methyl iodide gives the corresponding tertiary alcohol, and the latter spontaneously loses water on distillation, giving a hydrocarbon identical in boiling point, density, and refractive index with campholene from β-campholenic acid.—Sodium anilarsenite in syphilis: Paul **Salmon.** This substance is sold commercially under the name of atoxyl, and by its use comparatively large quantities of arsenic can be administered with comparative impunity. A physiological comparison of three commercial specimens, two amorphous, one well crystallised, showed that no appreciable differences could be detected. It was noteworthy that whereas in animals poisonous symptoms in the medulla were not infrequent, no such untoward effects were observed in man. Of 181 syphilitic subjects, only about 15 per cent. showed intolerance of the drug.—The causes of trypanolytic crises and relapses which follow: A. **Massaglia.** From experiments *in vitro* it is concluded that the crises are due to the formation of an anti-body in the blood of the animals infected by trypanosomes; a small number of the parasites escape destruction and grow accustomed to the action of the anti-body, and it is to these parasites which escape that the relapses are due.—The true accelerating action of sodium fluoride on the coagulation of milk by vegetable ferments: C. **Gerber.**—A preliminary sketch of the geology of Dahomey: Henry **Hubert.**—The displacements of the maxima of the positive and negative anomaly of gravity relatively to the configuration of the earth: Giulio **Costanzi.**

DIARY OF SOCIETIES.

FRIDAY, NOVEMBER 1.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Resumed discussion by Capt. H. R. Sankey on Prof. Bertram Hopkinson's paper on The Indicated Power and Mechanical Efficiency of the Gas-engine.

GEOLOGISTS' ASSOCIATION, at 8.—Conversazione.

MONDAY, NOVEMBER 4.

ARISTOTELIAN SOCIETY, at 8.—The Presidential Address on The Methods of Modern Logic and the Conception of Infinity: Rt. Hon. R. B. Haldane.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Determination of Indigotin in Indigo-yielding Plants: Cyril Bergtheil and R. V. Briggs.—Analysis of Indigo (Part iii) and of the Dried Leaves of *Indigofera arrecta* and *Indigofera Sumatrana*: R. Gaunt, F. Thomas and W. P. Bloxam.

TUESDAY, NOVEMBER 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Address by the President, Sir William Matthews, K.C.M.G., and Presentation of Medals and Prizes awarded by the Council.

SOCIOLOGICAL SOCIETY, at 8.—The Evils of Cities: a Study of the Degeneration of Communities, and of the Deterioration of their Individuals: Prof. Geddes.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Presentation of the Huxley Memorial Medal to Dr. E. B. Tylor.—On Methods of Determining the Stature and taking other Measurements of the Living Person: Prof. D. J. Cunningham, F.R.S.

WEDNESDAY, NOVEMBER 6.

ENTOMOLOGICAL SOCIETY, at 8.—On some of the Butterflies of Tobago: Dr. G. B. Longstaff.—On a Large Series of Nycteribiidæ (Parasitic Diptera) from Ceylon: Hugh Scott.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Discussion on the Sealing of Samples.

THURSDAY, NOVEMBER 7.

ROYAL SOCIETY, at 4.30—*Probable Papers*: The Effect of Pressure upon the Arc Spectra of Metals: W. Geoffrey Duffield.—The Diurnal Variation of Terrestrial Magnetism: Prof. A. Schuster, F.R.S.—The Electric Discharge in Monatomic Gases: F. Soddy and T. D. Mackenzie.—On the Measurement of Temperature in the Cylinder of a Gas Engine: Prof. H. L. Callendar, F.R.S., and Prof. W. E. Dalby.—Note on the Association of Helium and Thorium in Minerals: Hon. R. J. Strutt, F.R.S.

RÖNTGEN SOCIETY, at 8.15.—The Presidential Address, The Production of High Frequency Oscillations, with Demonstrations: W. Duddell F.R.S.

LINNEAN SOCIETY, at 8.—The Origin of the Di-trimerous Whorls among Flowers of Dicotyledons: Rev. George Henslow.—Unrecorded Acari from New Zealand: Albert D. Michael.—On *Ænigmatistes africanus*, a new Genus and Species of Diptera: R. Shelford.—*Exhibits*:—A copy of Hudson's "Flora Anglica," 1778, with numerous annotations by the Rev. William Kirby: Alexander Stevenson.—Abnormal Stem of *Eucalyptus salmonophloia*, F. Muell., from West Australia: Dr. A. B. Rendle.

CHEMICAL SOCIETY, at 8.30.—Gaseous Nitrogen Trioxide: H. B. Baker and Mrs. M. Baker.—The Atomic Weight of Tellurium: H. B. Baker and A. H. Bennett.—The Isomerism of the Double Sulphites of Sodium and Potassium: M. H. Godby.—Studies in the Camphane Series, Part xxiv, Camphoryldithiocarbamic Acid and Camphorylthiocarbimide: M. O. Forster and T. Jackson.—The Vapour Pressures of Triethylamine, of *sym*-Trimethylpyridine, and their Mixtures with Water: R. T. Lattey.—Liquid Triethylamine: R. T. Lattey.—The Action of Sulphuretted Hydrogen on Solutions of Sodium Hydrosulphite: F. S. Sinnatt.—The Alkyl Compounds of Gold. Diethylauric Bromide. Preliminary Note: W. J. Pope and C. S. Gibson.—Note on the Constitution of Homoeriodictyol: F. B. Power and F. Tutin.—The Interaction of Methylene Chloride and the Sodium Derivative of Ethyl Malonate: F. Tutin.—Preparation of Aliphatic Nitro-compounds by the Interaction of the Alkyl Iodides and Mercurous Nitrite: P. C. Rây and P. Neogi.—Some Mercury Derivatives of Camphor: J. E. Marsh and R. de J. F. Struthers.—Contribution to the Chemistry of the Terpenes. II. The Oxidation of Limonene with Chromylchloride: G. G. Henderson.—The Synthesis of Acridines and Phenonaphthacridines: Tetra- and Hexa-methylacridines: Dimethylphenonaphthacridines: Dixylylmethylenediamines: A. Senier and A. Compton.

FRIDAY, NOVEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—Description of a New Species of Clathurella, probably from Ceylon: H. B. Preston.—On the Mollusca of Birket-el-Qurun, Egypt: C. A. Smith.—*Turbo granoliratus* (New Guinea); *Sistrum chrysalis*, *Purpura bougei*, *Natica bougei* (New Caledonia); *Urosalpinx walkeri*, *Listra walkeri* (N. W. Australia); *Amalthea coxi* (Port Stephens); *Pitaria elata* (Sierra Leone); all new species: G. B. Sowerby.—Note on the Originals of the Illustrations for E. M. da Costa's "Historia Naturalis Testaceorum Britanniæ," London, 1778: Alex. Reynell.

PHYSICAL SOCIETY, at 8.—Discussion on Mr. Campbell's Paper on the use of Variable Mutual Inductances.—A Graphic Method for Stream-lines and Equipotential Surfaces: L. F. Richardson.—On the Lateral Vibrations of Bars Supported at two Points with one end Overhanging: Dr. J. Morrow.

CONTENTS.

SUPPLEMENT TO "NATURE."

DENATURED ALCOHOL.

Denatured or Industrial Alcohol. By Rufus Frost Herrick. Pp. x+516. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 17*s*. net.

THE tax-gatherer, nowhere a *persona grata*, by some strange irony of circumstance finds that one of the most convenient modes of raising revenue is to tax that which, proverbially speaking, maketh glad the heart of man. Nevertheless, this fact rather detracts from his general unpopularity than adds to it, at least with all right-thinking communities. For alcohol, unlike certain much-advertised pens, is not an unmitigated boon and a blessing; there are some people, indeed, who, if they had their way, would tax it out of existence altogether.

Without entering on the vexed question as to whether alcohol, in its manifold forms, is or is not of alimentary value, it is universally agreed that if articles of food and drink are to be taxed at all, human nature being what it is, there is no more convenient substance by which to raise a revenue than the spirit of wine. But the industrial value of alcohol is hardly less important than its potable value. It is the starting-point in the manufacture of a great variety of useful and beneficent products, and it has special merits as a fuel and as a solvent. The tax-gatherer-in-chief, that is the Chancellor of the Exchequer, of every civilised State is, therefore, confronted with the problem how to raise a due amount of revenue from alcohol without hampering or crippling those industries which need alcohol in their manufacturing operations. This country was the first to attempt to settle this difficulty by introducing the system of what is called "denaturing" the alcohol, that is, so treating it as to render it practically worthless as an article of drink without materially impairing its application to industrial purposes or materially increasing its cost to manufacturers. The effective solution of the problem is by no means an easy matter. An efficient denaturant must fulfil certain necessary conditions. In the first place it must render the spirit nauseous, even when used in comparatively small quantity. Secondly, it must not be capable of being easily removed by distillation or by mechanical or chemical treatment; next, it must be capable of ready and certain detection, even if present in very small quantity; and, lastly, it must not affect the industrial value of the spirit. The ideal denaturant has not yet been found, but by general consent of all who have studied the question (and it has been inquired into and reported upon by the revenue authorities of nearly every country), the method suggested by the late Mr. George Phillips, and first adopted in Great Britain about half a century ago, has been found in practice to be on the whole the most convenient and suitable. It consists in adding to the spirits a certain quantity of wood-naphtha, or crude methyl alcohol, which, if containing a sufficient quantity of the associated pyroligneous products, renders the alcohol practically unpotable, except perhaps to the hardened dipsomaniac, who, like Porson, will drink even ink if it intoxicates, and who, to the extent that he is a curse to himself and society, must be treated by special means. Alcohol thus denatured, although not wholly released from revenue control, can be supplied for industrial use free of duty and without any charge to the user beyond the cost of "methylation."

With the spread of manufacturing industry, especially of chemical and pharmaceutical products, and in consequence of the increasing stress of competition, it was but natural that this question of the relations of alcohol to industry on the one hand, and to the revenue on the other, should be the subject of frequent inquiry, and for some years past an agitation was kept simmering in this country to effect the relaxation of the conditions under which duty-free alcohol may be employed in industry. It culminated in a departmental inquiry, and a considerable body of evidence was accumulated which had the unlooked-for result of entirely disproving the allegation that the attitude of the revenue authorities was in the least degree answerable for the position in this country of those industries which are concerned with, or are dependent upon, the use of alcohol. At the same time, the inquiry was not only of benefit to manufacturers in this country by opening their eyes to the real causes which affected their industries, but resulted in some substantial concessions to them. For although the contentions on which they originally based their demands were hardly supported by such evidence as they were able to adduce, it was found that the cost of "denaturing" might be materially reduced without risk to the revenue, and, what was of more importance to manufacturers, that the Treasury could afford to grant a considerable rebate to industrial alcohol. It is too soon, perhaps, to draw conclusions as to the operation of these concessions, or as to their commercial effect. It is, however, quite certain that if the results are not commensurate with anticipation, the fault will not rest with the inland revenue authorities.

All these matters are treated at length in the volume before us, which is, if we mistake not, the first treatise in our language on the subject to which it relates. Of course, much has been written on the methods of manufacture of alcohol, and Mr. Herrick's book contains little on this point which is not already familiar to distillers. Nor is it to be expected that what he has to say respecting the value of alcohol as an illuminant and as a fuel, or as a source of power, contains much original matter. But his compilation will be welcomed by all who are concerned in these subjects, and especially by those mechanicians who are interested in alcohol as a source of light and power. Mr. Herrick has been at some pains to put together all available information in the confident expectation that his countrymen will not be slow to turn it to account.

"It is the hope and belief of the author that we Americans can solve for this country the problem of Denatured Alcohol in such a successful manner that all the world may secure, from the results we here attain, uses and benefits much greater than those heretofore achieved."

As America has only known anything of denatured alcohol since the beginning of this year, Mr. Herrick's anticipation has all the enthusiasm and optimism of inexperience. At the same time, we shall look with interest to the realisation of his belief. Meanwhile we commend his book to the attention of those older nations to whom the problem of denatured alcohol has been familiar for generations past, in the hope that their energies may be quickened and their inventive genius stimulated by its perusal.

WATER AND WATER POWER.

Hydraulics. By Prof. S. Dunkerley. In two volumes. Vol. i., Hydraulic Machinery. Pp. vii+343. (London: Longmans, Green, and Co., 1907.) Price 10*s.* 6*d.* net.

HYDRAULICS, the practical side of the science of hydrodynamics, is a subject of no little interest and importance, not only from a technical, but also from an historical point of view. The energy contained in running water was one of the earliest sources of power utilised for the service of man. Water-wheels date back to a remote age, and are no doubt coeval with windmills. It is interesting to note that water power and wind power share the unique distinction of being found in nature "ready made," in which respect they stand apart from other motive agencies, which have to be generated.

It is mainly within a comparatively recent period that the capabilities of hydraulic power for industrial purposes have been thoroughly and systematically exploited. No little of the initiative in this matter was due to the genius and enterprise of the late Lord Armstrong, whose inventive mind was, he tells us, first set to work in this direction on the occasion of a journey through the Craven district of Yorkshire in 1836. He was then struck by the large number of mountain streams descending the steep slopes of the hills and expending their energy to no apparently useful purpose. Applying himself to the problem with characteristic energy, he became the pioneer and founder of the modern system of hydraulic power transmission, which has had such an enormous vogue during the past fifty years; and although at the present time its popularity is threatened by the growing importance of its junior rival, electricity, yet there still remains a vast field of usefulness for it which it can never wholly lose.

Prof. Dunkerley is thoroughly qualified to deal with a subject of this kind, requiring, as it does, a combination of close mathematical reasoning with practical common sense. He divides his material into two volumes, the first of which, and the one now under review, is entirely concerned with the theory of hydraulics in its relation to machinery. Dealing primarily with fundamental principles, he lays down the laws which have been demonstrated by experiment, and then proceeds to describe the means of their practical application.

Admirable, however, as is Prof. Dunkerley's work in its general scheme, we find that it bears here and there several traces of a slight lack of care in preparation, and some mistakes (due most likely to an imperfect scrutiny of the proof-sheets) which it would be well to correct in future editions. In certain parts the book would appear to have been compiled somewhat disconnectedly, and without that sustained continuity of reasoning and progressive demonstration which constitute features of a scientific treatise no less essential than accuracy of detail and clarity of diction. The author frankly admits that one article (p. 192) is out of its proper sequence, and it seems to us that other sections might have been more advantageously arranged. For instance, we venture to suggest that it would have been preferable for article 62 to follow directly after article 34, to which it appertains, and there is no apparent reason why the frictional resistance of bends and elbows should be dealt with in widely disconnected sections on pp. 56 and 87.

Over and above some evident misprints of an ordinary type, one or two strange inaccuracies seem to have crept in. The rendering of Kulter for Kutter (the familiar name of the Swiss experimentalist, who with Ganguillet propounded the well known formula now commonly known as Kutter's formula) is surely a *lapsus plumae* of rather more than ordinary significance, seeing that it occurs no less than four times, and is nowhere given correctly. The formula for bends, quoted on p. 87 as that of Weisbach, and presumably covering the general case, is certainly incomplete, and should read:—

$$h_b = m \cdot \frac{v^2}{g} \cdot \frac{\theta}{\pi},$$

where, for circular culverts,

$$m = 0{\cdot}131 + 1{\cdot}847\left(\frac{r}{R}\right)^{\frac{7}{2}},$$

θ being the angle of deflection. Even supposing the expression intended only to apply to rectangular bends of circular section (which is not expressly stated, and cannot be strictly inferred), the essential power index is lacking.

We mention these points in no carping and fault-finding spirit, but simply by way of enabling such few blemishes as there are to be removed. It is infinitely more pleasant to direct attention to the really commendable features, which are not a few. A number of worked examples are inserted throughout the book. These have been so carefully selected, and are so eminently helpful, that the author is to be congratulated upon their introduction. Then, too, he has been at pains to choose for his illustrations instances of some of the more recent applications of hydraulic science to engineering and commercial operations, instead of confining himself to old-fashioned types. A predilection for naval appliances is no doubt due to his past association with the Royal Naval College at Greenwich. In chapter iii. there are very full details of the hydraulic gun brake and of the method of operating bulkhead doors. Other articles worthy of mention are those relating to the hydraulic ram (pump), the Gutermuth valve, and the various adaptations of the centrifugal system of pumping, including the turbine. A good portion of the book is devoted to chronicling Prof. Osborne Reynolds's researches, including an article on the theory of lubrication. We do not notice any allusion to Prof. Hele-Shaw's experiments in stream line flow, but possibly this is reserved for the second volume, which is announced to deal with the resistance and propulsion of ships.

Altogether, there is a great deal to commend this book to students and others interested in the practice of hydraulics. The type is clear, the setting good, and the diagrams are very distinct. There is a large amount of new matter, and some old matter presented in a new light, and to those who are desirous of possessing a record of Prof. Reynolds's investigations, the volume forms a much readier source of reference than the original papers and the proceedings of various learned societies in which they are embodied.

COMPARATIVE ANATOMY OF THE LABYRINTH.

The Labyrinth of Animals, including Mammals, Birds, Reptiles, and Amphibians. By Dr. Albert A. Gray. Vol. i. Pp. x + 198; 31 plates. (London: J. and A. Churchill, 1907.) Price 21*s.* net.

ONE turns away from the examination of this work with a mixed feeling in which admiration is tempered with disappointment. In the volume under review the author reproduces thirty-one excellent stereoscopic photographs of exquisite preparations of the inner ear of various species of mammals—structures which hitherto have been left unexplored owing to the grave technical difficulties involved in their preparation. These difficulties the author has overcome by the application of a new technique whereby the delicate and complicated membranous labyrinth is freed from its surrounding bone, and clearly exposed as a transparent body, perfect in form and texture. Besides the photographs of these structures, which are novelties to the anatomist, the author gives scores of accurate measurements relating to the fenestra ovalis, the semicircular canals, and the cochlea; careful records are given of the development of the perilymph system, of the degree of twisting of the cochlea, of the pigmented areas on the ampullæ and lamina spiralis, and of the form and size of numerous other structures. The technique, the industry, and the field of fresh observation compel our admiration; it is when one comes to consider how far this research has really advanced our understanding of the inner ear that a feeling of disappointment creeps in. What Dr. Gray has really succeeded in showing is, that the mammalian labyrinth—if the monotreme form be excluded—is almost identical in form and arrangement in all; the variations shown relate only to minor details. That is what one ought to expect, seeing how strictly the organ subserves the same function in all—at least so far as it serves as an organ of hearing. But as part of the mechanism of balancing and of orientation, one might expect a greater degree of variation in structure than Dr. Gray has actually found. In the case of the sloth the semicircular canals are certainly peculiar in form. From the data of comparative anatomy one is frequently able to obtain valuable suggestions of the functional meaning of obscure structures, but in this respect Dr. Gray's inquiries, so far as can be seen at present, are remarkably barren.

Dr. Gray is of opinion that many of his observations may afford indications of the relationship of one mammalian order to another. He divides the forms of cochlea into flat conical and sharp conical. To the sharp type belong the Carnivora and Rodentia, while Primates, Ungulata, Sirenia, Cetacea, Insectivora, and Cheiroptera possess the flat type; the Edentata show an intermediate form. Unfortunately one knows so little of the real meaning of the twisting of the cochlea tube that it is hazardous to say at present what importance should be attached to its form. Amongst marsupials, Dr. Gray found both forms of cochlea to occur. He is inclined to attach a taxonomic value to the size of the perilymph space in the semicircular canals, a wide space being, in his opinion, the primitive form. The seal, for instance, has a wide perilymph space, while the sea-lion, like the land Carnivora, has a very narrow one, from which he concludes that the seal must have branched off from the primitive Carnivora stock while this space was still wide, whereas the sea-lion dates his departure from the period at which this space had already diminished in the land forms. To estimate the worth of such an observation one wishes to be quite certain that the size of the perilymph space has no functional significance, and, secondly, that the wide form is really the primitive mammalian form. Man and all the monkeys possess an ample perilymph space, whereas in the lemurs it is of small size. The slow loris differs from the typical lemur in many points so far as regards the anatomy of the inner ear, but here again one wishes to know how much of this difference is really due to a difference in function, and how much is really due to a difference in descent.

While expressing an unqualified admiration for the results obtained by the application of Dr. Gray's technique, one must also admit that it is a technique with very serious limitations. The finer structures of the ear, the organ of Corti and the nerve-endings cannot be thus examined, and are only to be explored by the old, laborious and accurate method of sectional reconstruction. A. K.

BRITISH WILD LIFE.

The Woodlanders and Field Folk: Sketches of Wild Life in Britain. By John Watson and Blanche Winder. Pp. xii + 304; illustrated. (London: T. Fisher Unwin, 1907.) Price 5*s.* net.

THE demand for books on country life and popular natural history (and from the number of volumes on these subjects issued nowadays from the press it may be assumed that such demand is large) is a healthy sign of the times. A *sine quâ non* with such books is, however, that they should be fairly accurate and reasonably up to date. Whether the volume now before us fulfils these conditions we will leave our readers to judge for themselves after perusal of the following extracts and comments.

In the chapter headed, not very happily, "A Miniature British Fauna," it is stated (p. 109) that "British voles are diminutive beavers"; while on the next page we are told that there are three British species of these rodents—the water-vole, field-vole, and bank-vole. Now to call the water-rat, or water-vole, a beaver is bad enough, but to include the short-tailed field-mice, or field-voles, under the same term is a positive absurdity. With such lack of knowledge it is not surprising to find the authors completely ignorant of the existence of the Skomer Island and Orkney voles. Again, it is a little late in the day to refer (pp. 113–114) to the bank-vole as having only recently been recognised as a species, especially when mention is made of Yarrell's description of it "as lately as 1832." While excluding "voles," the authors class the dormouse among mice, stating that we have four representatives of that group—the dormouse, the harvest-mouse, the long-tailed field-mouse, and the house-mouse. What may be the authors' views as to the systematic position of rats we dare not venture to guess!

In connection with mice, we may refer to the statement (p. 109) that, "with one exception (the harvest-mouse), the long-tailed field-mouse is the smallest British mammal," the shrew-mice being totally forgotten! As regards the matter of sizes of animals the authors are, indeed, very casual, as on p. 249 they tell us that the rock-dove is the smallest of the British pigeons, although they include in that group the turtle-dove, as they likewise do the passenger-pigeon!

Other instances of carelessness or want of knowledge occur in the statement that the fur of the water-shrew is warm brown (p. 110), and the mention of silver fox where white fox is obviously intended (p. 37). If true, the statement that otters feed mainly on crayfish (p. 101) is new to us; while we are startled by the suggestion on p. 67 that British cuckoos occasionally incubate and hatch their eggs. In using the term loon (p. 206) to designate the grebes, the reader should have been informed that it is generally applied to the divers; or if that information was considered superfluous, it was surely unnecessary to suggest (p. 101) that most persons are ignorant of the fact that owls reject the waste portions of their food in the form of pellets.

Owing to its many errors the naturalist will be very disappointed with the volume; while the nature-student who desires to use it as a source of information will find that he has much to unlearn.

The illustrations of scenery and of nests of birds in their natural situations are for the most part good, and many of them excellent. As for the photographs of stuffed birds among pseudo-natural scenery, perhaps the less said the better; but if such artificial pictures are used, it would be well to see that the toes of the birds are made to grasp the boughs on which they are placed, instead of sticking out in an aimless manner, as in the photograph of the turtle-dove facing p. 252. R. L.

POPULAR ORNITHOLOGY.

(1) *Birds I have Known.* By Arthur H. Beavan. Pp. 256; illustrated. (London: T. Fisher Unwin, n.d.) Price 2s.

(2) *A Ready Aid to Distinguish the Commoner Wild Birds of Great Britain.* By David T. Price. Pp. 62. (London: Gurney and Jackson, 1907.) Price 1s. net.

(3) *Birds of the Countryside: a Handbook of Familiar British Birds.* By Frank Finn. Pp. xvi+190; illustrated. (London: Hutchinson and Co., 1907.) Price 5s. net.

(4) *The Useful Birds of Southern Australia.* By Robert Hall. Pp. xvi+306; illustrated. (Melbourne: T. C. Lothian, 1907.) Price 3s. 6d.

(1) THAT there is an increasing interest taken in wild birds by amateurs is abundantly proved by the steady stream of books on the subject intended for the use of beginners which issues from the publishers. Perhaps there is no better way of fostering their interest than relating one's lifelong experience of birds, and Mr. Beavan has done this very pleasantly in "Birds I have Known." Beginning with his childhood, when he lived in a "dreary London square" which could not repress his ornithological instincts—these finding an outlet in the parks, rare visits to the Zoo, and to Margate, where he made the acquaintance of a living gull—the author passes on to his school-days. They were schooldays under the old, hard system. To read of them should make the modern boy contented with his lot, although he may perhaps long for the greater amount of liberty and the greater opportunities for training the powers of observation enjoyed by boys before games were put before everything else. But he will follow with delight the author's adventures in search of birds' nests, and his experiences with tame hawks and owls, &c. Later, in the holidays, this particular boy found his way to Leadenhall Market, with its then rich show of ruffs and reeves, avocets, godwits, and rare waterfowl, at which he used to gaze long and admiringly. Altogether the progress of the young ornithologist, with the real, keen love of birds in him, making the best of not very favourable conditions, is admirably traced. But the author soon went to sea, and succeeding chapters take us among ocean birds, and recount his experiences of birds "during many years in many lands and over many seas." Here he deals "with Nature like an open book," "uncomplicated by references to scientific theories as to the origin and distribution of species." And very good reading these chapters are, although home-staying bird-lovers may find their chief pleasure in those upon Cornish and London birds. But wherever made, the personal observations of a keen bird-man are always worth reading by his fellows, and really are a great help to the younger ones. Mr. Beavan has certainly known a great many birds. The frontispiece is a reproduction of one of Wolf's incomparably beautiful pictures of eagles. The rest of the illustrations seem to be original, but will hardly escape criticism to-day.

(2) Even nowadays, under the narrowing influence

of primary education and the counter attractions of cheap holiday outings and cigarettes, some of our ploughboys grow up knowing the names of nearly all the birds around them, without having even seen a book on the subject; and a generation ago such knowledge was general among them. But there are now many educated people, it appears, who would like to be able to recognise the birds they meet with, and having come to mature years without knowing anything about them, seek for a short, if not a royal, road to that knowledge. For them a pocket key has been cunningly devised by Mr. Price. In the second part will be found short descriptions of about one hundred of the commoner British birds, written specially for the observer with a field-glass, dealing therefore with habitat, flight, and characteristic habits rather than with details of plumage. In order, however, that it shall not be necessary to search this part of the volume from beginning to end in the process of identification, the first part has been devised. In this part—which might be called an index—under seven headings, each heading constituting a certain locality, and in two columns (for winter and summer), will be found lists of the species that are likely to be seen in such localities.

"By dividing these lists into groups according to the size of the species, and by adding a two-word description of each, it is hoped that but two or three species will remain as possibilities. The descriptions of these will then be found in the second part on the page indicated."

The idea has been very well carried out, and we are sure the little book will be a help to those for whose use it is intended; but we confess to having our doubts as to whether anyone who *wants* such a key for use in the field will ever know his birds as well as our ploughboys. The single illustration explains the meaning of the names of the different portions of a bird's plumage.

(3) Mr. Finn's stouter volume is also intended to help the beginner to identify birds, but the subject is dealt with more fully therein. It is a handbook, not a key, although the descriptions here again are of the bird as it catches the eye at a distance as well as close at hand—its general colour, shape, and peculiarities of motion and cry. The book is primarily intended to serve as a means of identification of the birds most conspicuous in life or literature, free or in captivity in this country; and the easiest method of learning to know birds, in the author's experience, is to identify those which first catch the eye, and then learn their relations. To this end he has arranged the species dealt with according to the circumstances under which they are likely to be first met with. As most of his readers will be more interested in "the bird in the bush" than in that in the hand, he has cut the descriptions of the species as short as possible, so as to facilitate identification. Here again the birds are grouped according to their locality, the chapters being subdivided in some cases for summer and winter. The complete and pleasing, though concise, account of the general life habits of the different birds (and the nesting habits of those that breed in this country) seems well calculated to help the novice to acquire the knowledge he desires. There are directions for encouraging the presence of desirable birds, by the provision of nesting-boxes, food, and water, as well as for the rearing up of orphaned or deserted young birds—directions which will, of course, be quite as useful for birds taken out of the nest. Finally, to give the reader some idea of classification, at the end of the book there are enumerated and briefly diagnosed all the natural families of birds occurring in our islands, even where these are only represented by casual stragglers.

For the dozen coloured plates we have the highest praise. Many of the black and white illustrations are most interesting and novel, *e.g.* one showing the peculiar appearance of pea-pods torn to pieces by hawfinches. But those of captive birds (so apt to look ragged and dejected) and stuffed groups are not always so happy. We hardly think the photographs of the "house martin," the missel thrush and fieldfare can be much aid to identification, nor can we, by the way, fall in with the statement that the martin seems more common in England than the swallow nowadays. But we do not know where else you can get so many good and interesting bird-pictures for so little money.

(4) Those who are interested in the economic aspect of ornithology, especially the good, or harm, done by birds in the course of the satisfaction of their hunger will profit by a perusal of Mr. Hall's careful treatment of the subject in his account of some of the birds of southern Australia. The book will be welcomed also by those who would like to get some idea of what manner of birds inhabit the far distant island continent, and learn something of their habits. There is, of course, a raven, crow, and kestrel, which for some reason, like the Americans, they will call a sparrow hawk. But the birds on the whole are so utterly different from ours that it comes as a surprise to find a meadow pipit of the same genus as ours, and it is interesting to compare the habits of the two birds. There are no less than six kinds of cuckoo in South Australia, but they do not call "cuckoo," and their notes do not in the slightest degree resemble those of our northern bird—they are described as high-sounding, as weird, and as melancholy. But these cuckoos are just as troublesome to their small neighbours, "upsetting hundreds of family arrangements." The pallid cuckoo chooses open nests like that of the fantail for this purpose; the other species distribute their favours among the wide, open, cup-shaped nests and those with a side entrance. The fan-tailed species and two bronze species choose 75 per cent. of dome-shaped nests, while the square-tailed cuckoo is content with 50 per cent., and the remaining half of open nests. The whole of the account of the cuckoos is most interesting, and the home life of some of our best-known cage-parrots may be learned in this pleasant little book. It concludes with some account of birds which have been introduced. The goldfinch and song thrush are naturally well spoken of; nothing bad is yet known there about the greenfinch or the skylark, and the blackbird's character is much what it

is with us. Few introduced species have succeeded in firmly establishing themselves, and not all of them have been a success in other ways. The starling has already taken to turning out of their nesting holes certain useful native species, and the author says "certainly a part of the cost of upkeep in every well-settled district will need to be expended on the annual subjection of sparrows and starlings." Altogether the acclimatisation of birds in Australia does not seem to have been attended with very encouraging results. The book is, of course, mainly intended for use in the colony. It is nicely illustrated.

O. V. A.

AN UNFREQUENTED ITALIAN COAST.

The Shores of the Adriatic; the Italian Side. By F. Hamilton Jackson. Pp. xiv+358; illustrated. (London: John Murray, 1906.) Price 21*s.* net.

OF the hundreds of English-speaking tourists who annually visit Italy, the great majority consider that they have "done" the Adriatic when they have seen Venice, while a few are attracted a little further afield by the curio shops of Ravenna or Rimini or the postage stamps of San Marino. In exploring the coast-line from Brindisi to Udine by gradual stages, omitting Venice, Mr. Hamilton Jackson has opened up a region practically unknown to English and Americans. There is a good deal of French, Italian, and German literature regarding this part of Italy of which a fairly long list is given in the preface, but English writings are few in number, and this circumstance alone would afford sufficient justification for the publication of the present book, if indeed any justification should be needed.

The district is one of great historical interest. It has been occupied by Greece and Rome, raided by Saracens and Turks, invaded by Gauls, and the southern part conquered by the Normans, of whose methods of strategy an interesting narrative forms part of the first chapter. It comprises the province of Apulia, the Abruzzi, the Marche, Emilia (Romagna), and Venetia. Geographically, the most important feature along the coast-line is the Monte Gargano, with its shrine of Monte Sant'Angelo, founded by Constantine. From its prominent position it was for a long time a Saracenic stronghold, and still retains its name of Monte Saraceno.

It is with the architectural beauties, in particular the churches, that this book mainly deals, and the illustrations are an important feature. In these days of "process blocks" line drawings come as a pleasant change and relief from the monotonous "half-tone" illustrations. Mr. Jackson has made use of both forms of illustration. A number of photographs, mostly taken by Mr. J. Cooper Ashton, are reproduced in the form of plates, while the illustrations in the text show the advantages of pen and ink sketches for bringing architectural details into due prominence. The dual mode of illustration has undoubtedly served another useful purpose. In the narrow streets of an Italian town there are many buildings which cannot possibly be got into the field of view of a camera fitted with even the widest angle lens, and we may be fairly sure that if the author had trusted to photography alone many of the choicest and most picturesque bits would never have figured in this book. Of the difficulties of taking photographs when boys will persist in standing in front of the camera we have an example on p. 165, while the arrival at Brindisi described on p. 33 gives a familiar instance of the way the English traveller is imposed on in Italy when he keeps to the beaten track. On the other hand, the author speaks warmly of the courtesy shown him by officials and others in regions where English tourists are practically unknown. As a set-off against this advantage, Mr. Jackson had to put up with somewhat rough and primitive accommodation in places, and his photograph of an interior under the title "Stable and house in one, Foggia," gives some insight into the insanitary conditions prevailing in many of these unenlightened little Italian towns.

Of the buildings of interest, the following rough summary may give some general idea:—At Bari, cathedral, church of San Nicola, with treasury, King Roger's Castle; at Bitonto, church of San Valentino; at Terlizzi, eleventh century church; at Giovenozzo Molfetto, Trani, Troja, Lucera, cathedrals; at Barletta, church of Santa Maria Maggiore; on Monte Sant'Angelo, the grotto church, with fine bronze doors dating from 1006; San Clemente in Casauria, church; Ascoli Piceno, Roman bridge and prison, churches of SS. Vincenzo and Anastasia, San Giacomo, San Francesco; at Ancona, arch of Trajan, cathedral of San Ciriaco, with beautiful panels, church of Santa Maria della Piazza; at Rimini, bridge of Augustus, church of San Francesco, castle of Sigismond Malatesta; at Ravenna, mausoleum of King Theodoric, cathedral, tomb of Galla Placida, church of San Vitale; at Pomposa, abbey church of Santa Maria, with great campanile; Chioggia, a picturesque town on two canals easily reached from Venice; at Treviso, cathedral; at Udine, cathedral and excursions to Cividale, with its picturesque bridge, castle, churches of San Martino and Santa Maria in Valle. It would be impossible to quote the author's descriptions of these and other objects of interest, but the above list will afford some idea of what there is to be seen by anyone who will follow in Mr. Jackson's footsteps, while the stay-at-home reader will certainly, as the author claims, by reading the descriptions and examining the figures, obtain an insight into Italian art which will be quite new to him.

A number of plans of churches and cathedrals are inserted in the text, in addition to the other figures. There is, however, one point which is too often overlooked by writers of books of travel. A map, however rough and sketchy, of the district traversed greatly adds to the interest. It is true that most people have a map of Italy in their possession, and it must further be admitted that the towns follow each other in fairly regular order along the coast, so that the descriptions can be followed fairly well in any case. At the same time, a very useful purpose would be served by having a map in the book itself. If only on the ground of convenience, it would be consulted more frequently than an atlas, and the reader would acquire a better knowledge of the geography of the interesting and practically unspoilt towns that Mr. Jackson has so ably brought before our notice. This is the only fault, and that not a serious one, that can be found with this charming and delightful book. On the other hand, the vivid descriptions recall to our mind the bright colours of a southern town, the shouts and gesticulations of the populace, and last, but not least, the scent of burnt incense in the churches and the unsavoury odours of narrow Italian streets.

G. H. Bryan.

SCIENCE AND PRACTICAL BREEDING.

Farm Live Stock of Great Britain. By Robert Wallace. Fourth edition. Pp. xxxi+758. (Edinburgh: Oliver and Boyd, 1907.) Price 16*s.* net.

THIS edition of Prof. Wallace's handbook cannot fail to be of value to owners and to students of the history and management of stock. The illustrations are a special feature of the book; more than 400 of them are excellent reproductions of photographs, and had the animals been taken in a position which would admit of measurement, and a scale provided, the collection would have been of unique value.

After a chapter on wild cattle, in which the various herds recorded are referred to, and, where possible, described, there follow nine chapters on breeds of cattle. The origin and history of these breeds, their points, character, and management are well set forth; but what is of special interest is the attention devoted to variation, to the development of special qualities and of new types, to the influence of climate, and to the results of crossing. Chapters on the breeding and management of calves, on grazing cattle, and on the house-feeding of cattle follow, and this section concludes with two valuable chapters on dairying.

Pigs are somewhat perfunctorily dismissed in two short chapters.

Six chapters are given to the horse. Extinct and wild horses are briefly referred to, and a few inconclusive words said on the subject of the origin of our domestic breeds. Clydesdales and shire horses are more fully treated than are any of the other breeds, as must be expected in a book of this kind, but the space devoted to horses is meagre, and the treatment accorded them not comparable to that given to cattle and sheep.

On sheep there are eight chapters, in which the various breeds are separately and, as a rule, fully treated, while four short chapters contain advice as to the management of sheep, their feeding, the parasites which infest them, and the diseases from which they suffer.

The author claims in writing this book to have kept "in view not only the interests of one special breed, but also its connection with other breeds and the position it occupies in the great live stock economy of the country." This is a high aim, and, if he has not entirely succeeded, either to the satisfaction of certain special breeders or to that of the advanced student of live stock economy, his work is valuable, and will be of real service to those who follow him in their efforts to attain this end.

To readers of Nature it is to the first chapter in this book, on the principles of breeding, they will turn with special interest, and it is disappointing to find that the author has failed to give an account which adequately represents the results attained by modern scientific workers or the influence such work must exert on the future development of the breeding industry.

It is not from books, he says, that a student can learn to master the peculiarities of different breeds or the constitution of different animals; a long apprenticeship as a practical breeder is essential for such knowledge and for the success of the stock-owner. That is undoubtedly true, but one may surely have expected the professor of agriculture in Edinburgh to point out in his book that the scientific principles which govern the right application of all practical experience are of no less importance; to emphasise the fact that a scientific training which teaches the practical observer what to look for, how to sift his observations, how to apply his knowledge effectively, is necessary for the student of the subject, and a sound knowledge of the scientific principles of breeding essential for the highest success of the modern stock-owner. This omission is greatly to be deplored.

W. H.

A NEW DICTIONARY OF SOLUBILITIES.

Solubilities of Inorganic and Organic Substances. By Atherton Seidell. Pp. x+367. (London: Crosby Lockwood and Son; New York: D. Van Nostrand Co., 1907.) Price 12*s.* 6*d.* net.

DURING the thirteen years which have elapsed since the publication of Comey's "Dictionary of Chemical Solubilities," so great an activity has been shown in the determination of solubilities as to necessitate a new compilation of the data. As it is impossible to tell whether the solutions used in most of the earlier determinations were saturated in contact with a single definite solid phase, a considerable degree of uncertainty characterises such values. At the time when Prof. Comey's "Dictionary" was written it appeared inadvisable in the majority of cases to attempt to select from the discordant results of different observers the most trustworthy values for any particular substance, but the author of the present work points out that such a discrimination can now be made with advantage. In general, the values he gives were chosen by calculating the available determinations to a common basis, and plotting the data so given on squared paper. A comparison of the curves obtained, together with a consideration of the experimental details, usually furnished clear evidence for a trustworthy selection.

One advantage of this system is that the results are expressed in a uniform manner throughout; usually the solubility is given for regular intervals and in terms of weight of dissolved substance per given weight of solvent or of solution. In all cases where it is possible, the nature of the solid phase is clearly defined.

The value of such a work of reference must be determined by two factors, its completeness and its accuracy. As regards the former, there is little doubt that great pains have been taken to search thoroughly the literature of the past twenty-five years; concerning the latter, an opinion can only be formed after the book has been for some time in constant use. It is to be regretted that more care has not been given by the author to his nomenclature. On the same page we have acetamide and acetamid; acetanilide, acetanilid; anilin and aniline. The names of many organic substances appear curiously disjointed; for example, Tri Chlor Acetic Acid, Di Phenyl Amine, Epi Chlor Hydrine. It is unfortunate that the author considered it advisable to give to substances the names "found in the original papers," because this has led to the introduction, for example, of such terms as toluyl acid, anis acid, and napthion acid for the well known toluic, anisic, and naphthionic acids. Phenyl thiocarbimide is found under the German disguise of "Senföl"; suberic acid is, however, given its correct name, and is not seen masquerading as "Cork acid."

In several cases it would appear that the author does not know the German equivalents of the names of very well known organic compounds; quinine and chinin are regarded as different substances, and the data given under these two headings are quite different, being derived from different sources. Glycollic acid is termed glycocholic acid. Misprints of names are numerous.

Such blemishes, occurring with extraordinary frequency, are very unfortunate in a book which must have involved great labour in its preparation, and is bound to be widely used. The author in his preface modestly craves "all indulgence for errors and omissions," thus in a manner disarming criticism. The value of future editions of this work will greatly be enhanced if the nomenclature be carefully revised.

W. A. D.

A TEXT-BOOK OF OCEANOGRAPHY.

Handbuch der Ozeanographie. By Dr. Otto Krümmel. Vol. i. Die räumlichen, chemischen und physikalischen Verhältnisse des Meeres. Pp. xv+526. (Stuttgart: J. Engelhorn, 1907.) Price 22 marks.

THE treatise on oceanography published in Ratzel's "Bibliothek geographischer Handbucher" in 1884 has remained the standard work on the subject. Few branches of science have made more progress, absolutely and relatively, during the last twenty years than those which concern our knowledge of the sea, and the book has been seriously out of date for a considerable time. A new edition is therefore practically a new book, and a new standard treatise on oceanography will be hailed with relief by every student of the subject who has toiled more or less successfully to keep up with the unfailing streams of original memoirs which have issued from almost innumerable sources in recent years.

Prof. Krümmel's new volume, issued in the same series, which is now under the editorship of Prof. Penck, takes the place of vol. i. of the older treatise, written by the late Prof. von Boguslawski. Its general scope is the same, inasmuch as it treats of the form and distribution of the seas and oceans, the formation and composition of deposits, and the physics and chemistry of sea-water, and leaves dynamical questions to be dealt with in vol. ii., which in the older treatise was written by Prof. Krümmel himself. But the arrangement of the different parts, and the space devoted to each, are, of course, widely different. A comparison of the two works brings out in an unusually striking manner the enormous advances which have been made in the comparatively short interval, and places in their proper perspective the great contributions made, amongst others, by Murray in the concluding volumes of the *Challenger* reports, by Pettersson, Nansen, the deep-sea and Antarctic expeditions and the cable-ships, and the smaller researches in home waters which have culminated in the institution of the International Council for the Study of the Sea. It may be added that a comparison also makes clear the immense complexity of many problems which once seemed comparatively simple, and the urgent need, on economic as well as scientific grounds, for continued independent and combined effort in exploration and research.

Detailed description of the contents of Prof. Krümmel's book is impossible in the space at our disposal. The author gives an account under each head of the methods of observation employed by the chief investigators, more particularly in the most recent work, states the quantitative or distributive results arrived at, and applies them systematically to the description of special phenomena or of special geographical divisions. The amount of labour involved by this method is, of course, enormous, and the compression of the results into a volume of 526 octavo pages has been done with masterly skill. Criticism is by no means wanting, and we note with satisfaction that Prof. Krümmel has been able to retain many of the earlier observations, which, with their obsolete methods and cruder equipment, have sometimes been regarded as unworthy of comparison with those of the high precision more recently attained. Controversial questions concerning the application of these observations to the discussion of dynamical questions will doubtless be dealt with in vol. ii., the publication of which we await with interest. For the present it suffices to record the debt which all oceanographers owe to Prof. Krümmel for placing at their disposal so vast and orderly a store of material.