THURSDAY, JANUARY 4, 1912.

THE CLIMATE OF AFRICA.

The Climate of the Continent of Africa. By Alexander Knox. Pp. xiv+552+13 maps. (Cambridge University Press, 1911.) Price 21s. net.

SUCH a work as this has not only become highly necessary, but should be in great demand amongst Governments, mining and commercial companies trading in Africa, missionary societies, and all individuals who intend to visit Africa for any length of time, or to settle in any part of that continent for purposes of health, science, education, or commercial gain. It is to be regretted therefore that the book on its first appearance should contain some needless errors and be chargeable with not a few omissions. And in the hope that some indication of these may be of use in the preparation of a second edition, it may not be thought ungracious on the part of the reviewer to point them out.

First, in regard to the spelling of African names. Nothing is more irritating to those who believe in the desirability of simplifying and standardising the orthography of place and tribal names in all those regions of the world (in other words, all aboriginal America and Oceania, and nearly the whole of Africa and Asia) than attempts on the part of authors to avoid conforming with the standard spelling of the Royal Geographical Society, the Indian Government, the Royal Asiatic Society, the African Society, and most Government departments and learned institutions which are qualified to pronounce an opinion on this subject, and to promulgate a fixed spelling for all parts of the world where no standard has hitherto existed. In some cases this official spelling, though logical as to the use of consonants and vowels, may not have been quite consistent with the original and most widespread native pronunciation of the name. For example, there is no doubt but that the late explorer, Sir Henry Stanley, had a defective hearing (the reviewer speaks from much personal knowledge), and not infrequently wrote down an incorrect version of the native name. No traveller subsequent to Stanley has been able to hear any native of eastern equatorial Africa say "Ruwenzori." Perhaps the nearest form to Stanley's rendering is Runsoro or Runsori (a considerable list of native names of this mountain mass is given in the reviewer's book on the Uganda Protectorate and in the monumental works published in connection with the Duke of the Abruzzi's expedition). But, however that may be, Ruwenzori has long been the form adopted by all Governments and all geographers of any note. Why, therefore, in the work under review should the author introduce a meaningless name of his own—Ru Nzori? There is no linguistic justification for this variant, and in looking through the index it is a matter of inconvenience to find the familiar name Ruwenzori absent.

In regard to the place-name Quelimane. Both the author and several geographical societies and map-makers are at fault. The author spells it phonetically as Kilimane, as though it was a native name. Other authorities give it as Quilimane. Neither is correct. As a matter of fact, the official Portuguese name is Quelimane, which is an ancient corruption of a Swahili-Arab word, Kalimani, meaning "interpreter." This was the nickname of some person who met the ships of Vasco da Gama or other Portuguese pioneers, and served as intermediary between them and the natives. If we are to continue to use the place-names "Moçambique" and "Inhambane," we have no recourse but to go on citing the name of this river mouth on the north of the Zambezi delta as Quelimane. If Mr. Knox desires that his work shall be perfect from the point of view of conformity with the best opinion in the rendering of African names in any further edition of the work, the spelling requires careful revision. The author points out his own spelling of Morocco as Marocco, as though it were preferable to the commonly accepted term. As the phonetic foundation for this name is really Marākesh, we do not seem to gain much by departing from the widely accepted English form, Morocco, unless we go the whole hog and call the land of the Moors either Marākesh or Maghrib-al-Aksa.

In the same way, appendix 1, a glossary of the principal vegetable productions of Africa, except timber trees, by Miss Mary S. Knox, also requires revision and a slight extension to be perfectly useful and unimpeachable. Under the heading of "Acacias" the information is too vague; no species of capsicum (chillies) is *native* to Egypt, the whole of this genus being of American origin. Under the head of "Coffee" nothing is said about the very important species, *Coffea liberiensis*; and the assumption that there is but one species indigenous to or cultivated throughout tropical Africa, *Coffea arabica*, is quite incorrect and out of date. A reference to the works of Auguste Chevalier (amongst others) would enable Miss Knox to give much fuller and more useful information regarding the various species of coffee indigenous to tropical Africa and cultivated therein. It would be invidious to go on pointing out the errors in this appendix, but there are others. Yet it would be comparatively easy to make the whole appendix absolutely accurate and of great interest and importance in correlation with the main part of the book dealing with the African climate.

It is incorrect to say that the indigenous rubber of the Uganda Protectorate is "of poor quality." On the contrary, this protectorate is noteworthy for containing a large number of *Funtumia elastica* trees, which actually produce rubber attaining the highest value, when properly prepared, of any samples, even exceeding occasionally in price the best Para. Although a reference is made to the climate of Liberia (a region which, though small in extent, is very peculiar in flora and fauna—singularly so in fauna—and represents the culmination in rainfall of any part of real West Africa—as distinguished from Central Africa), the information is incomplete and old in date. Had the author glanced at the work on Liberia by the present reviewer, published in 1906, he would have found later and more complete statistics; and there is still further information in the reports and papers published by M. Auguste Chevalier. In the parts dealing with Sierra Leone and Southern Nigeria, no reference seems to be made to the valuable rain and temperature records kept and published by (or under the direction of) Mr. Frederick Shelford, the chief engineer or constructor of the railways in those countries. Mr. Shelford has made his records sufficiently public in the papers of scientific societies for them to be easily accessible.

The maps contributed to this book by Mr. J. G. Bartholomew under the direction of the author are admirable, and great praise must be awarded to the author for his general research, the clearness with which he sets forth his details and his conclusions, and the way in which he has invested what might seem to be a somewhat uninteresting subject with an interest and an importance sufficient to attract the general reader as well as the specialist. The book, indeed, is so good that it ought to be made as perfect as possible in all its details, which is why the reviewer has expatiated more on these slight defects than on the general excellence of what should prove a standard work.

One last criticism, for the publishers. It might on the whole be better in future editions to paste the twelve maps on monthly rainfall into the body of the work. Although in some ways it is convenient to have them in a pocket and to handle them separately, they are very liable in library use to be lost.

H. H. JOHNSTON.

THE NEW ANIMAL PSYCHOLOGY.

Animal Intelligence: Experimental Studies. By E. L. Thorndike. Pp. viii+297. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 7*s*. net.

ONE of the most remarkable examples of sudden and rapid development of a new scientific method and a new and extensive body of scientific fact is to be seen in the growth of the study of animal psychology during the last ten or a dozen years. As in the case of the general science of psychology, the change came with the introduction of experiment as the fundamental method of investigation, but the transition was accentuated by a craving for objectivity of results, which focussed the attention upon the objective performance or behaviour of the animal under examination, not only to the detriment, but even, in the case of many observers, to the complete neglect of speculation as to its psychical life. If the new psychology claimed to be a psychology without a soul, the new animal psychology threatened, and still threatens, to become an animal psychology without consciousness. Many investigators have indeed openly declared for this ideal—not denying the presence of consciousness, but regarding it as of no importance or value in an explanatory scientific system. Nevertheless signs are not wanting in the most recent work of a healthy reaction from this extreme view, based as much upon observed fact as upon *a priori* speculation.

After the most detailed investigations have been made into the manifold relations of stimulus and response presented by organisms, there is still room to be found for psychical factors of a greater or less degree of complexity, if the explanations are to be complete, although it is a sound principle of methodology that appeal should not be made to them until the possibilities of an exclusively mechanical or chemico-physical explanation have been exhausted. Indeed, it is the new experimental method that has succeeded in demonstrating, in certain cases, the existence of sensations not to be suspected from ordinary observation of the animal. Thus, fish do not ordinarily react to certain musical tones. If, however, such a musical tone is sounded repeatedly when food is supplied to the animal, the latter will ultimately respond to the sound by coming to be fed. In this case, as in many other similar cases, the existence of the sensation or its neural equivalent is demonstrated by the method of association.

Although the general tendency of the science is to become more and more closely assimilated to biology in its methods and explanatory hypotheses, its most marked characteristic at present is a certain distrust of the adequacy of the principle of natural selection to explain the facts, and a greater faith in physical, chemical, and physiological explanations. It shows an equal distrust for finalistic, and, in particular, anthropomorphic views, and is more ready to form its own scientific conceptions and seek the explanation of the more fundamental facts of human behaviour in them than conversely. Its scientific independence is well symbolised by the appearance in America, at the beginning of last year, of a new journal, *The Journal of Animal Behavior*, which is issued bi-monthly, and contains excellent and extremely interesting articles upon the modes of behaviour and (perhaps) consciousness of various kinds of animals. A very complex and efficient technique has been developed, which contrasts with the anecdotal method of the English school of the last generation almost as pronouncedly as do modern chemical methods with those of the mediæval alchemists. One must hasten to add, however, that the well-known works of Prof. Lloyd Morgan form an honourable exception to this method, and are, of course, exempt from the criticism.

In the case of the psychology of vertebrates, it is to Prof. E. L. Thorndike, of Columbia University, that the great credit is due of inaugurating the new methods of research and indicating those modes of experimentation which have met with such signal success at the hands of himself and his successors. The book on "Animal Intelligence" which he has just published is a reprint of four experimental studies already well known to the specialist, viz. "Animal Intelligence; an Experimental Study of the Associative Process in Animals" (first published in 1898), "The Instinctive Reactions of Young Chicks" (1899), "A Note on the Psychology of Fishes" (1899), and "The Mental Life of Monkeys" (1901), together with an interesting introductory chapter on "The Study of Consciousness and the Study of Behaviour," and two concluding chapters, also of a general character, headed "Laws and Hypotheses of Behaviour" and "The Evolution of the Human Intellect" respectively.

It will at once be seen how important the volume is. We have here a compact and well-arranged statement of the views of a classical investigator, alive with the enthusiasm of their first production, and amplified by the maturer judgment of their author. No better book could be put into the hands of the intending research student, or even of the general student of psychology interested in the bearings of the results of experimental animal psychology upon psychology at large.

Thorndike's first research is the well-known one upon the learning-powers of cats, dogs, and chicken, as the result of which he was led to the conclusion that animals at this stage of evolution make little or no use of free ideas in solving the problem of a new situation, if indeed they possess such ideas at all. Hungry cats and dogs shut up in cages, the doors of which can be opened by the manipulation of more or less complex mechanisms of levers, bolts, and buttons which enable them to get at food placed just outside, learn to escape by the method of "trial and error," and by that alone, as is shown by the *gradual* descent of the curves representing the times taken to escape in successive experiments. The resultant pleasure of eating the food upon escape tends to "stamp in" the immediately preceding association of the appearance of the interior of the cage with the impulse and experienced muscular movements involved in working the releasing mechanism. On the other hand, the pain of failure tends to "stamp out" the corresponding misleading impulses, and to prevent their association with the appearance of the box's interior. This is Thorndike's "sense-impulse" theory of learning, which he finds also to apply in the case of fishes and even of monkeys. With the latter the learning is more rapid, but of the same type.

Thorndike discovered no unambiguous evidence in his animals of the power of learning by imitation or by being put through the required movements, whence he concludes that ideas, even if present, are not used in solving such practical problems as he had devised. Some of his critics have stated or tacitly assumed that he denied the presence of ideas in his animals. This is an error. Others have suggested that he did not always succeed in gaining the attention of the animals to the matter in hand, again a criticism which is not justified, since much space is devoted in the memoirs to the discussion of this very point, and success in this is explicitly claimed. Even if later experiments have definitely proved that the power of learning by imitation is present, not only in monkeys, but also in some of the lower animals, and that in so lowly an animal as the frog (see September–October number of *The Journal of Animal Behavior*), "intelligence of a relatively high order" is indicated by the great rapidity with which certain habits may be formed, Thorndike's "trial and error" method remains, if not the exclusive, yet the predominant method of learning in all animals, including man himself.

The book is full of interesting discussions of minor points of psychology—there is, *e.g.*, a most convincing criticism in the "Laws and Hypotheses" chapter of the ordinarily accepted view of so-called "ideo-motor" action—but space does not permit of a consideration of these. Whole books have been written on Thorndike's work, and in a limited review like the present one cannot attempt to do more than summarily state a personal opinion. The book is a very valuable addition to "The Animal Behavior Series," of which it forms the third volume.

WILLIAM BROWN.

THE ASTROLABE À PRISME.

Description et Usage de l'Astrolabe à Prisme. By A. Claude and L. Driencourt. Pp. xxx+392. (Paris: Gauthier-Villars, 1910.) Price 15 francs.

DURING the experimental period of the *astrolabe à prisme* the authors have from time to time communicated various articles to several papers, in which they have described their apparatus generally and shown its practicability. But the experimental period is now assuredly passed, and this ingenious apparatus may be looked upon as part of a field equipment capable of giving results of the highest precision. Hence its description calls for fuller treatment, and certainly no other instrument was ever awarded a more satisfactory description and discussion than this one is in the volume before us. The work is a manual containing practically all there is to know about the *astrolabe à prisme,* its form, its advantages and defects, its adjustments, and the full treatment of the errors and observed values in securing the most dependable results from its use. It is characteristic of the book that its publication has been several times delayed because new modifications were introduced or new results secured.

MM. Claude and Driencourt were not the original proposers of such a device, for, as they point out in the introduction, the method involved was treated theoretically by Dr. Beck in No. 3102 of the *Astronomische Nachrichten*; but they were unaware of this when they commenced the work in 1903.

The principle involved is the determination of position by the method of equal altitudes, a method inherently good in theory, but somewhat out of repute among practical men by reason of the difficulties of manipulation attending the sextant. In the *astrolabe à prisme* of the present day—a far different instrument from that proposed by Dr. Beck, or those first designed by the present authors—these difficulties are eliminated, and portability, rigidity, and ease of manipulation are now actually features of the instrument.

After relating the history of the development of the apparatus in the introduction, the authors proceed to give a detailed description of the principle in chapter i.; this is no mere description, but is a very lucid and masterly discussion in which it would be difficult to find an omission. A discussion of the adjustments then follows, and we arrive at chapter ii. only to find that discussion and description are again necessary because M. Jobin, the constructor, has so greatly improved the instrument as a field apparatus that a chapter dealing specially with his forms became necessary.

Having learned the principle and construction of the *astrolabe à prisme,* we are next introduced (chapter iii.)

to the method of equal altitudes for the determination of latitude and time, and the application of this method to the particular forms of observation for which the instrument is suited. The problem of determining geographical longitude is treated in the fourth chapter, and forms a very pretty example of astronomical geometry.

The authors are not content with thus having given at length, yet tersely, the fullest instructions as to the principle, the construction, and the use of their admirable device; they now give complete directions as to the preparation of the observations, the preparation and use of tables in the reduction, graphical solutions, and special cases.

The second part of the book is eminently practical, in which actual operations are described, actual tables given, and values from actual observations are reproduced.

It will be seen that the manual is intended to leave no question in reference to the *astrolabe à prisme* unanswered, and the intention has been rigidly followed. For example, in any astronomical operation the question as to the ease with which accidental and instrumental errors may be isolated and eliminated is a crucial one, and to this question MM. Claude and Driencourt pay special attention. Possible, but not obvious, imperfections in the glass of the prism are, perhaps, the chief source of error; therefore they make the determination of the possible amount and action of this error a special feature.

As to the practicability of the method and apparatus, the book contains actual evidence in the observations of the difference of longitude Paris–Brest, and in those made by Lieutenant Mailles in delimitation of the Congo and the Cameroons. In both cases was the *astrolabe à prisme* employed, and in both cases were results of the highest precision secured.

The different types of instrument are well illustrated by diagrams and reproductions at the end of the book.

THE TEETH OF VERTEBRATES.

Vergleichende Anatomie des menschlichen Gebisses und der Zähne der Vertebraten. By Dr. P. de Terra. Pp. xiv+451+200 figures. (Jena: Gustav Fischer, 1911.) Price 12 marks.

TO write a comprehensive treatise on the teeth of vertebrates demands a familiarity with a very wide range of anatomical, zoological, and especially palæontological literature (the book under review contains a bibliography of about 3000 titles!), infinite patience to master and assimilate it, and industry to arrange and set forth so vast a material in orderly fashion. That this colossal task should have been accomplished with some measure of success by a dental surgeon reflects great credit upon the author of this book, Dr. Paul de Terra, of Zürich.

He describes his aim as an attempt to fill what has hitherto been a serious lacuna in German literature, namely, the lack of any book of the nature of the English classic, Tomes's "Manual of Dental Anatomy, Human and Comparative."

He has also endeavoured to supply the generally felt want of a detailed and systematic summary of the scattered literature embodying the results of recent research in odontology—a statement of the facts, and the theories put forward to explain them, in such a manner as to suggest the phylogenetic development of teeth.

Dr. de Terra is of opinion that the time has not yet arrived for compiling an adequate treatise upon the comparative anatomy of teeth, because many of the most fundamental problems relating to the interpretation of the arrangement, structure, and evolution of teeth are still in dispute. He has aimed, therefore, at presenting an impartial statement of all the facts and the views of different authorities, without committing himself to any one explanation. A good example of his mode of dealing with such disputed problems is seen in his non-committal statement (pp. 60–69) concerning the hypotheses of trituberculy and concrescence.

This attitude may perhaps commend itself to the expert reader and be useful to the teacher, who wants a detailed statement of the evidence for and against a particular view; but we think the student has a right to expect from the author of a treatise, who presumably has a much more intimate acquaintance with the evidence than even his writings reveal, some guidance in picking his steps amidst the tangle of conflicting views.

This book is really an encyclopædia of dental anatomy: it deals in great detail with the comparative anatomy of teeth, jaws, and skull, their minute structure, their developmental history, and the discussions that have sprung from attempts to interpret the significance of their form and arrangement. It consists of an introduction, in which such general questions as nomenclature, general embryology, and zoological classification are discussed, and three sections, dealing respectively with (1) the comparative anatomy of the skull and buccal cavity in the Vertebrata; (2) the nature, composition, structure, and significance of teeth; and (3) a detailed systematic account of the teeth in all the vertebrate groups.

The colossal bibliography is well classified; but it includes a number of references to small handbooks on general anatomy, zoology, and embryology which might have been omitted with advantage. Moreover, one may search in vain in this list of literature for many of the most important memoirs on strictly dental anatomy that the last decade has produced. Osborn's important treatise on mammalian teeth is a case in point. Andrews's monograph on the evolution of the teeth in the Proboscidea, which is not mentioned, is perhaps of more importance than the whole of the fifty-six works quoted in reference to this subject.

There are also some curious groupings of mammals: the Sirenia and Cetacea are included in one order (Cetomorpha) and the Hyracoidea are included in the order Proboscidea!

No doubt it would be easy for the specialist to find fault with much of the detail in a compilation such as this. But the book will serve a very useful purpose as a work of reference; and the majority of those who will have occasion to consult it are not likely to be led astray by its inaccuracies or omissions.

G. E. S.

BASIC OPEN-HEARTH STEEL-MAKING.

The Basic Open-hearth Steel Process. By Carl Dichmann. Translated and edited by Alleyne Reynolds. Pp. xii+334. (London: Constable and Co., Ltd., 1911.) Price 10*s*. 6*d*. net.

NEARLY half this work is an elaborate chemical treatise on gas-producer practice, and the next ninety pages deal with the chemistry of slag-making and the heat equivalents of the oxidisable constituents charged into the furnace. The remaining portion treats of the various basic methods adopted, from the scrap and carbon to the ore and molten pig-iron processes.

Judging from the tables on German practice the author has been very fortunate in having to deal with pig-irons only slightly inferior in quality to our ordinary hematite varieties, instead of the varied classes of basic pig-iron available in this country; hence the large outputs obtained. Tables on pp. 190, 191, 216, 271, 277, 281, 284, 287, 292, show the character of the practice quoted, which is mainly washing metal and running down to the mildest steel; hence the method of sampling the bath mentioned on p. 230, and the tapping of the bath by the judgment of a sample breaker, even if successful under the very favourable conditions assumed, is entirely unsatisfactory where the sulphur and phosphorus contents are so different, these factors necessitating rapid chemical analysis combined with the malleability test made by subjecting a sample to forging. When the metal in the bath has passed the required malleability test, an addition of ferro-manganese is made to the bath, and, after allowing it time to settle down again, the heat is tapped.

This German and American type of practice with comparatively low phosphorus irons is entirely unsatisfactory with English pig-irons, a return of phosphorus to the metal being the general result, when the phosphoric acid in the slag exceeds 5 per cent. and the silica is fairly high. Additions of hematite pig-iron, containing over 1½ per cent. of silicon or of silico-spiegel, give similar uncertain results. As a consequence the addition of ferro-manganese and other alloys for special steels is made in the ladle, great care being taken that the last of the additions is added well before the slag comes. The percentage loss of manganese in the furnace or in the ladle is given at 40, as per H. H. Campbell's acid practice. This is a mistaken idea as regards ladle practice, as advantage is taken of this even in the acid process to save ferro-manganese, whilst in basic work, with slags low in iron oxide, the loss of manganese is very small with 0·05 per cent. of phosphorus in the metal; about 15 per cent. when the phosphorus is between 0·025 and 0·045 per cent.; and may reach 35 per cent. when the metal has been taken down to 0·01 per cent. phosphorus with 0·07 to 0·12 per cent. of carbon.

The paragraph on recarburisation on p. 239 is very interesting. With skill and experience it is possible with regularity to "catch the carbon" that is to work the process, so that the bath is in a suitable condition for tapping when the desired carbon percentage is reached, instead of running down to a dead mild or almost carbonless bath and then recarburising. The difficulty spoken of in the molten pig and ore process, the impossibility of regulating the slags so as to stop at the desired carbon content, is due to the ore charged having a curious action of its own, a sudden drop of 0·30 to 0·40 per cent. of carbon in the sample in a few minutes even if the slag is practically ore-free. This action is very noticeable when a tapping temperature is attained. If the slag is not in a fit condition for tapping when the required carbon has been reached, it is not good practice to add large quantities of low-silicon hematite or spiegel to increase the carbon. It is much better and more economical to go down for a lower carbon.

The removal of sulphur, that bugbear of the basic steel melter, is discussed on pp. 167–171, and dismissed with the conclusion that it is more profitable to take care that sulphurous materials are not charged into the furnace. This is what everyone would do if he could always get nearly sulphur-free materials to use, but much of the English basic material some of us have to use contains 0·08 and occasionally even up to 0·3 per cent. of sulphur; hence one may easily with such material have 0·2 per cent. of sulphur in the charge when melted. This can be quickly reduced by the combination of heat and lime whilst the carbon is above 0·3 per cent., the trouble with regard to desulphurisation coming when a charge melts out with a low carbon content (p. 194). The sulphur problem is intensified by the fact that materials averaging 0·03 per cent. of sulphur may be charged into a basic furnace and melt out at 0·1 per cent. sulphur even when melting rapidly, owing to sulphur being taken up from the gas when one had to use a coal containing more than 2·5 per cent. sulphur. It is very good work to finish with 0·05 per cent. sulphur in the ingot in such circumstances. Although there is not very much clear guidance on practical working, the book as a whole gives a large number of interesting calculations on matters connected with the reactions directly or indirectly bearing on the general working of the basic open-hearth steel process.

THE GEOLOGY OF NEW ZEALAND.

The Geology of New Zealand: an Introduction to the Historical, Structural, and Economic Geology. By Prof. J. Park. Pp. xx+488+xvi plates, 140 figures, 6 maps. (London: Whitcombe and Tombs, Ltd., 1910.) Price 10*s*. 6*d*. net.

THE geology of New Zealand is of exceptional variety and interest. The literature is very scattered, and the valuable reports published by the Geological Survey and Mines Department of New Zealand are often troublesome to those who are not well acquainted with New Zealand topography. Prof. James Park has therefore undertaken a most useful work in compiling a guide to the geology of the dominion; and his book will be an indispensable work of reference owing to its clear account of the stratigraphical and economic geology, the detailed bibliography of fifty-eight pages, and the many beautiful plates of New Zealand fossils. The book is well printed, and the new illustrations are all excellent; but a few of the old figures taken from the Survey reports, such as Fig. 72, might have been omitted as unworthy of place beside the new figures. Prof. Park's work not only shows what has been done, but directs attention to the problems which are still matters of vigorous controversy in New Zealand, and to various conclusions for which the evidence is still unconvincing.

The author is to be congratulated on many features of the stratigraphical classification adopted. Thus the Maitai series is now referred to the Carboniferous, a conclusion for which the evidence appears adequate, for the supposed Inoceramus, which led to the reference of the series to the Mesozoic, turns out to be an inorganic structure. The famous Cretaceo-Tertiary system of Hector has finally disappeared. It was based upon the commingling of fossils from two distinct horizons; and Prof. Park describes one of the beds to which some of these fossils were attributed as quite unfossiliferous. The volume includes a valuable note by Mr. F. Chapman on the correlation of the Oamaru series, which, with their Australian equivalents, he assigns to the Miocene. One may be excused for suspecting whether a stratigraphical difficulty in regard to the Kaihiku series is not due to another mixture of fossils.

Prof. Park's identification of the Maniototo series, the lowest part of the Manipouri system, as Cambrian appears to be the most doubtful point in his classification. The lithological characters of the Maniototo rocks are characteristically Archean, and though they are overlain by the graptolitic Kakanui series, which is Ordovician, far more convincing evidence than any yet forthcoming will be needed before the underlying gneisses can be safely accepted as Cambrian. The author is disposed to take a perhaps somewhat extreme view as to the range of the Pleistocene glaciation in New Zealand. His discussion and photographs of the well-known Taieri moraine give more satisfactory evidence of its glacial origin than any previously published. Prof. Park admits that the explanation of the Taieri moraine is still incomplete; that moraine is very far south and the evidence that glaciers reached sea-level further to the north is less satisfactory. He gives an interesting account of the glaciers and glacial deposits around the peaks of the North Island, and his account of the Tarawera eruption, with the exception of his recent paper in *The Geographical Journal*, is the best account of it yet written.

Prof. Park gives a very interesting account of the fault system of New Zealand, and admits the great influence faults have played on the existing geography of the country. He thus justifies the conclusions of Mackay, which were once so discredited in New Zealand. The account of the economic geology of New Zealand is of especial importance; but the author appears to be unnecessarily alarmist as to the approaching exhaustion of the world's stores of iron. "In two centuries or less," he says, "the battleships will be beaten into ploughshares and the ploughshare will be treasured by each family as a priceless heirloom." He makes the very sound proposal (p. 292) that some of the coalfields should be reserved for naval purposes; for since much of the power required on land can be derived from water, he holds that factories and domestic consumers should not be allowed to exhaust the fuel, which he thinks will always be indispensable for use at sea. Prof. Park makes no reference to the oilfields of New Zealand, to which prominent attention has recently been directed elsewhere.

J. W. G.

OUR BOOK SHELF.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1912. Edited by G. E. Brown. Pp. 1436. (London: Henry Green and Co., n.d.) Price 1*s*. 6*d*. net.

OUR readers are so familiar with this bulky but indispensable accessory to the photographic studio that the mere announcement of the new issue is enough to make them obtain their copy. With 1436 pages the book is a veritable mine of information, and not only is it now almost a standard book of reference, but it is instructive in a host of ways. This year the editor contributes a very valuable article on lantern-slide making, and as this subject is a very popular one to-day, it should find a great number of readers. No less instructive is the admirable way Mr. C. H. Hewitt tells us how both in- and out-door portraiture may be successfully accomplished without any special appliances, and with the ordinary camera and lens; the article is also well illustrated with eleven examples of specimen work.

The "Epitome of Progress," by the editor, is full of interesting material, hints, and dodges, and the method of obtaining the effect of a portrait having been taken in a high wind is a good illustration of the last mentioned. In the section devoted to the recent novelties in apparatus, the editor occupies about eighty pages, so numerous are the articles to which reference is made. "How to do it" is the title of the section which gives 120 hints in picture form. Each picture is a hint showing how to select a hand or stand camera, use a tripod, carry the camera on tour, copy drawings or pictures, &c. There is little doubt but that this section will be considerably enlarged in the next issue. Mention need only be made of the lists of formulæ, tables, miscellaneous information, &c., and other distinguishing features which go to make us this useful volume.

While the book contains numerous diagrams and other illustrations, we may perhaps direct special attention to the very excellent three-colour print by Willfried Deyhle, of Berlin, from a photograph by F. Leiber, entitled "Kongsbay on Spitzbergen," taken with a Zeiss-Tessar f/4·5, equivalent focus 5¼ inches. The book concludes with full indices of the text, the advertisers, and the goods advertised.

Alpine Plants of Europe, together with Cultural Hints. By H. S. Thompson. Pp. xvi+287. (London: G. Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., n.d.) Price 7*s*. 6*d*. net.

A VALID claim for originality is preferred by the author on the ground that this volume contains descriptions of plants from all ranges of the Alps, and it may be added, that a few species of extra-alpine habitat are included, as *Iberis gibraltaica*. The altitudinal signification of the work "Alpine" is also implied, so that for the most part the species noted find a congenial home at a higher elevation than 5000 feet. Inclusion of all the alpine species growing within the area has not been attempted; in fact, only nine species of Carex are included, and the list of grasses is limited to one species from each of eight characteristic genera. But for the more interesting alpine genera the list is nearly complete; thus, under Saxifraga about fifty species are described, and a few others are mentioned; this is very inclusive, although the species *Rudolphiana* and *Clusii* do not appear.

Most botanists are aware that Mr. Thompson has an intimate knowledge of the Alps and is familiar with many of the floral rarities; they will therefore be prepared to find the concise descriptions and useful critical notes that form a prominent feature in the book. Another subject on which Mr. Thompson is equally qualified to advise is the cultivation of alpine plants, and this aspect of the book, dealing with a popular hobby, is likely to attract so much attention that, contrary to the opinion expressed in the preface, one is inclined to say that it will be more sought after and used by the enthusiastic cultivator of alpines than by the ardent botanist who wishes to find and identify alpine species. The latter would in the first instance prefer a local flora that includes all the plants of the country; but subsequently he would find the present work most desirable for corroboration, critical determination, and comparison with allied species from other countries. There is a measure of inconsistency in the omission of generic descriptions for many genera, but this does not detract from a book which is primarily valuable for its expert and critical information. The three hundred coloured illustrations are on the whole accurate in the matter of form and colour. Certain general facts and the broad outlines of cultivation are discussed in three interesting introductory chapters.

Vocabulaire Forestier: Français—Allemand—Anglais. Par J. Gerschel, revu par W. R. Fisher. Cinquième édition, considérablement augmentée. Pp. vi+192. (Oxford: Clarendon Press, 1911.) Price 5*s*. net.

THIS is the fifth edition of a dictionary in French, German, and English of the technical terms which are usually met with in books on forestry in those languages. Compiled by Dr. Gerschel, late professor at the Nancy Forest School, the present edition was revised by the late Prof. W. R. Fisher, of Oxford, shortly before his death, and is now issued by the Clarendon Press. The book contains 192 closely printed pages, and is very useful, as it not only includes the technical terms peculiar to the art of forestry, but also most of the common terms of the sciences of botany, zoology, and geology, and, in addition, words pertaining to hunting and shooting. The German and French parts appear to be well done; but the English part requires to be thoroughly revised, as it contains many curious errors and omissions.

A good many words are doubtful or obsolete English, as "imp" used instead of "graft," "wood-apple tree" instead of "crab tree." "Virginian climber," p. 149, is commonly called "Virginia creeper," and "forest science," p. 149, should be "science of forestry."

Printer's errors are not uncommon, as, p. 20, "*Picea excelsa*, Hink," should read "Link"; p. 142, "*encelsa*" should read "*excelsa*"; p. 152, "*Liquidamber*" should read "*Liquidambar*"; and p. 175, "Scot's fir" should read "Scots fir." The statements made on p. 164 that the "durmast" is the "Turkey oak" and that "*Q. coccifera*" is the "scarlet oak" are erroneous. "Oseraie," p. 190, is not "willow culture," but "osier-bed."

An objectionable feature in the English part is the constant use of hyphens, where they are not usually employed, as "expectation-value," "coppice-with-standards," which are usually printed "expectation value," "coppice with standards."

It is to be hoped that in the next edition these obvious faults, which impair the value of this useful book, will be removed.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Edited by Sir John B. Tuke and Dr. James Ritchie. Vols. x. and xi. (Edinburgh: Oliver and Boyd, 1911.)

THESE two handsome volumes are evidence, if that were needed, of the activity of research in the laboratories of the Royal College of Physicians of Edinburgh. They are also a testimony to the valuable work which may be done by means of the funds of a private corporation, aided in this case by a grant from the Carnegie Trust. The papers (which have all appeared elsewhere) are divided into four groups, those appertaining to anatomy, pathology, pharmacology, and physiology. All appeal to the specialist, and it is not possible to select any for special comment.

Of some general interest is the dietary study of the five halls of residence for students in Edinburgh, by Miss J. D. Cameron. The average cost per man per day (exclusive of condiments and beverages) is 15·1 pence, of which 66 per cent. is expended on animal food. The waste varies considerably, from 2·4 to 7·0 per cent. of the total money spent on food, but is about one-half of that in the American studies of college residences.

Dr. Berry Hart discusses the nature and origin of the "free-martin"—an apparently sterile cow, co-twin with a potent bull—of which John Hunter described three specimens, the organs of which are preserved in the museum of the Royal College of Surgeons, London. It seems to be established that the free-martin, when the co-twin is a potent male, is a sterile male, and not a sterile female. 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.*]

January Meteor-showers, 1912.

THE following are the computed particulars of the meteor-showers which become due during nearly the first fortnight in January:—

Epoch 1912, January 4, 11h. 30m. (G.M.T.), twenty-first order of magnitude. Principal maximum, January 3, 2h. 55m.; secondary maxima, January 3, 9h. 50m., 13h. 40m., and January 4, 10h. 25m.

Epoch January 5, 10h., approximately ninth order of magnitude. Principal maximum, January 6, 4h. 10m.; secondary maximum, January 6, 15h. 35m.

Epoch January 7, 0h. 30m., thirteenth order of magnitude. Principal maximum, January 5, 18h. 20m.; secondary maxima, January 6, 9h. 40m., and 19h. 30m.

Epoch January 7, 6h. 30m., fifth order of magnitude. Principal maximum, January 6, 22h.; secondary maxima, January 5, 21h., and January 6, 15h. 45m.

Epoch January 8, 2h., approximately eighteenth order of magnitude. Principal maximum, January 8, 3h. 35m.; secondary maxima, January 9, 2h. 30m. and 20h. 40m.

The first few days of January are comparatively quiet, the greatest meteoric activity occurring during the period January 5–9. The Quadrantid epoch of January 4, which is not so strong as the corresponding epoch of 1911, has its principal maximum early on the afternoon of January 3, but the other maxima will probably furnish some bright meteors, notwithstanding the presence of a full moon.

Dublin, December 23, 1911. JOHN R. HENRY.

Microkinematography.

IN the article on "Microkinematography" in NATURE of December 14, 1911, there are one or two points which are expressed in a manner that may lead to misconception. Dealing with these as they occur, is it correct to describe the process as having been developed during the last few months? The method adopted by M. Comandon was described in *La Nature* so long ago as November, 1909, and reproductions of kinematograph films were used to illustrate the paper. In this country, too, Dr. Spitta has done and has exhibited numerous examples, and I believe I am right in stating that his work extends back to an even earlier date.

The method of illumination, which in any case is quite well known and in use in every well-appointed bacteriological laboratory to-day, is described as an application of the "ultramicroscope." This is incorrect. Illumination has clearly been effected by means of a paraboloidal or spherical surface dark-ground illuminator, and with this appliance any object, such as a bacterium or trypanosome, which is within the limits of the resolving power of the objective used, may be rendered visible.

In the ultramicroscope, much smaller objects than these are dealt with, but owing to the method of illumination the images obtained are not of necessity an indication of the size or form of the objects under observation. They appear as diffraction discs, which are visible or invisible, and vary in apparent size, according to the intensity of the source of light used.

In the case of certain colloids, for instance, it is possible to observe particles that approach molecular dimensions, and no ordinary method of dark-ground illumination could accomplish this.

Confusion of thought often arises from failure to appreciate that there is an important difference between the limits of visibility and of resolution in the microscope. The objects shown in the paper in question are well within the limits of resolving power of even a high-power dry objective, so that they are in no sense "ultramicroscopic." The term should only be applied in cases where the objects are in all dimensions beyond the limits of resolution of the best objectives, where special arrangements are necessary in setting up the object to ensure that only the particular layer under observation is illuminated, and where the source of light is of sufficient power to render visible isolated particles which are much smaller than the resolution limit. The subject is one on which much might be said, but it is clearly impossible to do more than indicate the line of argument.

Spirochaeta pallida is especially referred to, but even this is easily and perfectly shown under ordinary laboratory conditions by a dark-ground illuminator.

Is the statement literally true that "some thousands of successive photographs" are taken per minute? If so, then it appears to be necessary to give a much shorter exposure in the kinematograph than when taking instantaneous photographs of any of the subjects illustrated. Without wishing in any way to minimise the achievements described, it should be borne in mind that the main difficulty is the almost prohibitive cost. There are many photomicrographers who are competent to carry out such work and to overcome such technical difficulties as exist, but there are scarcely any who are able to face the great cost of the films. In the present case, the immense resources of Messrs. Pathé Frères have been placed at the disposal of the worker, so that this difficulty has not been experienced.

J. E. BARNARD.

King's College (University of London),
Strand, W.C., December 18, 1911.

IT may be admitted that the word ultramicroscope is misplaced, and its use may inadvertently cause some confusion, though the remarks which immediately follow should prevent any possible misconception as to the method employed. The large cost involved is, of course, a consideration of great importance to those actually concerned in the production of the films, but scarcely one to be insisted on in an article such as that under discussion.

THE WRITER OF THE ARTICLE.

UNIVERSITY EDUCATION IN LONDON.

WE published on June 15, 1911, an article giving some information as to the proceedings which led up to the appointment of the Royal Commission on University Education in London, and dealing with the second volume of evidence issued by the Commission. The third volume of evidence [Cd. 5528, price 3*s*. 8*d*.], recently issued, contains the evidence presented between November 10, 1910, and July 28, 1911. Much of this evidence is not of direct interest from the point of view of the promotion of science, dealing as it does with such matters as legal education, the position of individual colleges, and the relation of the University to secondary education, though the discussion of these questions is of importance as indicating the general form of organisation for the University which the Commission will propose, and which must in the future exercise a potent influence over scientific education in London and elsewhere. There are, however, two subjects of more immediate interest on which a good deal of new evidence is now published; first, the work and government of the Imperial College of Science and Technology at South Kensington, and its future relations to the University; and, secondly, the organisation of medical education in London. Each of these questions is extraordinarily complex, and might well engage the sole attention of a Royal Commission; and it will only be possible in a short article to indicate in a rough way the character of the evidence presented.

The witnesses for the Imperial College, who were heard on February 23, 1911, were Lord Crewe, the chairman of the governing body, Sir William White, Dr. R. T. Glazebrook, Mr. R. Kaye Gray, and Sir Alfred Keogh, and their evidence was based on the following resolution adopted by the governing body:—

> The Imperial College of Science and Technology having been established "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," the governing body is of opinion that, in order to attain the purposes contemplated—
>
> (i) The autonomy of the Imperial College should be maintained, and incorporation with the University of London should not take place; and
>
> (ii) Some means shall be found, either by the establishment of an independent department or faculty of technology or otherwise, by which students of the Imperial College of Science and Technology who satisfactorily complete the associateship courses of the college, and students duly qualified by research, advanced study, or in other approved ways, may obtain degrees without further examination.

Throughout their evidence the witnesses laid great stress on the importance of the higher, or post-graduate, work of the college, especially in its industrial aspects, and the action already taken by the governing body in developing this side of the work of the college was fully reported. With reference, however, to the basing of the claim for autonomy on this special characteristic of the work of the college, the witnesses were subjected to somewhat severe examination by Sir Robert Morant in regard to the obligation imposed on the governing body in the charter to carry on the work of the Royal College of Science and the Royal School of Mines, which has been in the past, and, as statistics published in the volume show, is at the present time mainly undergraduate—that is, of the standard required for the first degree of a university. In reply, it was contended that the governing body had power to modify the courses in these colleges; but Sir Robert Romer thought that the extent to which this power could be exercised under the present charter was one for a court of law.

"I doubt," he said, "if you could change it. You could not change its nature substantially. It is a question of substance. Minor modifications undoubtedly, but anything which would really change the nature of the school you have no power to do, and it would be changing the nature of it, if chiefly occupied with pre-graduate instruction—it would be a substantial alteration in my view—if you changed it into a post-graduate system of education" (Question 7840). To this Sir William White replied: "If it were considered desirable, on national grounds, to make the change, that would mean an alteration of the Charter."

This important question is discussed elsewhere in the evidence. Sir Arthur Rücker expressed himself as strongly opposed to the policy.

"If this policy were adopted at present," he said, "the institutions forming the Imperial College would be ruined financially. Then, again, it is more than doubtful if the ideal of having none but post-graduate students can be attained. The well-known case of Johns Hopkins University is in point. It started as a post-graduate institution, with the best professors that could be got, and it was a most successful institution, but some five or six years ago they had to give up their scheme, and the latest statistics I have looked at showed that about one-fourth of the college consisted of undergraduates, instead of being wholly post-graduate. I do not think that what, under the most favourable conditions, failed there is likely to succeed in London, and, if it does succeed, success cannot be attained for a very long time. We have already had something like 700 students; we are now spending just on a quarter of a million pounds on new buildings, and, putting it at a very low figure indeed, could very easily have 1000 students. If there were none but post-graduate students there, they would take up more room than the ordinary undergraduates, but if we say only 700, I think the ideal of having 700 post-graduate students in technological subjects concentrated in one institution in London is at present absolutely chimerical" (Question 9094).

While, however, the witnesses for the Imperial College maintained generally their claim to autonomy, they discussed in a not entirely unfriendly way the possibility of devising some faculty organisation in the University which would meet their special requirements. Such an organisation they regarded as a second-best alternative to the establishment of a distinct technological university, as to which, however, not much encouragement was forthcoming from the Commission. The chairman stated, early in the evidence, that "The Commission feel, that if it can be avoided, it is not desirable that there should be two bodies of university rank in the London area" (Question 7727), and this question was not further discussed.

In the evidence of Prof. M. J. M. Hill, then vice-chancellor, some interesting information is published, we believe for the first time, on the proposals put forward by the Senate of the University before the issue of the charter for the Imperial College, from which it appears that the Senate was prepared to consent to some alteration of its own constitution in the direction of increasing the representation of technical interests, and it advocated the government of the Science College and the Technical College by distinct committees.

With reference to the organisation of medical education in London, some very interesting evidence is published by Mr. Abraham Flexner, of the Carnegie Foundation of New York, Prof. Friedrich Müller, of Munich, Sir William Osler, and others. There appears to be general agreement as to the urgent need for the reorganisation of the London medical schools in order to promote in a more thorough way the scientific study of medicine. It was admitted by several witnesses that London students have exceptional advantages in the amount and variety of clinical material available in the hospitals, but the system under which the clinical teaching is almost entirely undertaken by physicians and surgeons whose time is very fully taken up in the practice of their profession was considered to be defective, though there was no strong feeling that even the principal teachers should be rigidly barred from professional work. The Continental and American systems of hospital clinics are described in detail, and the desirability of organising one or more of the London hospitals and medical schools on similar lines is considered, with reference both to the financial aspects of the question and the difficulties arising from vested interests. As, however, the medical evidence is not at present complete, it may be well to defer further consideration for the present.

The fourth report of the Commission [Cd. 6015] was published on December 23. This is substantially the first report, for it is the first document which has been issued in which the Commission gives expression to its corporate opinions. On the whole the report must be pronounced as reassuring, for it shows that the Commissioners have risen above petty and sectional jealousies, and have formed a high ideal of the University which London should possess. The Commissioners evidently wish the University to put its house in order in a physical sense as a preliminary to a scheme of reorganisation in an academic sense, for the report deals exclusively with the need for a permanent building for the University, "appropriate in design to its dignity and importance, adequate in extent, and specially constructed for its purposes, situated conveniently for the work it has to do, bearing its name, and under its own control."

The present building of the University at South Kensington is condemned for various reasons, in particular its situation, Government ownership, and inadequacy. In adumbrating the form of new building required and the purposes to which it is to be put, the Commission is forced to deal to some extent with vexed questions of policy, but it lays special stress on the need for a great hall and for suitable accommodation to promote the social interest of teachers, graduates, and students. Lecture halls and some library accommodation would be required, but the Commission defer any definite judgment on the policy which has been urged upon them from some quarters of providing a series of research laboratories in direct connection with the University.

The Commission, in the last paragraph of its report, appeals in eloquent terms to the generosity of benefactors in order that an endowment may be provided for a reconstituted University, and a new building may be available which would be a visible sign of its recognition and acceptance as a great public institution. "A great university is not self-supporting, and can never be so. As an institution for learning, in which liberal education, instruction in the methods of advancing knowledge in a wide range of subjects, and the highest professional training, are combined with large scope for the free exercise of thought and with full opportunity and encouragement for the systematic prosecution of research, it can never exist financially on the fees of its students." The report is dated December 15, 1911, and is signed by all the Commissioners.

LIQUID CRYSTALS.[1]

DURING the seven years that have elapsed since the publication, in 1904, of his previous book, entitled "Flüssige Kristalle," Prof. Lehmann has in no way abated his energy, and has poured out a constant stream of papers giving the results of, and the deductions from, further observations, so that another or at least a supplementary work is already called for. Prof. Lehmann decided to write an entirely new book, which, being complete in itself, would readily enable any reader interested in the subject to learn what has been done in it and what is the present situation. The subject is not easily understood, and most of the experiments upon which it is founded cannot be performed without special apparatus. It has so far received scanty attention in this country, and its extreme importance is perhaps not fully realised. Outside Germany Prof. Lehmann has given demonstrations before the Mineralogisch-Petrographische Gesellschaft in Vienna, and the Société Française de Physique in Paris; may we not hope that some society in this country will be sufficiently enterprising to induce Prof. Lehmann to give a similar demonstration in London? No one who has witnessed these beautiful phenomena can fail to agree in the main with Prof. Lehmann's conclusions; to see is to believe, and, as Prof. Lehmann says (p. 5), "jeder, welcher Gelegenheit hatte die Versuche zu sehen, sich davon überzeugte, die Erscheinungen könnten unmöglich anders gedeutet werden."

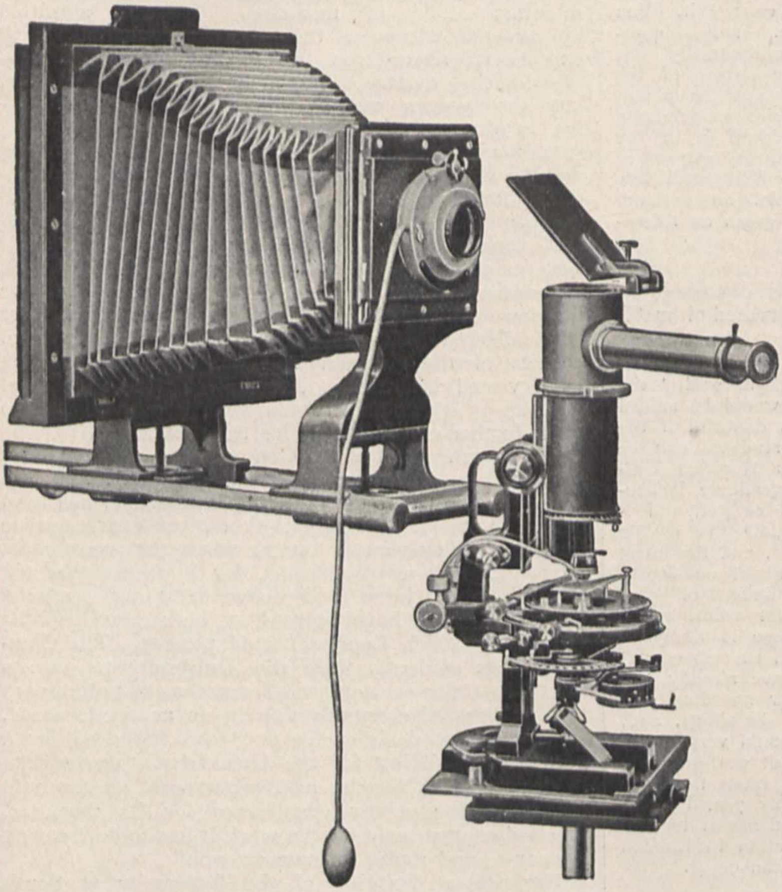


FIG. 1.—Crystallisation-microscope with camera attachment.

The tendency during the past forty or fifty years was for active workers in science to become specialists, *i.e.* to confine their attention wholly to one or two small compartments, and to pay little or no heed to what is being done by others in contiguous compartments; the most striking feature, on the other hand, of recent development of science is the revelation it has afforded of the true interdependence subsisting between the so-called branches of it. This is eminently true of crystallography; for long regarded only in its general aspect as an adjunct of physics and in its specific aspect of mineralogy, it is already recognised as of considerable importance to the chemist and petrologist, and now Prof. Lehmann tells us that crystals are potent factors in the processes of life, and therefore that they form a subject with which biologists should be cognisant.

The field of research into which Prof. Lehmann struck out nearly forty years ago was then so utterly unknown and yielded such amazing results that it is no matter for surprise if his early reports were received with the scepticism usually accorded to travellers' tales. His observations were set down as optical illusions, and his conclusions vigorously combated, but the passage of time has gradually brought about a change, and at the present day most of those who have given any serious study to the subject are in general agreement with him; for instance, Prof. Wallerant, the eminent French crystallographer, has remarked, "La découverte de M. Lehmann est certainement une des plus importantes du siècle dernier; ses conséquences sont nombreuses et de premier ordre

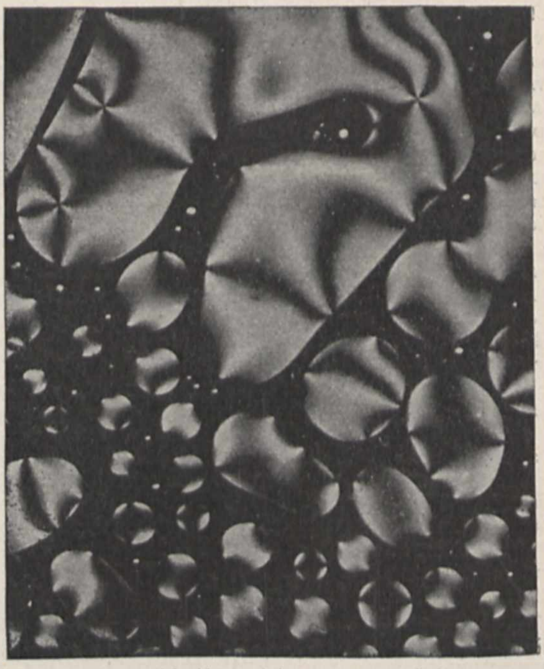


FIG. 2.—Liquid crystals between crossed nicols.

[1] "Die neue Welt der flüssigen Kristalle und deren Bedeutung für Physik, Chemie, Technik und Biologie." By Dr. O. Lehmann. Pp. vii+388. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1911.) Price 12 marks.

et elles permettent en particulier de préciser nos connaisances sur la structure des corps cristallisés." The change is not without its drawbacks; Prof. Lehmann finds complacent acceptance more irritating than ignorant scepticism, and complains (p. 5), "In neuester Zeit machen sich sogar Stimmen geltend, die glauben machen wollen, es handle sich um eine längst bekannte Sache, die ganz selbstverständlich sei."

We discussed the scope of Prof. Lehmann's researches two years ago (1909, vol. lxxix., p. 286), and need not traverse the same ground again. The present volume is naturally more coherent and easier to read and digest than a series of isolated papers published in various journals, and it may be commended to all who would fain learn of a remarkable subject. In chapter x. the author gives, with illustrations, descriptions of the various forms of the crystallisation-microscope, the invention of which rendered his researches possible. The principal conclusions arrived at may be summed up briefly. The old idea of a crystal as necessarily a rigid body bounded by plane faces must be definitely abandoned, as the author says (p. 149), "Demnach gehört auch die Bildung in ebenflächiger Form nicht unbedingt zu dem Kristallbegriff." Crystals may, indeed, be solid and rigid, and liquid and mobile, and there is no break in the transition from one sort to the other. The ultimate particles are invariably anisotropic. Isotropic crystals result from the neutralisation of the action of the particles by their mutual arrangement, which is regular; amorphous substances, on the other hand, are isotropic because their arrangement is irregular. Prof. Lehmann points out (p. 194), "Dass regulär Kristalle durch Zug und Druck doppelbrechende werden, ist veilleicht teilweise darauf zurückzuführen, dass sie anisotropen Molekülen bestehen, welche verdreht gegeneinander angeordnet sind, so dass keine Richtung bevorzugt wird." We are left therefore with, as the fundamental character of a crystal, its power under suitable conditions to grow; it is thereby sharply differentiated from an amorphous mass, which cannot in any circumstances grow. It is this important character which has led Prof. Lehmann to believe that crystals are the agents in the growth of living organisms. The curious and beautiful silicate-vegetation affords an instance of growth of purely unorganised matter. The close similarity in behaviour and appearance between certain kinds of crystals and bacteria has often been remarked, and cannot be dismissed as accidental.

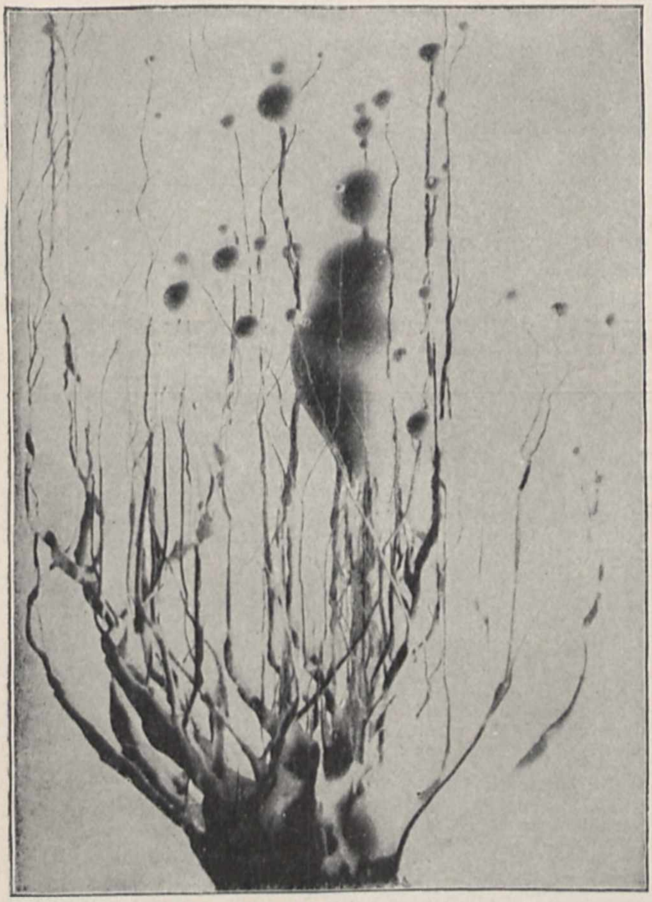


FIG. 3.—Silicate-vegetation.

Prof. Lehmann gives us a lucid exposition of the subject which has constituted his life's work and has been developed almost solely by himself, and the reasoning is rendered easier to follow by the aid of numerous excellent illustrations, three of which we are permitted to reproduce here. An index, which might perhaps have been fuller, is provided. The printing and the paper used are both good.

THE TIDAL SURVEY OF JAPAN.

IN the Journal of the College of Science of Tokyo for April, 1911 (vol. xxviii., article 7), Prof. Hirayama publishes results derived from tidal observations made during the last sixteen years at fourteen places distributed round the coasts of Japan and Formosa. The tide-stations were administered by the Land Survey, but the reductions are in the department of the geodetic committee, of which Prof. Terao is president.

The sites of the observatories have been carefully chosen so as to give good representations of the tides in the neighbouring seas, and twelve of the stations are permanent establishments, while two are temporary. Samples are given of the tide-curves recorded at nearly all the stations, and it is clear that perturbation due to seiches has been slight. Many of the observatories are at somewhat inaccessible places, and therefore the clocks of the gauges were regulated by the aid of a simple form of sundial. The gauges themselves were for the most part of Lord Kelvin's pattern, and have been found very satisfactory. The paper shows that the work has been carried on with Japanese thoroughness.

In the office of the United States Coast Survey a number of stencil plates pierced by holes are laid successively on the tabulated hourly values of the heights of the water, and the numbers which are visible through the holes are those which are to be added together to form the sums required to furnish the data for harmonic analysis. The late Dr. Börgen attained the same end by means of sheets of tracing paper laid on the tabulated values which indicate by zigzag lines the columns for addition. Prof. Hirayama tried both these plans, but he finally concluded that the use of my tidal abacus[1] was the most convenient method, and it alone was used. The work involved in treating the observations at the fourteen stations must have been enormously laborious, as no fewer than sixty-six years of observation have been reduced.

I have not tried to make a minute examination of

[1] Proc. Roy. Soc., vol, lii. (1892), p. 345, or "Scientific Papers," vol. i. p. 216.

the harmonic constants tabulated, but the following are some conclusions which may be drawn.

On the Pacific coast the diurnal and semi-diurnal tides are both nearly "inverted," and the tide-wave reaches the north-easterly parts of the islands somewhat earlier than the south-westerly coasts. The diurnal inequality is large. The Japanese Sea is almost a lake, and it is natural that the range of tide on the western coast should be much less than on the east; it is, in fact, only about one-seventh as great. But the phases of the tides are puzzling, for it is diurnal high-water almost simultaneously throughout the Japanese Sea at the same time that it is diurnal low-water on the Pacific coast, and the diurnal amplitudes are not very different throughout. On the other hand, the semi-diurnal phases on the west are so diverse that it is not easy to interpret their meanings, and there is some diminution of amplitude to the north. If the Straits of Korea are wide enough to admit the diurnal wave so freely, why is the semi-diurnal tide so much broken up? These questions deserve more attention than I am able to give to them.

It seems a pity that in the tables of harmonic constants the heights should be given to one-tenth of a millimetre, and the phases to the hundredth of a degree, for this degree of accuracy is quite fictitious, as may be seen by a comparison of the values at any port for successive years. It may be well also to direct attention to the values of the phases assigned to the tides M_2 and O for the port of Tonoura for the year 1895. There must be a mistake, because for that year they are entered as being almost 180° different from the values for all the successive years. There is no misprint, because the suspicious numbers have been used in forming the mean values of M_2 and O. It is clear from the values assigned to these tides at other ports that 1895 was not an abnormal year—and indeed such an amount of abnormality would have been nearly incredible. No doubt the source of error will easily be discovered.

The tidal constants round the Japanese coasts have now been accurately determined, and Prof. Hirayama deserves warm acknowledgment for the care which he has bestowed on his laborious and useful task. G. H. DARWIN.

FISH PHOTOGRAPHY.[1]

DR. WARD'S book consists really of a fine series of photographs illustrated by a rather inadequate text. Considerable trouble has been taken by the author to represent British marine and fresh-water fishes as they would be seen by a human observer placed in much the same conditions as the fishes themselves. Many, for instance, were taken from an observation chamber built below the surface of water in a shallow pond, and others have been made from fishes living in tanks, lighted in various ways. The author gives a good account of these methods, which may be of assistance to those engaged in original work. The book also includes a number of microphotographs of eggs and larvæ of both fresh-water and marine fishes, and some of these are novel.

The author tells us, in his introduction, that he has endeavoured to show how fishes disclose their mental states in their attitudes and colour changes. The psychology of the pike and perch—contemplation, mental agitation, the rigidity of excitement, doubt, disappointment, disgust, alarm, &c.—are revealed (to Dr. Ward, at all events) by these attitudes. The interpretations may well be doubted, but the photographs themselves are interesting and beautiful. The author is more successful in his illustration of concealment-devices. Thayer's principle of counter or obliterative shading is extended to fishes. The darkening of the dorsal, and the lightening of the ventral surface produce, in a fish lit from above, a flat, ghost-like effect, well shown in the photograph of the dace on p. 26. The fusion of colour patterns with that of the background is illustrated by fine photographs of lemon sole and thornback ray lying on the sea bottom. A further device, imperfectly elaborated by the author, is the concealing effect of the reflection of light from silvery fishes, and the similar effect of the confusion of the iridescence of

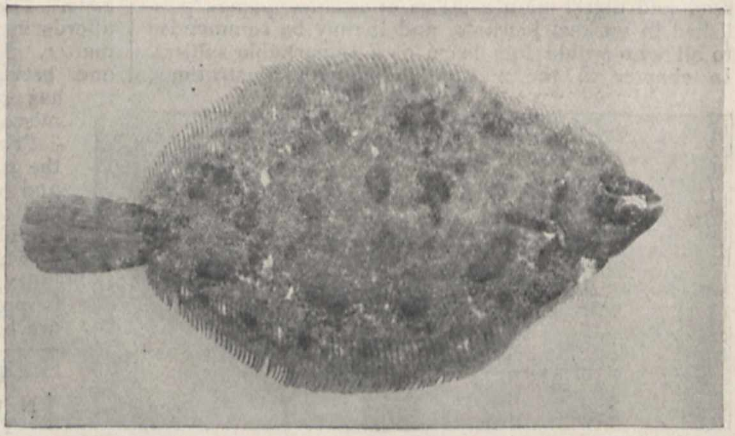


FIG. 1.—Lemon Sole seen against a white background. From "Marvels of Fish Life."

FIG. 2.—The same fish in natural surroundings. From "Marvels of Fish Life."

[1] "Marvels of Fish Life as Revealed by the Camera." By Dr. F. Ward. Pp. xiv+196+plates. (London: Cassell and Co., Ltd., 1911.) Price 6s.

such fishes as the mackerel and herring with the shimmering produced by light transmitted through a water surface broken by waves.

Many of the photographs of the eggs and young stages of fishes are very well done; we may direct particular attention to the series representing the hatching of the salmon egg, on p. 50; those illustrating the early stages of the roach on pp. 104–5, and the series taken at Port Erin Hatchery, which represents the larval metamorphosis of the plaice. All these are probably better than any hitherto published.

The defects of the book are in the text, which is sketchy and slight, and is not free from errors. The author evidently confuses the eel and lamprey on p. 126, for he speaks of the former fish as possessing several gill openings behind the pectoral fins. Haddocks (p. 129) are said generally to feed on herring eggs—certainly an exceptional habit. Skates, rays, and dogfishes are said to eat oysters (p. 150)—one would like to know where these observations were made. The starfish is also described as protruding its stomach and engulfing an oyster (p. 150)—surely this is impossible! Floating fish eggs are said to occur throughout the year (p. 109). The photograph opposite p. 190 is described as that of a shrimp. Evidently it represents a shank (Pandalus).

J. J.

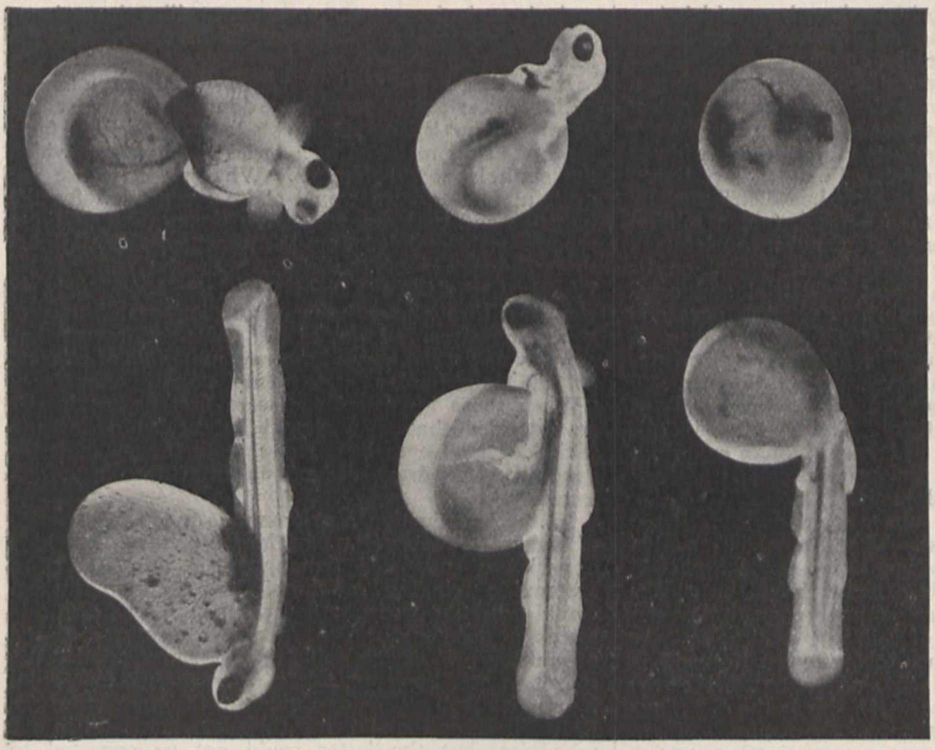


FIG. 3.—Hatching of the Salmon. From "Marvels of Fish Life."

FRANCE AND THE ENDOWMENT OF RESEARCH.

THE French intellect is proverbially clear. The quality implies foresight, no less than insight, and it is revealed in practical politics, no less than in scientific theory. It is also the characteristic of French statesmanship as well as of French thought. Nowhere is this *clairvoyante volonté* of a nation more practically demonstrated than in the attitude of the State to science, and in the relations between the spheres of government and of knowledge.

France recognises clearly the fact that a nation depends on its science; that its commerce, its industries, its education, all its sources of wealth and of character, are to be found alone in a living and growing material of experimental knowledge. And the nation translates this recognition into will.

In the *Revue Scientifique* of September 23 there is an article by M. A. de Foville, permanent secretary of the French Academy of Moral and Political Sciences, which may well stir envy in an English mind, and prove once more that they manage these things so much better in France. M. de Foville gives a sketch of the Government department known as the "Caisse des recherches scientifiques," which was instituted in 1901, and now celebrates its decennial anniversary merely by modestly directing the attention of capitalists to its existence. The Caisse owes its institution to M. Audiffred, now a member of the Senate; its object, to quote his words, is "to endow all the sciences with adequate means; to ensure that no serious investigator shall be hindered in his work by lack of the funds necessary for research." It is attached to the Ministry of Public Instruction, but is actually autonomous. It is not, as M. de Foville observes, a charitable institution, but a State Treasury for scientific research. It has a very strong technical committee, which decides upon the applications sent in, and sends its recommendations to the administrative committee. The latest volume of specifications and results of researches financed by the Caisse contains 800 pages. The researches financed or assisted hitherto are distinguished by their eminently social and racial importance, being chiefly concerned with the purification of water supplies, and the methods of combating tuberculosis, syphilis, and other scourges.

The following grants were made in 1910:—1200*l.* to Dr. Calmette; 600*l.* to M. Riolle, for researches into the purification of water supplies; 420*l.* to the late Prof. Arloing, for researches into the prophylaxis of tuberculosis; 400*l.* to Dr. Calmette, for the same purpose; 120*l.* to Prof. Courmont, for studying the prevention of cancer; 120*l.* to M. Gaston, the prophylaxis of syphilis; 120*l.* to Prof. Gley, immunity against toxic serums. Besides these sums, nearly 5000*l.* was allotted to various researches, the total being nearly 8000*l.*, distributed thus:—Biological research, 4692*l.*; water supplies, 2460*l.*; other research, 480*l.*

This Government bureau is not managed by "permanent officials"; its council, consisting of well-known men of science, heads of industrial and commercial firms, and some politicians, is honorary. The expenses of the department in 1910 were exactly 190*l.*! This last detail is one of the most instructive facts in the whole business.

The receipts of the Caisse in 1910 amounted to 18,000*l.* Its income is derived thus: the greater portion is allotted annually by the State from the State revenue as part of the National Budget; this averages about 8000*l.* Investments of capital bring in an increasing sum. Lastly, there are bequests, subscriptions, and gifts, from corporate bodies, societies, and individuals. This last source naturally fluctuates. In its ten years' history the Caisse has distributed 56,000*l.*, of which 36,000*l.* was allotted to biological researches, and 16,000*l.* to investigations and experiments connected with the purification of water supplies.

M. de Foville points out that the financial needs of science increase with the scale of scientific operations and with progress generally, and recommends the Caisse as a channel for private donations which has the advantage of imposing no restrictions or death-duties on bequests made to its funds.

France is also to be congratulated on possessing a society, *de Secours des Amis des Sciences*, the object of which is to aid men of science and inventors who are in material difficulties, and to relieve their widows and children from destitution. Founded by Baron L. J. Thenard in 1857, the society has distributed up to the present time more than 95,000*l.* (not a million pounds, as the *Athenaeum* of October 14 states). Prof. G. Darboux makes an eloquent appeal on its behalf to those who, like great industrial and commercial capitalists, owe so much to science, pure and applied. He points out that as the number of engineers, chemists, naturalists, biologists, and inventors increases, the risks increase proportionally, and the numbers, both of martyrs of science and of victims of *la misère*, with them. Charity of this kind, to those who have assisted to *prevent* human suffering, is, as the founder of the society remarked, "a work of reparation and of social justice."

England has only the precarious and arbitrary awards of the Civil List. The French charitable society is a complementary institution to its State aid of research. In it there is a channel for the charitable impulse, more humane and more patriotic than many of the usual forms of relief of destitution. As for the Caisse des recherches scientifiques, France has practically instituted (and the institution will grow) the Establishment of Science. In this is the Erastianism, and a sound Erastianism, of the future.

A. E. CRAWLEY.

FACTS OF MIGRATION.[1]

FOR learned and unlearned alike there is a peculiar fascination in the migrational movements of birds, and the more we know about them the more the wonder grows. The problems now clearly discerned will probably afford material for several centuries of inquiry, and there are others which we have not yet learned to state. In all such cases it seems to be in accordance with sound scientific method that we should tackle the more tangible problems first, that we should accumulate facts on all sides, and that we should pursue different paths of inquiry in the hope that their convergence may lead us to discovery. That we should occasionally relieve tension by flying a speculative kite will do no harm to anyone.

Of the various paths of inquiry three stand out prominently, and as each is not only theoretically reasonable, but has already led to something definite, it is gratuitous to pit one against another when more than all are needed. First, there is the method of registering the arrivals and departures, the changes and movements, in a small area, like Helgoland or Fair Island, which can be thoroughly explored. Second, there is the method of marking large numbers of migrants with indexed aluminium rings, in the hope of hearing again of the whereabouts of a small percentage. How this method has already led to the marking out of a more than provisional migrational-route for the white stork is well known. Third, there is the method of collecting data, year after year, from observers scattered over a wide area, both inland and on lighthouses and lightships, who record times of arrival and departure, great wave-like incursions, marked increase and decrease in numbers, and the like.

It is this third method which has been followed with praiseworthy persistence during the past six years by the British Ornithologists' Club, the facts reached being recorded in a series of reports, of which the sixth is now before us. What we have we are grateful for, and we would claim recognition for the industry and patience which the preparation of these reports has demanded from the members of the Migration Committee of the club, from the editor, Mr. W. R. Ogilvie-Grant, and from the large body of observers throughout the country. It is no disparagement, however, to point out that the report has scarcely as yet got beyond the raw materials of science. As the introduction states emphatically enough:—"When these investigations were first undertaken it was decided that they should be carried on over a period of ten years before any attempt was made to generalise, or draw deductions from the facts collected."

In the introduction a reference is made to a notice of last year's report (NATURE, March 9, 1910), in which a reviewer suggested (among other things) that a systematic "ringing" of the birds at the light stations would probably produce good results. To us also this seems a good suggestion, and the members of the committee are theoretically of the same mind. We regret to see, however, that they regard it as "quite impracticable." "We owe much to the courtesy of the Elder Brethren for allowing their keepers to fill in our schedules, but the latter could not be expected to 'ring' birds, nor is it to be expected that the authorities would allow unofficial observers to remain at the lights during the migration-season." We wonder, however, whether the difficulties are insurmountable. If so, it is a great pity. The lights are strategic points, the number of birds that might be "ringed" is often large, and a little "ringing" might save some of the keepers from life-harming heaviness.

The arrival of our summer migrants began in 1910 on March 5 (with the chiffchaff), but it proceeded slowly through that somewhat exceptionally fine month. Except in the case of a few species, the immigration did not begin until April 2, and continued until May 23. After that there was little movement observed, but a few species were unusually late (most of May was cold, inclement, and wet). The main body of spotted flycatchers did not arrive until June, and in some places sedge-warblers had not reached their breeding haunts by May 13. It will be very interesting to compare the data for 1910 with those for the extraordinarily fine summer of 1911, and it

[1] Bulletin of the British Ornithological Club, edited by W. R. Ogilvie-Grant. Vol. xxviii. Report on the immigration of summer residents in the spring of 1910: and also notes on the migratory movements and records received from lighthouses and light vessels during the autumn of 1909. By the Committee appointed by the British Ornithologists' Club. August, 1911. Pp. 313. Many maps. (London: Witherby and Co.) Price 6*s.*

may be that the final comparison of year with year will furnish a basis for conclusions which will justify the details and labour of these reports.

"The larger waves of migration were not very clearly marked, but there were smaller ones on April 12 and 13, and on May 15. The largest movement occurred on May 2, when no less than twenty-five species arrived simultaneously on our coasts." If these facts are really significant, we naturally wish to see whether they are correlated with weather conditions, and the report, like its predecessors, gives us facilities for speculation on this subject by giving a meteorological summary for each day. Special attention has been paid to the conditions observed over the north coast of Spain, the Bay of Biscay, the coast of France, bounding the Bay, the English Channel, and our southern shores. But the report remains firm in affording us neither countenance nor aid in this speculation. We must wait until the ten years are accomplished before there is any relaxation in the conspiracy of silence, which is a thoroughly scientific procedure.

In saying a moment ago, "if these facts are significant," we were not indulging in a superiority of tone begotten of our own enlightenment on the subject; we simply mean that in the long run the question must be faced whether the net of observation is spread sufficiently widely, and has mesh sufficiently narrow to warrant one in speaking very definitely of waves of different magnitudes, or, in some cases, of waves at all. It is difficult to get rid of the uncomfortable suspicion that what is recorded may be in many cases the exceptional, the normal passing unobserved because there is no one there to see. We wish, therefore, that a large addition to the body of observers throughout England could be secured, so that it might be seen whether a marked narrowing of the mesh is followed by any marked alteration in the general tenor of the records. It may also be that the detailed comparison of one year with another may afford an answer to our difficulty.

There are some interesting remarks in the introduction on the variable length of the immigration period. "The immigration of the wheatear (including both races) extended over a longer period than that taken by any other species, the first arrivals being observed on March 6, the last on May 19. Other species occupying a prolonged period were the willow-warbler (March 19 to May 19) and the whinchat (March 26 to May 23), while the shortest time seems to have been taken by the wood-warbler (April 11 to May 6). The average length of the arrival period for 1910 was about five or six weeks."

We may refer also to the provisional classification of the birds observed into four sets according to their general routes. (*a*) There are those that arrive *solely* on the western half of the south coast—ring-ouzel, pied-flycatcher, and landrail; (*b*) there are those that arrive along the *whole* of the south coast, but first and chiefly on its western half—wheatear, redstart, common whitethroat, garden-warbler, chiffchaff, willow-warbler, spotted flycatcher, swallow, house-martin, sand-martin, and swift; (*c*) there are those that arrive along the *whole* of the south coast, but first and chiefly on its eastern half—whinchat, blackcap, grasshopper-warbler, reed-warbler, nightjar, cuckoo; (*d*) there are those that arrive along the south-east coast, from Essex to Hampshire—nightingale, white wagtail, yellow wagtail, tree-pipit, red-backed shrike, wryneck, turtle-dove. This grouping is still, as we have said, provisional; but there is in it, so to speak, the bud of a generalisation. In some of the items of fact which form the body of the book, there doubtless lurks the beginning of a discovery.

THE POSITION OF TECHNICAL INSTRUCTION IN ENGLAND.

DURING the last six months or so there have been issued several reports which deal in broad outline with the position of technical instruction in England. The last annual report of the British Science Guild deals with the financial position of higher technical education and with the need for coordination and centralisation of our resources. Attention is directed to the close connection between scientific research and prosperity of national industries, which more and more closely follows the encouragement of scientific investigations. The report of the Imperial Education Conference contained a strong indictment by Mr. J. H. Reynolds, director of higher education for Manchester, of the lack of appreciation of science shown by many political and industrial leaders. The discussion at the Portsmouth meeting of the British Association Section L report on overlapping of educational work brought clearly into view the lamentable truncation of our secondary education, which fails to provide, except in the case of a small minority of pupils, any adequate foundation for higher study of a proper university grade. The Board of Education has quite recently published statistics which emphasise the poor attendance of students at places of higher technical instruction. Readers of NATURE are already aware of the main facts; unfortunately they are not sufficiently realised by the general public.

Present Shortcomings.

The essential features of the present position appear to be:—

(1) The low leaving age of secondary schools, and therefore the low standard of entrance into technical schools. The average school life in our secondary schools does not exceed three and a half years, whereas German technical universities require the completion of the full nine years' secondary-school course before admission of fully qualified students.

(2) The preponderance of evening work in English technical institutions. A few evening students are doing amazingly good work under very difficult conditions; but however creditable this may be, and indeed is, to these overworked men and their teachers, it does not seriously affect the following statement in the latest Board of Education report:—"The total amount of advanced instruction of the kind provided in technical institutions is still disappointingly small. In some of the more important industries, as, for example, engineering, the instruction is largely used by students; but in a great many others the supply of students is very small. It is to be deplored that there are several schools in which the well-equipped staffs and the excellent equipment practically stand idle in the daytime through lack of students." There are no evening students at German universities.

(3) The majority of evening students are doing work of a continuation-school character; moreover, for many of them regular attendance is impossible.

(4) Speaking generally, technical teachers are underpaid to a degree which in the long run will surely result in impaired efficiency. Incidentally it may be remarked that the value of the annual production of the German chemical industries alone is about 50,000,000*l*., so that the expenditure by Germany of half a million per annum in excess of England's provision for higher technical instruction yields a good business profit.

(5) Taking the relative populations into account, England stands below the United States, Germany, and Switzerland as regards the training and output of industrial experts having the highest scientific and

technical knowledge. Writing as a chemical manufacturer, Dr. Levinstein warns us against "thinking that we can replace efficient captains by a large number of fairly good corporals."

Interaction between Instruction and Industry.

It will have been observed that engineering holds the best position in the Board of Education review, from which we have quoted, dealing with the technical instruction of the United Kingdom. It is not by accident that British engineers are found all over the world. Any advance in an industry leads to wider and more intense study, to greater demand for instruction, and a consequent improvement in its quality. The loss of the chemical dye industry is frequently attributed to lack of knowledge on the part of English manufacturers. It appears more probable to the writer that the high duty on spirit stifled the industry in its cradle; the loss of the manufacture removed the incentives (moral as well as pecuniary) to study and research from this country, and transferred them to Germany. How the rise of this new German industry promoted study and research into coal-tar derivatives, how this research developed the industry yet farther, and how this reciprocity of industrial and instructional progress has helped the industrial advance of Germany is a story that needs no repetition. But it is still necessary to drive home the importance of close connection between our technical instruction and our industries, and to remove the lost traces of antagonism between the "practical man" and the "theoretical person."

When college training was a new thing, it was to be expected that some of the young men should imagine that their up-to-date theoretical knowledge made them better engineers than their experienced seniors; but such youthful conceit soon finds its Nemesis. By this time many of the managers in engineering works have themselves been through a college course, and the recruit with the ink scarcely dry on his diploma finds his proper level at once. With the realisation of what a college course can, and what it cannot, do towards making a real expert, we may expect an absence of friction and misunderstanding, and the establishment of a right appreciation of college training. There can be no doubt that the United States has profited greatly by not undervaluing courses of study pursued in university institutions. It should not be overlooked that an increase in the number of such trained men raises the status of the nation as a whole. In 1897 there were found to be 7000 chemists trained in Germany holding responsible positions, of whom one thousand were employed in other countries. Deducting another thousand employed in the manufacture of organic compounds—*i.e.* assuming that we do not wish to challenge Germany's supremacy in this department—is it likely that we have 5000 chemists of first-grade qualifications who have been trained in England? It appears probable that we are more nearly forty than fourteen years behind in this respect. The potentialities of our technical institutions are not properly appreciated by chemical manufacturers, and the interaction between industry and instruction is not so free and constant as is requisite for full industrial health.

Some Suggestions towards a Constructive Policy.

A preliminary step would be the limitation of the application of the epithet "technical." The Board of Education should confine the designation "technical institution" to establishments of really advanced staffing and equipment. Elementary classes doing the work of repairing defects in school education should be classed as continuation classes; "technical class" should imply a serious attempt to impart knowledge and skill of a technological character. Stronger efforts should be made to improve the quality of the teaching, both in subject-matter and method, in elementary schools. No boy or girl should leave the elementary school (unless to enter a secondary or trade school) before the age of fourteen. Continuation classes should be available in every locality, as soon as suitable teachers can be obtained, and the recommendations of the Consultative Committee of the Board of Education should be put into practice. In particular employers should liberate young people for a certain number of hours per week in order that they may attend day classes. The leaving age from secondary schools should be raised, and the universities and university colleges should not admit students below eighteen years of age.

Based upon a proper school education in the elementary and continuation schools, trade schools, or secondary schools, evening instruction of great value could be given to the better workmen, foremen, and skilled craftsmen. Such instruction is already given in the polytechnics, in evening classes of university colleges, and in the smaller towns in the technical classes which are frequently styled "institutes." The higher grade of technical instruction should be carried out in the day classes of well-equipped institutions ranking as university colleges. The diploma of these institutes and colleges should deserve recognition as the hall-mark of a trained scientific man. Two years after obtaining his diploma, the holder should be permitted to present a research or thesis to the university, which should grant a degree for work of genuine merit. The approach to such a university degree should not be stopped by protective or revenue-raising barriers of the matriculation type. This demand is made with the idea of preserving the connection which at present exists between departments for higher applied science and the older and modern universities. The alternative would be the adoption of the German system of technical universities. It is by no means certain that these rapidly growing and in some respects very successful universities are models to be followed. There is at least a danger of over-specialisation in the German system—a tendency to produce machine-made men possessing a narrowly specialised knowledge and capacity, but without sufficient width and individuality. Our captains of industry have to control men, as well as to perfect processes.

In the plan roughly outlined above an attempt has been made to provide (*a*) technical education needed by the foreman, skilled artisan, &c., (*b*) technical education needed by the scientific leaders of industry. The former requires a large number of classes of a local character; the country should be peppered with such, and the financing and control should be to a considerable extent the duty of the local education authority. The latter should be large institutions, staffed by specialists, assisted largely by national funds, with centralisation as the dominant idea in their organisation. For both we need advisory boards, including employers and employees, also representatives of the teachers in the schools from which pupils are derived. Provision should be made for the passage of students of exceptional merit from the lower to the higher grade.

Further, it is highly important that greatly increased provision should be made for post-graduate research. Space and opportunity for this work and for carrying on monotechnical courses of an advanced type will be found by freeing the university colleges from the obligation to hold matriculation classes and by relieving our higher technical institutions from the necessity of teaching decimals.

Mr. Reynolds has reminded us that it was in 1869 that Scott Russell wrote "Systematic Technical Education for the English People" in order to "move the minds of English statesmen." Since that date we have nationalised elementary education, and the process of nationalising secondary education proceeds apace. Signs of further realisation of that national organisation of which Sir Norman Lockyer has long been an advocate are to be seen in the Minority Report of the Poor Law Commission and in the recent transfer to the Board of Education of the control of Exchequer grants to universities. The Continued Education Bill introduced by Mr. Runciman fails as a practical measure by reason of the absence of financial provision and of the too-early age for leaving school; but its introduction is welcome as evidence that educated public opinion calls for Governmental action. The London University Commission can scarcely fail to throw light on many of the difficulties which beset the subject. The proposed Teachers' Council will bring together in one national organisation teachers in universities, technical institutions, secondary and elementary schools. All these phenomena afford evidence of an awakening national spirit in matters educational, and the main purpose of this article is to urge all interested to bend their backs to the work of nationalising technical education. By so doing we may advance an important step towards the realisation of Scott Russell's ideal, viz. "to show how to form a nation of well-educated Englishmen, where each workman shall thoroughly know his work; where each foreman shall thoroughly understand the right principles and best methods of executing that work; and where each master of a manufactory, and each member of a profession, shall have received the highest education in the philosophical principles and modern methods of his art, science, or profession."

G. F. DANIELL.

ATOMIC WEIGHTS.

THE issue of the Proceedings of the Chemical Society for October 30, vol. xxvii., No. 390, contains the report of the International Committee on Atomic Weights for 1912. At the request of the society the committee wisely acceded to the suggestion that the annual report should be published prior to the beginning of the academic year in order that teachers and students during any given session may not be exposed to the possible inconvenience of having to deal with two sets of numerical values during their lecture or laboratory courses.

There is no doubt that the annual review of the state of contemporary knowledge respecting the values of the fundamental constants known as the atomic weights of the elements acts as a constant stimulus in securing the attention of workers to the importance of the subject; and the critical examination to which the various contributions to the more accurate ascertainment of these values is yearly subjected by the members of the committee tends to raise the standard of what should now be demanded as regards precision and validity of method. The consequence is that all the atomic weights of the commoner elements are now known to a degree of accuracy which stamps these values as among the best determined of all physical constants. They have been ascertained by a great variety of methods and by the use of a great variety of combinations in order to eliminate so far as possible the influence of constant errors. This is especially so in the case of elements such as oxygen, hydrogen, the halogens, nitrogen, carbon, sodium, potassium, silver, &c., which are themselves the bases upon which the determinations of the atomic weights of the other elements ultimately depend.

There is, however, still much to be done before the whole of the atomic weights of the eighty or so elementary bodies are known to this degree of accuracy. In a large number of cases, methods of obtaining suitable combinations of the elements have still to be worked out. It is not always easy to be sure of the purity, individuality, or constancy of composition of such combinations. Methods, too, of quantitative determination may be faulty, or may rest upon a doubtful basis. The efforts of chemists are therefore at the present time mainly directed to attempts to remove these conditions of uncertainty, since they constitute by far the chief sources of error —far greater, indeed, than any uncertainty due to the operation of weighing, for, thanks to the combined efforts of mechanicians and instrument makers, the modern chemical balance, intelligently and skilfully used, if not unsurpassed as an instrument of precision, is fully equal to the demands which modern atomic weights work, at least in its present stage of development, demands of it.

M. J. B. EDOUARD BORNET.

BOTANISTS will learn with regret that the death of the eminent phycologist, M. Edouard Bornet, occurred at Paris on December 18, 1911. Born at Guérigny in 1828, Bornet began by studying medicine, but early in his career turned his attention to cryptogamic botany, and under the direction of Tulasne and Léveillé devoted his energies to the study of algæ and lichens. On this subject, which he continued to pursue throughout his life, he published important papers and memoirs, whilst the garden at Antibes became during his supervision celebrated as a centre of phycological research.

Bornet's work was specially characterised by the care with which he unravelled the life-history of cellular plants, and in his numerous systematic papers the value of this fact is always apparent. His investigations in conjunction with Thuret on the fertilisation of algæ (especially of the Florideæ) were most valuable, and the two large volumes, "Notes Algologiques" and "Études Phycologiques" have been the admiration of all subsequent workers. Bornet also tackled the lichen problem, and the strong support which he gave to Schwendener's views as to the dual nature of these plants led to the early recognition of the accuracy of Schwendener's position. He isolated and specifically determined the algæ which enter into the composition of a large number of lichens, and described the method by which the hyphæ envelop the algæ, as well as the mutual benefit derived from the intimate association of the algæ and fungi. He came to the conclusion that every gonidium of a lichen can be referred to a species of alga, and that the connection of the hypha with the gonidia is of such a nature that it excludes the possibility of one organism being produced by the other. Amongst his systematic works the account of Schousboe's Mediterranean algæ and the joint revision with Flahault of the Nostocaceæ are the most important.

Bornet was "Officier" of the Legion of Honour, and was awarded the gold medal of the Linnean Society in 1891. In 1910 he was elected a foreign member of the Royal Society. British algologists often appealed to Bornet for aid in taxonomic questions, and always found correspondence with him a pleasure, not only on account of his characteristic thoroughness, but by reason of his appreciative interest and unfailing courtesy.

A. D. C.

NOTES.

The lists of New Year Honours include three new peers, seven privy councillors, ten baronets, and forty knights. Among the honours conferred we notice the following:—*Baronet:* Mr. R. C. Forster, who is known in the scientific world by his generous gifts to the new chemical laboratories at University College, London. *Knights:* Prof. W. F. Barrett, F.R.S.; Dr. John H. Benson, president of the Royal College of Physicians, Ireland; Dr. Robert J. Collie, medical examiner to the London County Council and chief medical officer to the Metropolitan Water Board; Mr. J. Mackenzie Davidson, distinguished for his researches in X-ray work; Prof. Henry Jones, professor of moral philosophy in the University of Glasgow; Dr. A. B. Kempe, F.R.S., treasurer of the Royal Society; Dr. H. A. Miers, F.R.S., principal of the University of London since 1908; Dr. G. H. Savage, a well-known authority on mental diseases; Prof. E. B. Tylor, F.R.S., emeritus professor of anthropology in the University of Oxford; Dr. Bertram C. A. Windle, F.R.S., president of University College, Cork, which, until the Irish Universities Act of 1908, was designated Queen's College. *Companion of the Order of the Bath:* Dr. A. Newsholme, medical officer of the Local Government Board. *Companion of the Order of St. Michael and St. George:* Lieut.-Colonel David Prain, F.R.S., director of the Royal Botanic Gardens, Kew.

The recent decision of Sir Samuel Evans (the President of the Admiralty Court) and Trinity Masters in the case of the *Hawke* and *Olympic*, that the accident was due to the influence of the latter on the former owing to the *Olympic* taking a too large turn coming into Spithead, is very interesting. The experiments carried out at the William Froude Tank at Teddington played an important part in the case, and have thrown considerable light on a subject which must necessarily come into prominence as the size and speed of vessels increase. These experiments took the form of the running of scale models of the *Hawke* and *Olympic* in the main experiment tank. Part of this had been fitted with a false bottom to give in the experiments the shallow-water effect that would be produced on the ships by the depth of water in which they were steaming. The models were run at the same speed, corresponding to eighteen knots for the *Olympic*, and at a fixed distance apart laterally, corresponding to 100 yards for the ships. In these circumstances, with the *Hawke* model quite free to move sideways or angularly, the experiments clearly demonstrated that in the shallow water the larger model did exert considerable influence upon the smaller, and that with the *Hawke* model in those positions where this influence became one of attraction at the bow and repulsion at the stern, these forces could not be overcome by the rudder even with considerably greater helm than the 15° which the *Hawke* had at the time of the accident. The canting tendency which occurs when one ship has partially passed another is far more difficult to overcome than the sheering (or bodily movement) tendency which occurs when the vessels are broadside to each other, and unless the overtaking vessel is going relatively fast enough to run ahead there is every chance of a collision.

On the night of December 31, 1911, a large mass of the chalk cliff fell into the sea at Abbottscliff, west of Shakespeare Cliff, between Dover and Folkestone. The fallen rock now extends as a platform stretching 400 yards seaward, with a breadth of about 200 yards and a height in places of 30 feet. The aspects of the cliff and shore have been entirely altered. The noise of the fall appeared to the coastguard like the firing of heavy guns, and the inrush of this vast bulk of rock into the sea produced so much effect upon the height of the water that it caused considerable disturbance to the shipping in Folkestone Harbour. Falls in the winter time are by no means uncommon on this part of the coast. The outline of Shakespeare Cliff was much modified by an immense fall in 1899; others took place in the month of January 1905, 1907, and 1909. It is possible that the long drought of the past summer, followed by the heavy rains of the latter part of the year, may have hastened the recent landslip. The gradual desiccation of the ground has been very marked in many places, and it has had a serious effect on the stability of numerous buildings owing to the shrinking of the foundation soil through loss of moisture. The chalk cliffs have no doubt been affected in the same way; joints have been opened to an extent that would not occur in a normal year, thus providing more channels for the recent rains. Though the chalk cliffs present so uniform an appearance when observed from a distance, they are formed, in reality, of layers of variable physical character, a circumstance which greatly facilitates their downfall.

One of the great founders of the science of physical anthropology has passed away in the person of Dr. Paul Topinard. He was a pupil, colleague, and friend of the illustrious Broca, "a man who," Dr. Beddoe said, "positively radiated science and the love of science; no one could associate with him without catching a portion of the sacred flame. Topinard has been the Elisha of this Elijah." Topinard made valuable investigations on the living population of France, and many researches in various other branches of physical anthropology. In 1876 he published a relatively small book, "L'Anthropologie," for which he obtained a gold medal from the Faculté de Médecine de Paris, and a second prize from l'Institut; it was translated into English, and published in the Library of Contemporary Science in 1878. This book is packed with information, as it contains numerous measurements and an exposition of methods of investigation; it has long been a guide for students and a manual of reference for travellers and others. In 1885 he published his "Éléments d'Anthropologie générale," a monumental work of 1157 pages, being the substance of his courses of lectures and laboratory instruction for eight years in the École d'Anthropologie. It is not the compilation of a mere library student, but is permeated by the author's personality and contains the results of his very numerous and varied researches; in it he broke free from the traditions of the monogenists and polygenists, and incorporated the new ideas spread by Darwin and Haeckel. This great work exhibits his vast erudition and untiring energy, and it is indispensable for all physical anthropologists. It is needless to add that Dr. Topinard has gained honours in his own country and the homage of his colleagues all over the world.

We regret to see the announcement, made in a Reuter report from Paris, that Mme. Curie is seriously ill with appendicitis, and has been taken to a hospital to undergo an operation.

Prof. Armin Baltzer, Berne, and Dr. Emmanuel de Margerie, Paris, have been elected foreign members of the Geological Society of London. Prof. Charles Depéret, Lyons, and Prof. Arvid Gustaf Högbom, Upsala, have been elected foreign correspondents of the society.

The extension of the Horniman Museum, Forest Hill, consisting of a lecture hall and a new library, the gift of Mr. E. J. Horniman, son of the donor of the museum, will be opened on Saturday, January 27, by Sir Archibald Geikie, K.C.B., president of the Royal Society.

MR. A. F. HALLIMOND has been appointed to the assistant curatorship of the Museum of Practical Geology, in succession to Mr. W. F. P. McLintock, who has been transferred to the geological department of the Royal Scottish Museum, Edinburgh.

DR. GILBERT T. MORGAN, assistant professor of chemistry at the Imperial College of Science and Technology, South Kensington, and junior hon. secretary of the Chemical Society, has been appointed to the chair of chemistry at the Royal College of Science, Dublin, rendered vacant by the retirement of Sir Walter Noel Hartley, F.R.S.

AT the ordinary scientific meeting of the Chemical Society on Thursday, December 21, 1911, it was announced by the president, Prof. Percy F. Frankland, F.R.S., that the council had awarded the Longstaff medal for 1912 to Dr. H. Brereton Baker, F.R.S., and that the presentation of the medal would be made at the annual general meeting to be held on March 28.

THE Selborne Society has arranged a Christmas holiday lecture for children, to be given in the Theatre at Burlington Gardens on Monday, January 8, by Mr. Wilfred Mark Webb. Lord Montagu of Beaulieu will preside, and the subject will be "Punch and Judy." Tickets may be obtained through members or from the offices of the society at 42 Bloomsbury Square, London, W.C.

A SCARE has been caused in Berlin by the occurrence of a mysterious "epidemic." Within a couple of days or so more than a hundred individuals were attacked with serious illness presenting the same symptoms, and some sixty or thereabouts have died. The victims seem to be of the poorest class, and the outbreak is not confined to one locality. The information to hand is scanty, but suggests that the condition is one of ptomaine poisoning, or of epidemic food poisoning, due to the ingestion of unsound food. The latest report states that certain spirits sold for consumption have been found to contain a large proportion of methylated spirit, and attributes the illness to this, but is hardly credible, unless German methylated spirit is very different from ours.

A SUMMARY, issued by the Meteorological Office, of the weather for 1911 for the several districts of the United Kingdom, obtained from the Weather Reports for the fifty-two weeks ended December 30, shows that the mean temperature was above the average over the whole of the United Kingdom, and in most of the English districts the excess amounted to about 2°. The range of temperature was everywhere large, being 84° in the Midland counties, 81° in the east of England, and 80° in the south-east of England. The maximum shade temperature exceeded 90° in all the English districts, and was 98° in the Midland counties, whilst the minimum temperatures were below 20° over the entire kingdom, except in the Channel Islands. The rainfall for the year was generally deficient, but the heavy rains which fell in October, November, and December have everywhere lessened the deficiency, whilst in the south-east of England and in the Channel Islands the aggregate rainfall was in excess of the average. The largest measurement of rain for any district for the year was 51·04 inches, for the north of Scotland, and the largest in any English district was 36·82 inches, for the south-west of England. The least measurement was 22·04 inches, for the Midland counties, which is 4·20 inches less than the average for the past twenty-five years. In the north of Ireland the deficiency is 4·75 inches. In the south-east of England, which district embraces London, the rainfall for the year was 28·05 inches, which is 1·14 inches more than the normal. The rainy days were fewer than the average everywhere, except in the south of Ireland. The greatest frequency of rain was 227 days, in the north of Scotland; the least 159, in the south-east of England. The duration of bright sunshine was largely in excess of the average over the entire country; the greatest excess in any district is 336 hours, in the south-east of England. The absolutely greatest duration of sunshine was 2028 hours, in the Channel Islands, and the least 1257 hours, in the north of Scotland. In the south-east of England the sun shone for 1933 hours.

THE congress of the Royal Sanitary Institute will this year be held at York on July 29–August 3. The Archbishop of York will be the president of the congress. The business will be divided among ten sections, presided over as follows:—A, sanitary science and preventive medicine, Sir Shirley F. Murphy; B, engineering and architecture, Mr. J. Walker Smith; C, domestic hygiene, Mrs. Edwin Gray; D, hygiene of infancy and childhood, Mrs. M. Scharlieb; E, industrial hygiene, Sir Thomas Oliver; municipal representatives, the Lord Mayor of York, Mr. Ald. N. Green; medical officers of health, Prof. A. Bostock Hill; engineers and surveyors to county and other sanitary authorities, Mr. A. F. Greatorex; veterinary inspectors, Prof. J. R. U. Dewar; sanitary inspectors, Mr. T. G. Dee.

IN another part of the present issue an account is given of grants which the Development Commissioners have made for forestry instruction and investigation in connection with the University of Edinburgh and the Edinburgh and East of Scotland Agricultural College. The Commissioners have granted the University a sum of 4500*l.* toward the erection of a new forestry building, 2000*l.* toward the equipment of the museums and laboratories, and 500*l.* a year for five years for an additional lecturer and assistant. In addition, the University and the Agricultural College have been promised conjointly an annual sum, for a period of years, for the rent and upkeep of a forest garden and an area of experimental plantations. We are glad that the claims of forestry and agriculture are receiving such generous treatment from the Commissioners. When the British Science Guild urged these claims upon the Board of Agriculture not very long ago, little consideration was given to the strong case then presented. The practical assistance now being afforded by the Development Commissioners to various departments of agricultural education and research suggests that the Guild's efforts to promote the advancement of scientific agriculture have not been in vain.

THE second Mendeléeff Congress of Pure and Applied Chemistry and Physics will be held in St. Petersburg on December 21–28 (January 3–10). These congresses were originated by the Russian Physico-Chemical Society as a suitable means of perpetuating the memory of Mendeléeff and other notable Russian chemists, and are organised by the society; the first congress was held in 1907. Anybody interested in chemistry and physics may become a member by paying a fee of five roubles. The executive committee of the present congress consists of about fifty members; its president is Prof. Borgman, and vice-president, Prof. Favorski (the honorary president, Prof. Beketoff, died on December 1). Local committees have been formed in twelve towns. The following are the sections and subsections of the congress:—(1) pure chemistry; (2) technical analysis; (3) metallurgy and metallography; (4) applied electrochemistry; (5) cement and glass;

(6) pharmaceutical, forensic chemistry, and bromatology; (7) biological and agricultural chemistry; (8) hygiene; (9) pure physics; (10) geophysics; (11) seismology; (12) astrophysics; (13) applied physics; (14) wireless telegraphy; (15) aërodynamics; (16) methods of teaching physics and chemistry. The meetings will be (*a*) sectional; (*b*) several sections combined; (*c*) general, where reports on the recent progress of chemistry and physics will be read. Up to the present time eight general reports and about seventy papers for the sectional and united meetings have been announced. Many excursions to the institutes and colleges of St. Petersburg, and to chemical and engineering works, have been arranged; there will be also an exhibition of new chemical and physical apparatus. Some hundreds of members from all parts of Russia have already announced their intention to attend themselves, and their numbers, owing to the attractions of the capital, will probably be as large as at the first congress.

THE council of the London School of Tropical Medicine has decided to establish a journal in connection with the school. Three parts are to appear each year, and part i. has just been issued. Sir Patrick Manson writes a foreword; original papers are contributed by Drs. Bayon, Daniels, Hutton, Leiper, Minett, and Wise; and surveys of recent literature on tropical medicine and reviews of books complete the matter.

A SERIES of studies of the motions of flagella of microscopic organisms observed by means of the ultra-microscope is contributed by V. Ulehla to the *Biologisches Centralblatt* (xxxi., Nos. 20–23). Interesting observations have been made on monads, bacteria, algæ, Euglenia, &c. In some cases when two flagella are present one revolves round the other. A classification of types of flagella and of flagellar movement is given.

THE report on the health of the Army for the year 1910, recently issued, contains matter of much interest. The health of the troops at home and abroad was better last year than ever before, and this applies to the admissions to hospital, deaths, invalids sent home, and the constantly sick; only in invalids finally discharged is there a fractional rise. Loss or decay of many teeth has caused the largest number of rejections of intending recruits, and venereal disease accounts for the largest number of the total inefficiency from sickness. In the Mediterranean stations there were only two admissions for Mediterranean fever in Gibraltar and one in Malta (out of an average strength of 6769), the latter a young officer just arrived who drank unboiled milk, probably goat's milk. There was an increase in malaria in Jamaica and West Africa, and a diminution in India, over the average for the previous five years. Venereal and tuberculous diseases have almost everywhere decreased as compared with the average of the previous five years, and there has been a welcome and remarkable diminution in enteric fever among the European troops in India.

THE second part of vol. ii. of the Museum Journal of the University of Philadelphia is devoted to a survey of New Zealand culture, based on the great collection made by E. W. Clark, the most important addition contributed in recent years to the museum. It includes splendid specimens of wood-carving, tail pieces of canoes, house posts, paddles, wooden staves, dancing clubs, and wooden boxes. In addition, we have clubs of polished whalebone, a chief's club in green jade, and a good example of the Heitiki, recognised by Captain Cook and other early travellers as the characteristic personal ornament of the Maoris. It is much to be regretted that this remarkable collection has not found a home in one of our imperial or colonial museums.

MR. C. B. MOORE, in a paper entitled "Some Aboriginal Sites on Mississippi River," contributed to vol. xiv., part iii., of the Journal of the Academy of Natural Sciences, Philadelphia, describes a number of Indian burial mounds along the course of the river. It is well that this survey has been undertaken, because many of these monuments are being destroyed by changes in the course of the stream or by agricultural operations. The discoveries throw little light on the age of the makers or on their death cult. The pottery is interesting, particularly some representations of animals like the tortoise and raccoon, and some human figures are represented sitting cross-legged, a very unusual position in the statuettes discovered in this region.

IN *The National Geographic Magazine* for November, Mr. J. E. Pogue, of the United States National Museum, describes the remarkable "Rainbow" bridge of natural formation in the Navaho reservation near the south-east corner of Utah. This towering arch, of rainbow shape, spans the canyon, the geological formation of which is a buff-coloured, fine-grained sandstone, brick-red on its surface and stained with vertical streaks of a darker shade. It hangs 309 feet above stream-bottom, and the abutments stand 278 feet apart. The causeway, upon which an observer can be lowered from an adjacent cliff, the sides of which are too steep to admit easy passage, is 33 feet wide by 42 feet thick at the keystone point. These figures, however, give only a faint idea of the majestic symmetry of this remarkable structure. It was visited by white men for the first time in 1909. It is satisfactory to learn that the United States Government has constituted it a national monument, and has taken adequate measures for its preservation.

THE Schweich lectures on Biblical archæology, held under the auspices of the British Academy, were delivered last month by Prof. R. A. Stewart MacAlister, late director of excavations of the Palestine Exploration Fund, who discoursed on the "Philistines, their History and Civilisation." Prof. MacAlister dwelt on the earliest known history of the Philistines, on their supposed origin in Crete, and on their raid into Egypt. The earliest references to them in the Old Testament, and details of the capture of the Ark and of its wanderings among the people, were given. The lecturer traced the growth in power of the Philistines during the reign of Saul, referring to the outlawry of David and to his relations with the King of Gath, and also to the battles between David and the Philistines. By these battles their power was broken, and they almost disappear from the Biblical records. Facts relating to them contained in the Assyrian records from the eighth and seventh centuries B.C., and instances of their traditions among the modern peasants of Palestine were given. Referring to the political and military organisation of this people, Prof. MacAlister stated that they had the oldest form of oligarchic government on record. At present we are very ignorant of their language, only a few proper names and some doubtful words being known. But little has been ascertained of their religion, the two chief deities being the fish-shaped goddess Atargatis and the god Dagon; the cult of this latter deity long survived in Gaza, where he was worshipped under the name Marna. As to the arts, they had reached a comparatively high level; witness the various jewels, pottery, and bronze mirror which were found in the five tombs recently discovered at Gezer. It is probable, indeed, that the alphabet was developed out of the Cretan linear script by this people.

A LARGE portion of vol. cxx., part vi., of the *Sitzungsberichte der k. Akad. der Wissenschaften* is occupied by a continuation of the accounts of the results of a recent survey of the plankton of the Adriatic. In the first paper Dr. A. Steuer discusses the amphipod crustaceans, describing a new species of Glossocephalus. The same naturalist also undertakes the stomatopod crustaceans and pteropod molluscs, while the tornarian and actinotrochan larvæ fall to the share of Dr. G. Stiasny.

ACCORDING to the report of the trustees for the year 1910–11, the details of the reorganisation of the Indian Museum have been worked out during the period under review, and the various sections of the collection handed over to the officers who will in future be respectively responsible for their preservation. Owing to the appointment of two additional officers, special progress has been made in the zoological section, both in regard to the arrangement and display of the exhibition series and in original research.

IN *The Zoologist* for December, 1911, Colonel C. E. Shepherd continues his account of the pharyngeal teeth of fishes, dealing in this instalment with those of the sea-breams (Sparidæ) and wrasses (Labridæ). Many members of each group feed on hard-shelled molluscs, and therefore require special crushing apparatus. Sea-breams effect this by the development of powerful molar-like teeth in the front of the jaws, and consequently require nothing special in the way of pharyngeals. The wrasses, on the other hand, rely solely on their pharyngeal dentition, of which the lower series forms a large plate resembling a cobbled road in miniature, while the upper is divided into two somewhat similar lateral patches.

THE distribution chart of a plant species serves not only to point out the areas occupied, but often throws light on its origin. These matters are discussed by Dr. C. H. Ostenfeld in a short pamphlet, with reference to seven species of Anemone, Hepatica, and Pulsatilla. It is unexpected to find that *Anemone nemorosa* does not extend to the western shores of Jutland, but, as would be expected, it grows further westward than *A. ranunculoides* and *Hepatica triloba*, which do not extend to the Atlantic coast nor yet to Great Britain. A curious feature is the mutually exclusive distribution of *Pulsatilla vulgaris* and *P. pratensis*. All the seven species are considered to be post-Glacial immigrants from the south.

THE biometrical investigations on the egg of the domestic fowl, carried out during the past four years at the Maine Agricultural Experiment Station, have necessitated the designing of methods for the accurate measurement of the whole or parts of eggs. These are collected in a recent report by M. R. Curtis, and will be found useful by others working at the same subject. It is considered that the methods possess a considerable degree of accuracy, while at the same time they have the advantage of simplicity of manipulation.

THE third report on the experimental work of the Sugar Experiment Station, Jamaica, shows continued progress in several directions. The station was not popular at first, but has gradually gained the confidence of the planters because of the valuable results it has been able to achieve. Manurial trials have demonstrated that on many of the island soils phosphates are not required, but nitrogenous and potassic manures are effective and profitable in seasons of normal rainfall, though not in dry years. New varieties of cane have been brought out considerably better than those formerly grown. The fermentation problems connected with the production of rum are being successfully investigated by Mr. Ashby, who has selected certain yeasts of high efficiency and sent them out in pure cultures to the estates, in most cases with very satisfactory results.

THE November (1911) number of *Petermann's Mitteilungen* contains the numbers of families in different provinces of China according to the official report of the recent census of the Empire. For Peking and some districts the number of individuals is also given.

La Géographie for December, 1911, announces that, in consequence of the misunderstandings caused by the old datum of Bourdalouë being still used in some river systems when giving flood warning instead of the mean sea-level at Marseilles, the Ministry of Public Works has ordered that, within five years, all bench-marks must be referred to the normal datum of mean sea-level at Marseilles.

A SHORT account of the work of the Norwegian expedition which visited Spitsbergen last summer to continue the topographical and geological surveys which had been carried on in previous years is given by M. A. Hoel in the October (1911) number of *La Géographie*. Photogrammetric methods were largely employed, on account of the short time which was available. In spite of much unfavourable weather, the work accomplished enabled a very complete topographical map to be drawn of the region between Ice Fiord and Bell Sound, as well as a general geological map of the quadrilateral formed by the north and south sides of the Spitsberg, Wijde Bay, and Ice Fiord.

IN the December (1911) number of *The Geographical Journal* Captain Rawling gives some information bearing on the geological structure of that part of Dutch New Guinea which he traversed, supplementing that brought back by Dr. Lorentz, who penetrated to the ridge of the main chain further to the eastward. A summary is given of the explorations of Mr. E. C. Abendanon in the Central Celebes. During 1909 and 1910 he travelled extensively in this island, and succeeded in throwing considerable light on its geology. While the southern peninsula was found to be a folded region with regular folds running in a general north-west direction, there is no pronounced folding in the south-eastern peninsula. A large number of altitudes were determined, and the results obtained are considerably lower than earlier observations had indicated.

Symons's Meteorological Magazine for December, 1911, contains the fourth and concluding part (winter) of Mr. W. Sedgwick's interesting notes on the weather of the seventeenth century, from information given in the diaries of Evelyn and Pepys (see NATURE, November 11, 1911). For this period (December–February) the observations are more complete than for the other seasons. The recorded instances of snow are surprisingly few, being only mentioned in thirteen winters in the period covered by the diaries (1648–1703), and only three of these falls appear to have been exceptional. Prolonged or severe frosts occurred in about ten of the winters; that of 1683–4 ("Frost Fair") far surpassed any within living memory; coaches plied to and fro on the Thames as in the streets, and the severe weather extended even so far south as Spain. At least eleven very mild or wet winters occurred in Evelyn's lifetime. In short, the author concludes, when all the information is considered, it does not appear that cold winters were more frequent, or mild winters less so, than they have been in the last fifty years, or that the average severity of the winters was greater than at the present time.

WE have received an interesting little booklet from the Silent Electric Clock Company, of 192 Goswell Road, with which is embodied the firm's latest catalogue and price-list. This booklet is worthy of notice, for it differs widely from the ordinary run of price-lists, inasmuch as it contains a complete description of this firm's system, a system which is based upon more than sixteen years' experience of a class of apparatus which the Silent Electric Clock Company has apparently brought to a wonderful degree of perfection, judging from the list of more than eighty recent installations which have been supplied, no doubt much to the satisfaction of the users, amongst which we notice several British, colonial, and foreign Government departments, home municipalities, schools, and railway companies. It is interesting to observe that every department of time-keeping is provided for: large and small clocks; turret clocks; clocks for use on shipboard, with automatic adjustments for diurnal longitudinal correction; clocks arranged to strike and chime electrically, both for household as well as for public installations; and also for ringing bells according to variable programmes; high-grade astronomical clocks, and master clocks arranged for automatic synchronisation by means of the daily signal distributed by the Post Office Telegraph Department from Greenwich Observatory. Any of our readers interested in electric clock systems should certainly send an inquiry to this firm.

DURING the spring and summer of 1910 the United States Naval Wireless Laboratory carried out an extensive series of experiments on the range of communication by wireless telegraphy between two cruisers and the Brant Rock station, near Boston. An account of the work done and the results obtained is given by Mr. L. W. Austin in the October (1911) number of the Bulletin of the Bureau of Standards. The antenna of the Brant Rock station was 420 feet high, and of the umbrella type; those of the cruisers were 116 feet, and of the flat top type. In each case the coupling between closed circuit and antennæ was loose enough to cause only one wave to be emitted. Over salt water the received currents are proportional to the sending currents and to the product of the heights of sending and receiving antennæ divided by their distance apart and by the wave-length used. In addition, they are subject to absorption, which in the daytime is expressed by multiplying the above by e^{-ad}, where d is the distance and a a constant the value of which varies inversely as the square root of the wave-length. During the night the absorption is too irregular to be represented by any formula. The above statements have been tested over the following ranges:—sending currents, 7 to 30 amperes; antennæ heights, 37 to 130 feet; wave-lengths, 300 to 3750 metres; distances up to 1000 miles.

Engineering for December 29, 1911, contains an illustrated description of a floating crane of exceptional size which is now in use at the Austrian Naval Dockyard, Pola, on the Adriatic. The crane is designed to deal with the heaviest weights in ship construction, and also, on an emergency, to raise sunken submarines. According to the specification, the crane had to be provided with two crabs, each having a lifting capacity of 120 tons, the crabs being so designed that both could be used simultaneously, especially for the lifting of submerged loads, in which case the rear crab has to work at a maximum distance of 5 feet from a line corresponding with the front edge of the pontoon, the front crab being close against it. Arrangements are made whereby the submarine can be raised sufficiently out of the water for rescuing the crew through the conning tower, when the necessary steps could be taken with more leisure for salving the submarine itself. The crane can be propelled afloat at a speed of about 3·4 knots. Under test, each crab was made to carry a load of 150 tons, the rear crab being at a distance of 5 feet, and the front crab at a distance of 47 feet 7 inches, from a line corresponding with the front edge of the pontoon.

IN chapter xxxix. of his "Study of Bird Flight"—which is now appearing serially in the pages of *Flight*—Dr. E. H. Hankin discusses the cause of soaring flight. Two ancient theories are examined and rejected, *i.e.* that the soaring bird takes advantage of (1) ascending currents reflected upward from the walls of high buildings, &c.; (2) ascending currents or eddies caused by heat; for the reason, in the first instance, of personal observation to the contrary in the case of heavy birds, and, in the second, that soaring can in some conditions be impossible in the presence of heat eddies as well as in their absence, and *vice versa.* "There is no evidence whatever," says Dr. Hankin, "in favour of the view that the energy of soaring flight is derived from the kinetic energy of air in movement independently of the bird's wing." The conclusion drawn is that the energy used in soaring is stored up in the air in potential form, for which he coins the word "ergaer." On the question of the composition and decomposition of "ergaer," our author admits he knows nothing, but defends his theory as entirely scientific, merely advancing the opinion that "ergaer" is stored sun energy, and that "the air under the wing of a soaring bird is undergoing a change of the nature of a sort of continuous explosion." Later in the development of the idea we are asked to suppose a bird gliding into a patch of soarable air with its wings at full camber. In these conditions, the "pull" would no longer act at the centre of gravity and would no longer be the momentum, but would change to the tractive effect of soarable air on the cambered wing, and so would act on a level with the wings.

A COPY of the January issue of his catalogue of second-hand instruments (No. 49) has been received from Mr. C. Baker, 244 High Holborn, London. The list contains particulars of nearly 2000 items, the majority of which will interest the astronomer and the microscopist. The instruments are guaranteed to be in adjustment, and are for sale or hire.

THE twenty-eighth annual issue of "The Year-book of the Scientific and Learned Societies of Great Britain and Ireland" has now been issued by Messrs. Charles Griffin and Co., Ltd. This useful work of reference is a record, compiled from official sources, of the work done in science, literature, and art during the session 1910–11 by numerous societies and Government institutions. It is to be regretted that the summary of the proceedings of the British Association, given on pp. 10 to 23, refers to the Sheffield meeting held in September, 1910, and not to the Portsmouth meeting of last year. Since the whole of the titles of papers, reports, &c., presented at the Portsmouth meeting were available before the middle of September last, we suggest they might with advantage have been included, in addition to those relating to the 1910 meeting.

Errata.—The paper on "Momentum in Evolution" published in last week's NATURE was by Prof. Dendy, and not Den*ny*, as printed on p. 301.—We are asked to state that on p. 296, col. one, line ten, "a rubber ram" should be "an iron ram." The former words were given in the manuscript supplied to us, and were passed in proof by our contributor.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR JANUARY :—

Jan. 4. 15h. 20m. Neptune in conjunction with the Moon (Neptune 5° 39′ S.).
,, 16h. 0m. Mercury stationary.
9. 9h. 0m. Venus in conjunction with Jupiter (Venus 1° 38′ N.).
13. 10h. 0m. Neptune at opposition to the Sun.
14. 17h. 57m. Jupiter in conjunction with the Moon (Jupiter 4° 6′ N.).
15. 5h. 26m. Venus in conjunction with the Moon (Venus 5° 51′ N.).
,, 10h. 0m. Mercury at greatest elongation W. of the Sun.
16. 4h. 0m. Saturn stationary.
,, 18h. 23m. Mercury in conjunction with the Moon (Mercury 5° 48′ N.).
18. 23h. 51m. Uranus in conjunction with the Moon (Uranus 4° 33′ N.).
20. 7h. 0m. Uranus in conjunction with the Sun.
27. 12h. 10m. Saturn in conjunction with the Moon (Saturn 4° 9′ S.).
28. 13h. 58m. Mars in conjunction with the Moon (Mars 0° 37′ S.).

MARS.—A telegram from Prof. Lowell, published in No. 4543 of the *Astronomische Nachrichten*, states that, on December 17, 1911, the old south snowcap on Mars had practically disappeared, and new spots were forming outside.

M. Jarry Desloges, telegraphing from the Sétif Observatory on December 16, 1911, states that on December 15 the south polar cap was veiled, and that Libya, which was grey at the beginning of the Martian afternoon, was white towards sunset; Deucalionis Regio, clear during the morning, became grey in the afternoon.

Four splendid photographs of Mars taken by Prof. Barnard with the Yerkes 40-inch refractor in September, 1909, are published on the frontispiece of the September-October (1911) Journal of the Royal Astronomical Society of Canada.

EPHEMERIDES FOR COMETS 1911*a*, 1911*f*, AND 1911*g*.—As the position of Wolf's comet (1911*a*) during the summer will be unfavourable for observation, it is important that observations should be made during the next few months, and for this reason M. Kamensky publishes an ephemeris, extending to April 7, in No. 4543 of the *Astronomische Nachrichten*; observations already made show that his fourth (K_4) system of elements needs but small corrections. It is hoped that observations will be secured, as they may clear up the question of the possible enfeeblement of the comet. The present position (January 4) is 21h. 41·1m., −1° 55·5′, and the path lies nearly directly eastwards through Aquarius and Pisces; the magnitude is about 14·0.

Quénisset's comet (1911*f*) is still moving nearly directly southwards through Scorpio, and will soon enter Lupus: R.A. = 15h. 49·6m., dec. = −31° 54·7′. In the ephemeris published by Dr. Ebell the magnitude is 8·3.

Beljawsky's comet (1911*g*) is also too far south for observation in these latitudes. Dr. Ebell's ephemeris shows it to be in Corolla, and its magnitude is estimated as 8·6.

A PECULIAR VARIABLE STAR.—The measures and light-curve of the variable star 232848 Z Andromedæ, published in Circular 168 of the Harvard College Observatory, show the light-changes to be unique among stars yet observed. For the last six years the magnitude has been nearly constant at 11·0, but in 1901 there was a great outburst, the magnitude becoming 9·2. Prior to that, since 1889 there had been considerable oscillations of magnitude between 11·5 and 9·7.

This star is +48°4093, mag. 9·5, and its variability was discovered by Mrs. Fleming in 1901, who, examining its spectrum of October 17, 1900, recorded it as "Bright lines. Nova or Var?" An examination of the spectrum plates by Miss Cannon shows that the spectrum is unlike that of variable stars, and resembles that of several new stars. On the best photographs it is seen to be like those of Nova Persei, No. 2, on April 12, 1901; Nova Geminorum on March 29, 1903; and Nova Sagittarii, No. 1, on April 21, 1898; it also resembles that of RS Ophiuchi on July 15, 1898, at or near the time of the remarkable outburst of light in that object.

In addition to the bright lines Hβ, Hγ, Hδ, and Hε, there is one at about λ 4688 which, Prof. Pickering suggests, probably corresponds with the bright band in the spectra of fifth-type stars.

THE PARALLAX OF THE DOUBLE STAR KRUEGER 60.—During the period August 29, 1907 to April 10, 1910, Dr. Lau employed the 10-inch refractor of the Urania Observatory, on fourteen nights, to measure the interesting double star Krueger 60. From these measures he derived a value for the parallax, which he now publishes in No. 4542 of the *Astronomische Nachrichten*. His result is $+0·22'' \pm 0·038''$, with a probable error from one equation of $\pm 0·129''$; earlier measures by Barnard, Schlesinger, and Russell gave, in the mean, the value $+0·25''$.

THE HEIGHT OF PERSEID METEORS.—Employing the parallax method, Dr. Philipp Broch has calculated the heights of the beginnings and ends of 102 meteor paths observed during the period 1823–58, and now publishes the results in No. 4541 of the *Astronomische Nachrichten*. For all the meteors he finds the values 130·0 km. and 96·0 km. for the mean heights at the beginning and the end of the flights respectively, the mean length of the paths being 72·5 km. Of this number fifty-eight were certainly Perseids, and for these he finds the mean values 133·1 km. and 95·5 km., respectively, for the heights, the mean length of path being 72·0 km.

THE LILLE OBSERVATORY.—In No. 4543 of the *Astronomische Nachrichten* M. Jonckheere gives notice that his observatory, L'Observatoire d'Hem, taking the name of the prefecture under whose patronage it is, is to be known officially as the Lille Observatory.

PRIZE AWARDS OF THE PARIS ACADEMY OF SCIENCES.

AT the annual meeting of the Academy of Sciences, held on December 18, 1911, the prize awards for the year were announced as follows:—

Geometry.—The Francœur prize to Emile Lemoine, for the whole of his work in mathematics; the Bordin prize to A. Demoulin, for his researches on triple orthogonal systems.

Mechanics.—The Montyon prize to M. Jouguet, for his contributions to thermodynamics and chemical mechanics, Captain Duchêne receiving a recompense (500 francs) for his mathematical study of the aëroplane; the Poncelet prize to M. Rateau, for his work as a whole; the Vaillant prize (in equal parts) between Charles Doyère and Henry Willotte, for memoirs on the application of the principles of the dynamics of fluids to the theory of helices; the Vaillant prize to M. Liénard, for his memoir on the movement of an ellipsoid in a viscous liquid.

Navigation.—The extraordinary Navy prize between M. Doyère (1500 francs), for his study of the bending of a thin sheet or thin ring submitted to any forces whatever, H. Roussilhe (1000 francs), for his hydrographic work on the coast of Madagascar, M. Leparmentier (1000 francs), for his book on the calculations relating to inclined hulls, G. Simonot (1000 francs), for his memoir on the resistance of a cylindrical tube of infinite length submerged in water, Pierre Lemaire (750 francs), for his memoir on the theory of the gyroscopic compass, and E. Perret (750 francs), for his work relating to nautical astronomy; the Plumey prize to Robert Lelong (1000 francs), for his work on marine motors.

Astronomy.—The Lalande prize to Lewis Boss, for his star catalogue; the Valz prize to C. Rambaud, for the whole of his astronomical researches; the G. de Pontécoulant prize (increased to 1700 francs) to L. Schulof, for his researches on the theory of comets and on lunar tables; the Damoiseau prize (in equal parts) between M. Millosevich, M. Witt, and M. Lagarde.

Geography.—The Tchihatchef prize between M. de Schokalsky (one half) and M. Deprat and M. Mausery (one half); the Gay prize to Paul Lemoine, for his geological work in the French colonies.

Physics.—The Hébert prize to M. Hemsalech, for his work on spark spectra; the Hugues prize to Ch. Féry, for his researches in physics, especially those dealing with the laws of radiation and the measurement of high temperatures; the Gaston Planté prize to Paul Janet, for his researches in electricity and magnetism.

Chemistry.—The Jecker prize between M. Darzens (500 francs), M. Fosse (250 francs), and M. Tiffeneau (250 francs), for work in organic chemistry; the Cahours prize (in equal parts) between Louis Hackspill and M. Richard; the Berthelot prize to André Wahl; the Montyon prize (unhealthy trades) to M. Tissot, for his apparatus permitting work in a poisonous atmosphere, an invention of especial importance in mines.

Mineralogy and Geology.—The Delesse prize to Albert Michel-Lévy, for his petrographical and stratigraphical work; the Joseph Labbé prize to René Nicklès, for his geological and practical work in connection with the discovery of the coal basin at Meurthe-et-Moselle; the Fontannes prize to M. Cossmann, for his palæontological studies; the Victor Raulin prize to Emmanuel de Margerie, for the whole of his geological work.

Botany.—The Desmazières prize to Camille Sauvageau, for his recent researches on the brown algæ; the Montagne prize is not awarded, but Jean Beauverie and Antoine Lauby each receive an encouragement of 500 francs; the de Coincy prize to E. Achille Finet, for his publications relating to orchids.

Anatomy and Zoology.—The Grand prize of the physical sciences to M. Anthony, for his memoir on the characters of adaptation to tree life in vertebrates; the Savigny prize to Ferdinand Canu, for his work on the Bryozoa; the Cuvier prize to L. Cuénot, for the whole of his scientific work.

Medicine and Surgery.—Montyon prizes to L. Testut and O. Jacob (2500 francs), for their treatise on topographical anatomy; to Alexandre Besredka (2500 francs), for his work on the mechanism of anaphylaxia; and to E. Cassaet (2500 francs), for his memoir on the diagnosis of posterior pericarditis.

Mentions of 1500 francs are accorded to Pierre Nolf, Emile Feuillé, and E. Sacquépée, and citations to Léopold-Lévi and H. de Rothschild, S. Mercadé, G. Faroy, L. Panisset; the Barbier prize to H. Guilleminot, for his memoir on fluoroscopic radiometry; the Bréant prize is not awarded, but prizes from the foundation funds are given to M. Auclair and Louis Paris (2000 francs), to M. Dopter (2000 francs), and M. Duvoir (1000 francs); the Godard prize to Jean Louis Chirié; the du Baron Larrey prize to H. Coullaud and E. Ginestous, for their work on the physiology and vision of shooting, Maurice Boigey receiving a very honourable mention; the Bellion prize is divided between M. and Mme. Victor Henri, for their studies on the action of ultra-violet light on toxins and micro-organisms, and M. Courmont and M. Nogier for their researches on the sterilisation of water by the ultra-violet rays; the Mège prize is not awarded, but a prize of 300 francs is awarded to P. Nobécourt and Prosper Mercklen; the Chaussier prize to M. Imfert.

Physiology.—The Montyon prize (experimental physiology) divided equally between Dr. Marage and Raoul Combes; the Philipeaux prize between Mme. Z. Gruzewska, for the whole of her work in physiology, and Maurice Piettre, for his researches on bile; the Lallemand prize to Henri Piéron, for his work on the memory, Maurice Brissot receiving a very honourable mention, and J. Lévy-Valensi an honourable mention; the Pourat prize is not awarded.

Statistics.—Montyon prize (1000 francs) to René Risser, and a mention (500 francs) to Charles Heyraud.

History of the Sciences.—The Binoux prize divided between Antonio Favaro and Edmond Bonnet.

General Prizes.—Berthelot medals to MM. Darzens, Tiffeneau, Tissot, André Wahl, Louis Hackspill, Richard; the Gegner prize (increased to 4000 francs) to J. H. Fabre; the Frémont prize to Charles Frémont; the Lannelongue prize between Mme. Cusco and Mme. Rüch; Wilde prizes to M. Stefanik (2000 francs) and A. Trillat (2000 francs); the Lonchampt prize to M. Mazé, for his researches in agricultural chemistry and bacteriology; the Saintour prize to Jules Drach; the Fanny Emden prize is not awarded, but encouragements are attributed to M. Ochorowicz (1000 francs) and M. Boirac (2000 francs); the Pierson-Perrin prize to (the late) Henri Pellat, for the whole of his work; the Petit d'Ormoy prize (mathematics) to Jules Tannery and (natural science) to M. Depéret; the Serres prize to L. Vialleton, for his researches on embryology and comparative anatomy; the Jean Reynaud prize to Emile Picard; the Baron de Joest prize divided between H. Mouton and Charles Tellier; the Leconte prize is held over to this year; the prize founded by Mme. la Marquise de Laplace to Georges Marie Antoine Perrin; the prize founded by Félix Rivot between Georges Perrin, François Walckenaer, Henri Terrisse, and Jacques Denis.

The Bonaparte Foundation.

Thirty-four applications for grants from this fund were received, and the eleven mentioned below received favourable consideration:—M. Hartmann (4000 francs), for assistance in his experimental researches on the elasticity of solid bodies; M. Alluaud (3000 francs), for carrying on studies of the Alpine fauna and flora of the tropical mountains Kilimanjaro, Ruwenzori, and Kenia; H. Barbieri (3000 francs), for pursuing his chemical studies on nerve substance; M. André Broca (3000 francs), for constructing an apparatus for the measurement of geodesic angles by the Borda method; M. Krempf (3000 francs), for completing his work on the biology of the coasts of Indo-China; M. Sollaud (3000 francs), for pursuing his researches on the Palemonidæ; M. Topsent (3000 francs), for the zoological study of the fresh water of Saint-Jean-de-Losne (Côte d'Or); MM. Buisson and Fabry (2000 francs), for the purchase of apparatus to enable them to pursue their researches on the distribution of the energy in the solar spectrum; M. Gaubert (2000 francs), to acquire the apparatus necessary to pursue his work on liquid crystals; M. Houard (2000 francs), to permit him to pursue in America his researches on the Zoocecidæ; and M. Moureu (2000 francs), to permit him to pursue his studies on the rare gases and their distribution in nature.

The total grants from the fund amount to 30,000 francs for the year.

FORESTRY EDUCATION AT THE UNIVERSITY OF EDINBURGH.

IN October, 1910, Mr. E. P. Stebbing, who had been appointed university lecturer in forestry the previous May, delivered an inaugural lecture in the University, taking as his subject "Forestry Education: its Importance and Requirements." Extracts from this lecture were printed in NATURE of November 10, 1910 (vol. lxxxv., p. 61). Mr. Stebbing directed attention to the three chief requirements of the department of forestry of the University. These he considered to be: (1) a forest garden; (2) more accommodation for museums and laboratories; (3) an increase in the forestry staff.

The University has been giving undivided attention to these three wants of the department, and the following statement, which has been issued by the University to the Press, places the present position of Edinburgh as a forestry educational centre clearly before the public.

During the past year afforestation questions and forestry education have been receiving considerable attention in this country. In a resolution on the subject, the Development Commissioners decided that their first grants with the object of furthering the progress of afforestation would be made with the object of improving the means of affording sound forestry education in the country.

In Scotland a lecturer in forestry was appointed so long ago as 1888 at Edinburgh University, and an annual course of lectures has been delivered since that date during the winter session.

A few years ago the Edinburgh and East of Scotland Agricultural College inaugurated a short course of evening lectures in simple forestry for working foresters and others. This course has during the past year been extended, and a month's course of simple forestry, forest botany, and forest entomology is now delivered in August at the Agricultural College.

When, a few years ago, it became evident that the question of afforesting a portion of the British Isles had developed into a matter of considerable public importance, Edinburgh again led the way, and instituted a degree of B.Sc. in forestry and appointed lecturers to deliver the special courses which the forestry student is required to take, such as forest botany, forest chemistry, forest engineering, and forest entomology.

The University did not, however, rest content with this. The demands made upon the resources of the department led to the recognition of the fact that provision was required for three additional objects:—

(1) A forest garden, including an area for the experimental formation of woods.

(2) Extensions of the present museum and the provision of laboratories.

(3) Additional lecturers on the University forestry staff.

During the past year undivided attention has been devoted, in collaboration with the Edinburgh and East of Scotland Agricultural College, towards the attainment of these objects.

The Development Commissioners were approached by the University Court and the governors of the Agricultural College, and their applications were received with sympathetic consideration by the Commissioners, and have been accorded generous treatment.

A sum of money has been promised annually for a period of years for the rent and upkeep of a forest garden and area of experimental plantations. This sum has been promised conjointly to the University and College, and the authorities of these two institutions have appointed a joint committee to supervise the management of the area.

The Development Commissioners, recognising the urgent need of additional room for the extension of the forestry department within the University, its museums, and laboratories, have granted the University a sum of 4500*l.* towards the erection of a new forestry building, stipulating that the University should provide a similar sum. The University Court has undertaken to provide this amount, or a larger one should it be required. The Development Commissioners have also made a grant of 2000*l.* towards the equipment of the museums and laboratories, the money to be spent during the next five years. The Commissioners have promised to consider a further provision for this object should such be required at the end of this period. It is expected that the erection of the buildings will be commenced in the coming year.

The instruction in forestry proper for the degree will remain in the University, and with the object of supplementing the staff of the department the Development Commissioners have granted a sum of 2500*l.* (500*l.* a year for five years) as a provision for the salaries of an additional lecturer and for an assistant in the forestry department. One of these gentlemen has been already appointed, and the second will be shortly added to the staff.

The above detailed explanation of the present position of Edinburgh with regard to education in forestry will show that both the University and Agricultural College have gone thoroughly into the matter, and have determined that every effort shall be made to give the best forestry education possible alike to the student wishing to graduate in forestry and to the working forester and woodman who wishes to improve his education by following the simpler forestry courses delivered at the Agricultural College.

TESTS OF PROPELLERS FOR FLYING-MACHINES.

A SERIES of important and valuable experiments are being carried out at Chalais-Meudon by MM. Legrand and Gaudard with the object of testing propellers, while actually in use, on a flying machine, and of studying the action of the air on planes in flight. The machine used is a biplane specially built for the purpose at the laboratory; the propeller in front is run off a 60 horse-power Renault motor; the planes are staggered; and the total weight, including the pilot, is 780 kilograms.

In order to study the action of the air on the propeller and planes of a machine in horizontal flight, the following details must be known:—(1) the thrust of the propeller; (2) the speed of rotation of the propeller-blade or of the motor; (3) the actual speed of the aëroplane as it would be in calm air; and (4) the angle of incidence of the machine. The way employed in these experiments is to take simultaneous and instantaneous readings of all these details by the aid of special apparatus connected electrically, so that the pilot can choose his own moment and take the readings by pressing a button. The method of obtaining the angle of incidence and the speed of the machine is particularly ingenious. It consists of photographing the angle indicator—a pendulum moving in oil—and the manometer recording the pressure of the air-flow. In this way observers are not required, and the factor of personal error is eliminated.

Experiments have already been made with two propellers, A and B, A having a diameter of 2·65 metres and a pitch of 2·10 metres, and B a diameter of 2·85 metres and a pitch of 1·70 metres. The motor gave out 62 horse-power at 1800 revolutions, which was its normal speed, but in the case of A the revolutions in flight went up to 1870, and in B to 1980. It was found that a considerable deformation of both propellers took place during flight by which the pitch was reduced equally on both blades of A by 350 mm., but unequally on B to the extent of 350 mm. on one and 270 mm. on the other, so that when B was used considerable vibrations were observed.

At a speed of 17 metres per second propeller A gave out 168 kilograms thrust when the angle of incidence was 9° 45′, and at a speed of 16 metres, when the angle of incidence was 10° 15′, the thrust was 160 kilograms. B, on the other hand, at a speed of 15 metres, when the angle was 11°, only gave a thrust of 153 kilograms.

In static tests, A gave 225 kilograms and B 245 kilograms. The experimenters, as an outcome of these preliminary tests, state that many of the modern propellers in use have too small a relation between their pitch and diameter to be really efficient.

Lieut. Saunier piloted the machine on its trials, making only short, straight flights when there was practically no wind.

NEW MICROSCOPIC OBJECTIVES AND ACCESSORIES.

WE have received from Messrs. Angus, agents for R. Winkel, of Göttingen, some of his later productions which include special features.

With regard to the objectives, they have been examined and reported on by Mr. E. M. Nelson,[1] whose authority on such matters is second to none, so we may content ourselves by referring to his statements relating to the special colour correction of the achromats which Winkel employs, especially as he introduces a history of the changes made in these corrections which is of great interest.

"Before the introduction of Jena glass, the outstanding secondary spectrum of the old English archromat consisted of claret, or port-red, and apple-green colours. This was always looked for by experts, and its presence was thought to denote perfect correction. About 1870 (or a year or so later) Tolles, in America, altered the correction, and produced some very fine object-glasses with a flaring bright red, or crimson, spectrum. I well remember seeing a *Podura* scale shown with one of these glasses, a very brilliant lens, and a strong diatom resolver; the exclamation marks shone out like rubies, whereas if they had been viewed through an English objective of that date (Lister formula) the exclamation marks would have been seen with a more purple tint, something like an amethyst.

"About 1886, when Jena glass was introduced, an entirely new set of phenomena appeared; pale glasses, and those which gave decidedly bluish tints—which any expert of those days would have unhesitatingly condemned—were found to be not only strong diatom resolvers, but also to give sharp and bright pictures. For a time, experts, until they had learnt the effect of the reduction of the secondary spectrum by these new corrections, were all at sea, and did not know where they were.

"To-day, there is in my cabinet one of these Jena glass semi-apochromats which has such a violent purple secondary spectrum that it can be seen even when a peacock-green glass is used, a more monochromatic fluid

[1] Journ. R. Micr. Soc., 1911, pp. 451–52.

screen being required to shut the blue part of the purple out![1] Yet this lens gives particularly sharp images, and is a very strong diatom resolver. Now, however, Herr Winkel has revived the American red corrections with Jena glasses. The result is excellent, for brighter, sharper, or, for their apertures, stronger resolving object-glasses will not be found. This red correction is peculiarly suitable, because a peacock-green glass screen turns red into black, and so makes a strongly contrasted image. When the *Podura* was first examined with the 1/7 of 0·85 N.A., for the moment it was difficult to exclude the idea that one of the American red objectives was not on the nose-piece."

The outstanding colour in the fluorite objectives is of the same red tint. In these, of course, the outstanding colour is less, and their definition leaves nothing to be desired.

"Complanat" is a new word coined by Winkel for a new set of Huyghenian eye-pieces which are strictly achromatic and have a perfectly flat field.

Messrs. Angus have also sent us Winkel's new form of screw micrometer. This is based on a suggestion of Koch's. A combination of scale and screw replaces the combination of screw and thread, giving a ready means of obtaining the exact measurement of objects subtending a number of divisions of the scale, the fractional part only of an interval having to be determined by means of the screw. In the instrument real or lateral displacement is measured to 1/500 mm., one turn of the screw travelling over two divisions of the scale, an arrangement which we think will be found inconvenient.

The microscope stand is a beautifully finished specimen of the Continental model; an extension of the horseshoe backwards would make it more stable. The graduation of the scales in the attachable mechanical stage, and its general finish, leave nothing to be desired; the old reputation of the firm for fine metalwork is still kept up.

We have also received from Messrs. Angus a microscope and objectives representing the latest productions of the eminent firm of Reichert, of Vienna, together with a catalogue. As was to be expected, both the optical and mechanical parts are of the highest excellence. In the catalogue the number of fluorite lenses employed in each apochromatic objective is stated. The apochromatic of N.A. 1·30 sent us is a magnificent lens with little trace of colour, and its definition does not break down under a power of 3000.

THE FLORA OF FORMOSA.

PREVIOUS to the acquisition of Formosa by Japan, in 1895, little was known of the vegetation of the mountains of the interior. Many European collectors had visited the island, but none had been able to penetrate the central range, on account of the hostility of the natives. The Japanese soon organised a Botanical Survey, and several botanists have been engaged in the investigation of the flora, the results of their labours having been published from time to time, mostly in English, with Latin descriptions of the novelties, and figures of some of the most remarkable plants. The forerunner was the "Enumeratio Plantarum Formosanarum," by J. Matsumura and B. Hayata, which appeared in 1906. This was followed in 1908 by Hayata's "Flora Montana Formosæ"; and the same author has now issued a bulky and important supplement.[2] As is stated on the title-page, Dr. Hayata worked out his collections at Kew, where he had the opportunity of studying numerous types of genera and species of Eastern plants first described by the Kew botanists.

This work and its predecessors are mainly statistical, descriptive, and pictorial, though publications on the economic botany of the island are not wanting. However, it is possible to extract much that is interesting in the composition of the flora. Taking Dr. Hayata's own figures, the "Enumeratio" comprises 1999 species, belonging to 701 genera and 153 families; and the present supplement brings the numbers up to 2660, 836, and 156 respectively. It should be explained that these figures relate to the flowering plants and ferns and their allies only. In nearly all its features and generic elements the flora of Formosa is essentially Chinese, with a very large number of peculiar species. In all probability the number of species existing is far from exhausted; but the very small generic endemic element is not likely to be much increased by future explorations. Excluding ferns, Forbes and Hemsley's "Enumeration of Chinese Plants" includes representatives of 159 families, so that there are nearly as many in the smaller area as in the large. The same fact comes out in comparing a county flora with that of the whole of England, for example. Although the mountains rise to upwards of 13,000 feet, there is no real alpine flora in Formosa, though many genera are represented that are common to temperate and alpine zones.

Of the Cupuliferæ, the genera Fagus, Alnus, Carpinus, Castanea, Castanopsis, and Quercus are represented, the last-named by thirty-two species. Salix is represented by several species; Populus absent. About five and twenty Coniferæ are recorded, including *Chamaecyparis formosensis*, *Cunninghamia Konishii*, *Juniperus morrisonicola*, *J. formosana*, *Picea morrisonicola*, *Pinus formosana*, *P. taiwanensis*, *Tsuga formosana*, and *Taiwania cryptomerioides*, all of which are supposed to be peculiar to the island. The last is a monotypic genus endemic in Formosa. Nepenthes is not known to occur, nor Pedicularis, whereas in China there are about 150 species of the latter.

Vascular cryptogams are evidently strongly represented, as already there are on record upwards of 300 species of ferns, about twelve species each of Lycopodium and Selaginella, and two species of Equisetum. Orchids number about sixty species, mostly small-flowered and inconspicuous. The foregoing totals are partly compiled from Takiya Kawakami's "A List of Plants of Formosa," published in 1910.

W. BOTTING HEMSLEY.

THE INDIAN SALTPETRE INDUSTRY.[1]

THE production of potassium nitrate in India is probably a very ancient industry, and at the present time, in spite of German competition, the export still amounts to about 20,000 tons per annum. As is well known, the potassium nitrate is extracted by natives from soil collected in the villages, where in all probability it has been formed by bacterial decomposition of the organic matter, with production first of ammonia and subsequently of nitrates. The chemical and bacteriological changes have not yet been studied, but the actual methods of extraction have recently been described by Dr. Leather and Mr. Mukerji in a well-illustrated bulletin issued by the Pusa Research Station.

The soil from which the crude saltpetre is extracted usually contains about 3 to 5 per cent. of pure potassium nitrate, although there may be as little as 1 per cent. or as much as 29 per cent.; chlorides and sulphates are invariably present as well. The soil is scraped together in small quantities and collected by a very low caste called "Nuniah" or "Lunia," who also carry out the extraction process. An earthen chamber, called the "Kuria" or "Kothi," is first made of wet mud and then allowed to dry; the floor of this slopes somewhat from back to front, where a hole is made at the lowest point for the escape of the nitrate liquor. Raised a few inches above the floor, and supported by a few loose bricks, is a false bottom made of bamboos and matting, on which the saltpetre earth is laid with the greatest care and so trodden in that no crevices shall exist. As a rule wood ashes are mixed with the earth beforehand. The filling-in process is stopped when the layer of soil is about 6 to 8 inches in thickness; a small piece of matting is then laid on the top, and water is poured in until about one inch lies on the surface of the soil. Several hours elapse before the water has percolated and begun to flow out from the hole. It usually emerges as a fairly concentrated clear solution, coloured brown by

[1] A delicate test for colour is the raphæ of a Cherryfield Rhomboides, when mounted in balsam, quinidine, or styrax.

[2] Materials for a Flora of Formosa. Supplementary Notes to the Enumeratio Plantarum Formosanarum and Flora Montana Formosæ, based on a Study of the Collections of the Botanical Surveys of the Government of Formosa, principally made at the Herbarium of the Royal Gardens, Kew. Journal of the College of Science, Imperial University of Tokyo, vol. xxx., 1911, pp. 471.

[1] "The Indian Saltpetre Industry." By J. W. Leather and Jatindra Nath Mukerji. Agricultural Research Institute, Pusa. Bulletin No. 24, 1911.

organic matter. The first runnings are put into a pan and further concentrated by exposure to the sun, or by boiling over a fire until a mixture of sodium chloride and potassium nitrate, with varying quantities of sodium sulphate and magnesium nitrates, separates out. This is sold to the refiner as crude saltpetre. The mother liquor is thrown on to the heap of saltpetre earth, the so-called factory, to which are also added the wet soil from the "Kuria" and the weaker solution of nitrates coming out in the later stages of the percolation, and requiring too much fuel to make further concentration worth while. After a time the heap can again be extracted, and so the process goes on perpetually. Fresh village earth is constantly being added, but no special additions of organic matter seem to be made.

At the refinery the crude saltpetre, the impurities of which are soil, sodium sulphate, sodium chloride, and magnesium nitrate, is added to a boiling mother liquor from a previous operation. This liquor, being already saturated with sodium chloride and sodium sulphate, only dissolves the nitrate. When the insoluble matter has subsided, the clear liquor is run into wooden vats, and on cooling deposits a good deal of potassium nitrate, that only requires to be drained and slightly washed to be ready for market. The insoluble material still contains some potassium nitrate, and is thrown out on to the factory heap of nitre earth, from which more nitrate is subsequently again extracted as before. The mother liquor cannot be used indefinitely for the purification of the crude saltpetre, but it is not wasted. When it becomes too impure for further use, it is concentrated to deposit some of the sodium chloride, and the final liquor is simply thrown on to the factory heap again. Whilst the extraction process is remarkably efficient, considering that it has been evolved by the natives themselves without outside help, the refinery process is admittedly wasteful, and various improvements are suggested by Messrs. Leather and Mukerji.

GEOPHYSICAL RESEARCH.[1]

TO write the history of the earth is a very different undertaking from writing the history of a people. In the latter case, a diligent seeker can usually find some ancient monastery where far-sighted historians of an earlier generation have collected the more important records which he requires, and placed them within reach of his hand. With the earth's history, which is the province of geology, it is another matter. The great globe has been millions of years in the making, and, except for a mere fragment of its most recent history, it has had neither a historian nor an observer. Its formation has not only extended over an almost incomprehensible interval of time, but we have no parallel in our limited experience to help us to understand its complicated development, and no system of classification adequate to the task, even of grouping in an orderly way all the observed rock and mineral formations with reference to the forces which moulded them. And even if we could correctly interpret all the visible rock records, we are still quite helpless to comprehend all those earlier activities of the formation period, the record of which is now obliterated.

To the student of the earth's history, therefore, the problem of gathering and ordering such a widely scattered and heterogeneous collection of effects and causes is one of somewhat overwhelming scope and complication. In the industrial world, a situation of this kind soon results in replacing individual effort with collective effort, in the organisation of a system of a scope more appropriate to the magnitude of the task. We are familiar with industrial organisation and the wonderful progress in the development of American industries which has everywhere followed it. We are also familiar with organised geological surveys and the success which has attended them in geological and topographical classification. But the idea of organising research to meet a scientific situation of extraordinary scope and complexity is still comparatively new. The very words science and research are still regarded as referring to something out of the ordinary, something to be withheld from the common gaze, to be kept hidden in a special niche, behind a mysterious curtain and served by priests of peculiar temperament and unpractical ideals. This is both disparaging to our good sense and prejudicial to the progress of knowledge. Scientific research is not a luxury; it is a fundamental necessity. It is not a European fad, but is the very essence of the tremendous technologic and industrial success of the last twenty years, in which we have shared.

Prof. Nichols, of Cornell, as retiring president of the American Association for the Advancement of Science, put the case in this way: "The main product of science (research) . . . is knowledge. Among its by-products are the technologic arts, including invention, engineering in all its branches, and modern industry." The idea of scientific research is therefore not less tangible than industrial development, or less practical; it is merely one step more fundamental; it is concerned with the discovery of principles and underlying relations rather than their application. This being true, research should profit as much from efficient organisation as industrial development has done, or even more.

Although this conclusion is making its way but slowly in American science, in geological research, where material must be gathered from the utmost ends of the earth and even from within it, and where nearly every known branch of scientific activity finds some application, there is a peculiarly favourable opportunity for organised effort which is already coming to be recognised. "So long as geology remained a descriptive science," says President Van Hise, of Wisconsin, "it had little need of chemistry and physics; but the time has now come when geologists are not satisfied with mere description. They desire to interpret the phenomena they see in reference to their causes—in other words, under the principles of physics and chemistry. . . . This involves cooperation between physicists, chemists, and geologists."

In a general way, physics, chemistry, and biology have already supplied working hypotheses which have been used by students of geology to help in the examination, classification, and mapping of the most conspicuous features of the exposed portion of the earth. The geologist has gone abroad and has studied the distribution of land and water, the mountain ranges, the erosive action of ice and of surface water and the resulting sedimentary deposits, the distribution of volcanic activity and of its products, the igneous rocks; or more in detail he has studied the appearance of fossils in certain strata, and has inferred the sequence of geologic time. The distribution of particular minerals and of ore deposits has been carefully mapped. Regions which offer evidence of extraordinary upheaval through the exercise of physical forces have been painstakingly examined, and so on through the great range of geologic activity. In a word, the field has been given a thorough general examination; but the manifold problems which this examination has developed, although early recognised, and often the subject of philosophical speculation and discussion, still await an opportunity for quantitative study. They are often problems for the laboratory and not for the field, problems for exact measurement rather than for inference, problems for the physicist and chemist rather than for the geologist. This is not a result of oversight; it is a stage in the development of the science —first the location and classification of the material, then the laboratory study of why and how much.

Certain indications have led us to believe, for example, that the earth was once completely gaseous and in appearance much like our sun. Indeed, it possibly formed a part of the sun, but through some instability in the system became split off—a great gaseous ball which has cooled to its present condition. The cooling probably went on rapidly at first until a protecting crust formed about the ball, then more and more slowly, until now, when our loss of heat by radiation into space is more than compensated by heat received from the sun. Obviously, the earliest portions of this history are, and must remain, dependent upon inference, but the formation of a solid crust cannot advance far before portions of it become fixed in a form such that further disturbance does not destroy

[1] Presidential address delivered at the 700th meeting of the Philosophical Society of Washington, November 25, 1911, by Dr. Arthur L. Day. Reprinted from the Journal of the Washington Academy of Sciences, December 4, 1911.

their identity. From this point the history of the earth is a matter of record, and can be interpreted if only we have sufficient knowledge of the mineral relations through all the stages of their development.

It must have been a very turbulent sea, the molten surface of our earth upon which the rocky crust began to form. The first patches of crust were probably shattered over and over again by escaping gases and violent explosions, of which our waning volcanic activity is but a feeble echo. If the earth was first gaseous, and the outer surface gradually condensed to a liquid, its outer portions at least must have been whirled and tumbled about sufficiently, even in a few thousand years (which is a very small interval in the formation of an earth), to mix its various ingredients pretty thoroughly. It has accordingly been hard to see just how it came to separate into individual rocks of such widely different appearance and character. Of course, the number of its ingredients was large. We have already discovered eighty or more different elementary substances in the earth, and there is an almost endless number of more or less stable compounds of these. The freezing of an earth is therefore different from the freezing of pure water, but the freezing of salt water offers a clue to the explanation of the way in which the earth solidified as we find it. When salt water freezes the salt is practically all left behind. The ice contains much less salt, and the remaining water relatively more salt than before freezing began. Applying this familiar observation to the supposed molten surface of the earth as it begins to solidify, we have a suggestion of order and reason in its separation into so many kinds of rocks.

Now it happens that in the recent development of chemistry much attention has been given to the study of solutions of various kinds, and a great body of information has been gathered and classified, of which our observation upon the freezing of salt water is a simple type. Still more recently (quite lately, in fact) it has occurred to many students of the earth that here lies not only the clue, but perhaps the key, to their great problem. If the individual components which are intimately mixed in solution separate wholly or partially in some regular way upon freezing—and nearly all the solutions which have been studied appear to show such segregation—we have a quantitative system which will probably prove adequate to solve the problem of rock formation, provided only that the experimental difficulties attending the study of molten rock and the complications imposed by the presence of so many component minerals do not prove prohibitive. This is a very simple statement of the point of view which has led to the experimental study of rock formation in the laboratory as a natural sequence to statistical study in the field.

Geophysics, therefore, does not come as a new science, nor as a restricted subdivision of geology, like physiography or stratigraphy, but rather to introduce into the study of the earth an element of exactness, of quantitative relation. It may include physics or chemistry, biology or crystallography or physical chemistry, or all of these at need. The distinctive feature of geophysics is not its scope, which may well be left to the future, but its quantitative character. The geophysical laboratory of the Carnegie Institution at Washington has entered upon some of the investigations suggested by this long preliminary study of the earth—the physical properties and conditions of formation of the rocks and minerals. The department of terrestrial magnetism of the same institution has undertaken another—the earth's magnetism; the German Geophysical Laboratory at Göttingen a third—the earthquakes; and these will no doubt be followed by others.

The first effect of calling exact science into consultation upon geologic problems is to introduce a somewhat different viewpoint. It has been our habit to study the minerals and the rocks as we find them to-day, after many of the causes which have had a share in their evolution have ceased to be active—after the fire has gone out. If we attempt to reconstruct in our minds the operations which enter into the formation of an igneous rock or of a body of ore, we must infer them from present appearances and environment. The experimental geophysicist, on the other hand, confronting the same problem, says to himself: Can we not construct a miniature volcano in the laboratory? Can we not build a furnace in which an igneous rock can be formed under such conditions that we can observe its minutest change? He proposes to introduce temperature-measuring devices and apparatus for the determination of pressure, to investigate the character of the surrounding atmosphere and the quantity of water vapour which may be present. He insists upon the chemical purity of every ingredient which goes into the furnace, and guards it carefully against contamination. In these various ways he will undertake to ascertain the exact magnitude of all the causes, both physical and chemical, which have been at work in his miniature rock-producer, together with the physical characteristics of the product.

A very practical question now arises: Can he do all this successfully at the temperatures where the minerals form? We must press this question and insist upon a satisfactory answer, for it is by no means obvious that the relations which the physicist and chemist have established at the temperatures of everyday life—energy content, density, solubility, viscosity, dissociation—will continue to hold when substances are carried up to a white heat. The substances, too, are different from those with which the chemist and physicist have been generally familiar. Instead of simple metals, aqueous solutions, and readily soluble active salts, we encounter silicates and refractory oxides, inert in behaviour and capable of existing together in mixtures of great complexity. We must therefore extend the range of our physics and our chemistry to a scope in some degree commensurate with the wide range of conditions which the earth in its development has passed through. Let us follow for a little the actual progress of such an attempt.

The first step is to provide the necessary temperatures. Obviously, the common fire-clay crucible and the smelter's furnace, with its brick lining, will not serve us here, for all these are themselves mineral aggregates. The charge, furnace lining, and crucible would go down together in a fall as disastrous as Humpty Dumpty's. But experiment has taught us that platinum crucibles, magnesia furnace tubes enclosing an electrically heated helix of platinum wire, and electric temperature-measuring devices, provide a furnace in which nearly all the important minerals can be successfully studied, which is not enough to melt zinc, silver, gold, copper, nickel, or iron readily, and where any temperature up to 1600° C. can be maintained perfectly constant, if need be, for several weeks. All these temperatures can be measured with no uncertainty greater than 5°. This equipment preserves the chemical purity of the mineral studied, and enables the temperature to be controlled and measured at every step of the experimental work. Or an iridium furnace tube and an iridium crucible can be substituted for platinum, the magnesia supports can still be used, and we have it in our power to go on to 2000° C., which is quite sufficient for all the more important minerals which we know.

The physicist has therefore found a suitable melting-pot, and means of ascertaining what goes on within the pot; but he at once encounters another difficulty. Nature has provided us with relatively few minerals of high chemical purity. If a natural mineral is chosen for experiment, however typical it may be, several per cent. of other minerals may be expected to be present with it, the effect of which is at present quite unknown. Now the first axiom of the investigator in a new field who desires to undertake measurements which shall have a real value is that the number of unknown quantities in his equations must not be greater than he can eliminate by his experimental processes; in other words, he must begin with conditions so simple that the relation between a particular effect and its cause can be absolutely established without leaving undetermined factors. Having solved the simple case, it is a straightforward matter to utilise this information to help solve a more complicated one. If we would therefore reduce the mineral relations to an exact science, which is our obvious purpose, it is necessary from the outset to prepare minerals of the highest purity and to establish their properties. Having obtained such a pure mineral type, it may be, and often is, in the power of the mineralogist and his microscope to determine, by direct comparison with its natural prototype, the kind and amount of effect actually produced in the natural mineral by the one or more other minerals which it contains. We have therefore scarcely started upon our investigation before the need of an organised system is demonstrated: first comes the chemist, who prepares and analyses the pure mineral for investigation; then the physicist, who provides and measures the conditions to which it is subjected; then the mineralogist, who establishes its optical properties in relation to the corresponding natural minerals.

Having prepared such a mineral, of high purity and of known crystalline character, we can ascertain its behaviour at the temperatures which must have obtained during the various stages of earth formation. We can study the various crystal forms through which it passes on heating and the temperature ranges within which these forms are stable; we can also melt it and measure the melting or solidifying temperature. Another mineral, prepared with the same care and studied in the same way, may afterward be added to the first, and the relation of these two determined. If they combine, heat is absorbed or released; and this quantity of heat can be measured, together with the exact temperature at which the absorption or release takes place. If the mixture results in the formation of one or more mineral compounds, we shall learn the conditions of formation, the temperature region within which the new forms are stable, and the changes which each undergoes with changes of pressure and temperature, as before. If the new forms show signs of instability, we can drop them into cold water or mercury so quickly that there will be no opportunity to return to initial stable forms, and thus obtain, for study with the microscope at our leisure, every individual phase of the process through which the group of minerals has passed.

Without complicating the illustration further, it is obvious that we have it in our power to reproduce in detail the actual process of rock formation within the earth, and to substitute measurement where the geologist has been obliged to use inference; to tabulate the whole history of the formation of a mineral or group of minerals under every variety of condition which we may suppose it to have passed through in the earth, provided only we can reproduce that condition in the laboratory.

During the past quarter of a century there has arisen in the middle ground between physics and chemistry a new science of physical chemistry, in the development of which generalisations of great value in the study of minerals have been established. So long ago as 1861 the distinguished German chemist, Bunsen, pointed out that the rocks must be considered to be solutions, and must be studied as such; but inasmuch as comparatively little was known about solutions in those days, and the rocks at best appeared to be very complicated, no active steps in that direction were taken during Bunsen's life. But in recent years solutions have been widely studied, under rather limited conditions of temperature and pressure, to be sure, but it has resulted in establishing relations—like the *phase rule*—of such effective and far-reaching character that now, after half a century afterward, we are entering with great vigour upon the prosecution of Bunsen's suggestion. It is now possible to establish definite limits of solubility of one mineral in another, and definite conditions of equilibrium, even in rather complicated groups of minerals, which enables us not only to interpret the relations developed by such a thermal study as that outlined above, but also to assure ourselves that only a definitely limited number of compounds of two minerals can exist, that they must bear a constant and characteristic relation to each other under given conditions of temperature and pressure, and that changes of temperature and pressure will affect this relation in a definite and determinable way. Physical chemistry not only takes into account the chemical composition of mineral compounds, but their physical properties as well, throughout the entire temperature region in which they have a stable existence, and therefore furnishes us at once with the possibility of a new and adequately comprehensive classification of all the minerals and rocks in the earth. The value of an adequate system of classification appeals chiefly to those whose duties bring them into intimate relations with the subject-matter of a science; but so much may appropriately be said, that a consistent application of physical chemistry to the minerals may operate in the not far distant future to develop an entirely new conception of the science of mineralogy.

As the number and scope of such exact measurements increase, we gradually build up what may be called a geologic thermometer. Just as the location of fossils offers a basis for estimating geologic time, it often happens that a mineral takes on a variety of different crystal habits, according as it happened to form at one temperature or another. Quartz, for example, which is one of the commonest of natural minerals and one of the most familiar, undergoes two changes in its crystal form which leave an ineffaceable record. One occurs at 575° and the other at 800°. An optical examination of even a minute quartz fragment from the mountain side will reveal to the skilful petrologist whether the crystal formed at a temperature below 575°, between 575° and 800°, or above 800°. And if we could have at our disposal a great body of such exact measurements of the temperate region within which particular crystals originate and remain stable, we could apply that directly to terrestrial formations in which this mineral occurs, and read therein the temperature which must have obtained during their formation. All this will not be done in the first year, and perhaps not in the first decade; but the ultimate effectiveness of this method of procedure in establishing the relations between the minerals and the valuable ores is now as certain of success as the operations of any of the sciences which have now come to be characterised as exact, as opposed to descriptive.

There is one important difference between the great laboratory of nature and its feeble human counterpart. Nature operated with large masses, mixed with a generous hand, and there was always plenty of time for the growth of great individual crystals, at which we marvel whenever we encounter them, and which we have sometimes come to regard highly as precious stones. To carry these processes into the laboratory is necessarily fraught with certain limitations. The quantities must remain small, and the time and available financial resources will always be limited. So long as we are able to ascertain the optical character of a crystal with equal exactness, whether the crystal is of the size of the proverbial mustard-seed or a walnut, the scientific laboratory cannot properly afford the time necessary to produce the large crystals which nature offers so abundantly. Furthermore, the crystals of nature often owe their brilliant colouring to slight admixtures of impurity, which to the scientific laboratory spell failure, and are avoided with the utmost care. Most of the mineral crystals, when reproduced in the laboratory, are quite colourless. And so, although the question is often raised whether we are not really engaged in the artificial production of gems, and although the seductive character of such an investigation would no doubt appeal to many, it must be admitted that the geological laboratory is not, and probably will never become, the serious competitor of nature in those directions in which nature has produced her most brilliant effects.

In what has preceded I have laid emphasis upon the value of experimental measurements in the systematic development of a more exact science of the earth. It is a fair question, and one which is very often raised, whether all this investigation has a utilitarian side—whether the knowledge obtained in this way, and with such difficulty, will help to solve any of the problems arising in the exploitation of our mineral resources or assist in our industrial development. It is neither wise nor expedient in entering upon a new field of research to expatiate long upon its practical utility. Its principles must first be established, after which there is no lack of ingenuity in finding profitable application of them.

The development of thermoelectric apparatus for the accurate measurement of high temperatures was begun and has been perfected in the interest of geophysical research, and it has already found such extended application among the technical industries as to demand the manufacture and calibration of thousands of such high-temperature thermometers every year. The tempering and impregnation of steel are no longer dependent upon the more or less trained eye of the workman, but are done at measured temperatures and under known conditions which guarantee the uniformity of the product and admit of adaptation to particular purposes, like high-speed tools or armour-plate. This has the incidental but far-reaching industrial consequence that workmen of great individual skill in these industries are much less necessary now than formerly. Everything is accomplished by bringing temperature conditions under mechanical control, and making them absolutely reproducible without the exercise of critical judgment on the part of anyone.

A more intimate knowledge of the behaviour of the minerals themselves finds almost immediate industrial application. An industry which has grown to enormous proportions in recent years is the manufacture of Portland cement, about which little more has been known than that if certain natural minerals were taken in the proper proportions and heated in a peculiar furnace developed by experience, the resulting product could be mixed with water to form an artificial stone which has found extensive application in the building trades. Chemical analysis readily established the fact that the chief ingredients in a successful Portland cement were lime, alumina, and silica, with a small admixture, perhaps, of iron and magnesia; but the relation in which these ingredients stood one to another—that is, which of them were necessary and which merely incidental—and in what compounds and what proportions the necessary ingredients required to be present, has never been satisfactorily established. When we know the stable compounds which lime, alumina, and silica can combine to form, together with the conditions of equilibrium between these for different temperatures and percentages of each component, a formula can be written offhand for a successful Portland cement from given ingredients somewhat as an experienced cook might write out the recipe for a successful dish. Such definite and valuable knowledge is not beyond our reach. To obtain it requires, in fact, precisely the same system of procedure as that described above, which has already been successfully applied to many of the natural minerals reproduced and studied in the Geophysical Laboratory during the past five years. It happens that we have examined a considerable number of these very mixtures in our recent work upon the rocks. All the compounds of lime, silica, and alumina have been established, and a portion of the silica-magnesia series and their relations have been definitely determined throughout the entire range of accessible temperatures. There is no reason to apprehend serious difficulty in applying the same procedure to the commercial ingredients of Portland cement, and replacing the present rule-of-thumb methods and uncertain products with dependable cements. The problem of determining the relation of the ingredients in commercial cement and the conditions necessary for its successful formation is exactly the same in character as that of determining the conditions of formation of the rocks of the earth.

A physico-chemical investigation of the sulphide ores over a wide range of temperatures and pressures has also been undertaken, which has developed a large body of exact information of value in the mining industry. And such illustrations could be continued almost indefinitely if it would serve any useful purpose to do so.

The industrial world is not, as a rule, interested in scientific principles; the principle must first be narrowed down to the scope of the industrial requirement before its usefulness is apparent. The immediate effect of an industrial point of view is therefore to restrict investigation at the risk of losing sight of underlying principles entirely. An illustration of this has come down to us through the pages of history of a character to command and receive the utmost respect, for such another can hardly be expected to occur. We have honoured the early philosophers for their splendid search after broad knowledge; but in what is now the field of chemistry, they allowed themselves to be turned aside to the pursuit of a single, strictly utilitarian problem—the transmutation of base metals into gold. The history of chemistry is a history of this one problem from the fourth to the sixteenth century—twelve centuries before a man arose whose broader point of view enabled him to divert the fruitless search into other channels, from which a science has slowly arisen which is now so broad as to overlap most of the other sciences, and withal so practical that scarcely an industry is entirely independent of it.

The so-called practical questions may therefore as well be left to take care of themselves. There has been no lack of ingenuity in making profitable application of systematic knowledge whenever the need for it became insistent, for the rewards of such effort are considerable. And it is no longer an argument against proceeding to establish relationships in a new field that the scope of their application cannot be completely foreseen.

Now, what more promising questions occur to one than these: If the earth was originally fluid, as it appears to have been, and has gradually cooled down to its present state, its component minerals must at some time have been much more thoroughly mixed than now; how did they come to separate in the process of cooling into highly individualised masses and groups as we now find them, and what were the steps in their deposition? If the whole earth was hot, whence came the marble of which we have so much and which can withstand no heat? What has given us the valuable deposits of iron, of gold, of precious stones? What determines the various crystal forms found in the different minerals, and what is their relation? Some must have formed under pressure, some without pressure, some with the help of water, and some without. Where is the centre, and what the source of energy in our volcanoes? All these questions, and many more, the geophysicist may attempt to answer.

THE AGE OF THE EARTH.[1]

THE doctrine of uniformity in geology stated by Hutton in the words "we find no vestige of a beginning and no prospect of an end" was accepted by many until Lord Kelvin surprised this school of geologists in 1868 by drawing a very decided limit to the possible age of the earth.

Lord Kelvin assumed that in the remote past the earth was molten, and that it cooled down as a whole uniformly until the crust just solidified. Then the earth's interior is at a definite temperature (which we can now roughly estimate from the melting point of the rocks of the crust), while the surface has much the same temperature as now. The rate of cooling is determined by the thermal conductivity of the crust, *i.e.* by the rate at which the interior heat can escape.

It becomes possible to calculate what the temperature gradient near the surface will be at any subsequent time, or conversely, if we know the temperature gradient, to calculate what time has elapsed since the crust solidified.

By the age or antiquity of the earth I understand Lord Kelvin means the time that has elapsed since the crust solidified. The "geological age" would be less than this. The antiquity of a rock (or mineral) would only in the case of the oldest rocks be the same as the geological age. Thus the age of a mineral is a minimum estimate of the earth's age.

The temperature gradient at a depth x and time t is

$$d\theta/dx = \theta_0 e^{-x^2/4Kt}/\sqrt{4\pi Kt}.$$

where θ_0 is the initial surface temperature, K the conductivity of the material of the earth.

In applying this to the earth, we notice that x is small and t large, so that

$$d\theta/dx = \theta_0/\sqrt{4\pi Kt}.$$

All these quantities are known except t. Lord Kelvin's estimates of the antiquity of the earth, using this method, varied a good deal, but forty million years was the maximum he would admit latterly.

Sources of heat, the radio-active elements, are now known which Lord Kelvin did not, of course, take into account. The earth can no longer be regarded as a body possessing only its sensible heat to supply the stream continually flowing from the interior to the surface—heat which is, presumably, radiated into space.

Lord Kelvin's treatment of the problem might be modified by taking into account the additional supply of "radio-active" heat. But the discoveries of radio-activity afford, it appears to the writer, an alternative treatment of the history of the earth which is more convincing. This treat-

[1] Portion of the presidential address delivered to Section A, Australasian Association for the Advancement of Science, 1911, by Prof. T. H. Laby.

ment consists in accepting the antiquity of the earth, as found by Prof. Strutt using a radio-active method, and then examining the heat of the earth in the light of that result. Every estimate as to the age of the earth assumes to some degree a uniformity of present phenomena throughout the whole life of the earth; this uniformity is assumed by Sir Archibald Geikie in the rate of deposition of sediments,[2] by Prof. Joly for the addition of sodium to the sea,[3] by Lord Kelvin for the conduction of heat by rocks, and, finally, by Prof. Strutt for the rate of accumulation of helium in minerals or rocks.[4] Now of all these processes the last is the only one which is not altered by temperature, pressure, or other physical conditions.

Prof. Strutt has concluded from a very refined determination of (1) the present rate of production of helium, and (2) the total accumulated helium in thorianite that it has taken 280 million years for the helium to accumulate. As the earth is presumably older than the mineral, this is a minimum age for the earth.

The Heat of the Earth.

The question at once arises how is it that the temperature gradient of the crust is not less than it actually is, for, according to Lord Kelvin, after only forty million years the gradient would have fallen to the present value. During the remaining 240 million years it would have gone on decreasing at a rate proportional to the square root of the time. It becomes evident, then, that there is actually a need for the heat supplied by the radio-activity of the crust if all these deductions are to be reconciled.

The Heat Stream from the Interior.

The heat stream from the interior is that flowing through the earth's surface layers. This is

$$H = 4\pi r^2 K\, d\theta/dr$$
$$= 5{\cdot}1 \times 10^{18} \times 0{\cdot}004 \times 1/3200$$
$$= 6{\cdot}4 \times 10^{12} \text{ calories per sec.,}$$

where r is the earth's radius, $d\theta/dr$ the temperature gradient of the crust at the earth's surface, and K its thermal conductivity. We must attempt to substitute such numerical values for the temperature gradient and the conductivity as will give a correct result for the earth's whole surface. The nature of the data is indicated by the following[5] estimates:—

Land Surface; Average Temperature Gradient			
Prestwich ...	1° C. per 2430 cm.	Geikie ...	1° C. per 3100 cm.
Kelvin	,, 2750 ,,	Brit. Assn. ...	,, 3240 ,,
Schardt ...	,, 3200 ,,	C. King ...	,, 3890 ,,

The value used above is 1° per 3200 cm.

Land Surface	Conductivity at ordinary temperature in calorie degree^{-1} cm.$^{-1}$ sec.$^{-1}$
Sedimentary rocks	0·0053 to 0·0021; mean 0·0041
Igneous rocks ...	0·0053 to 0·0017; mean 0·0042

There is more uncertainty in the value of K than in that of $d\theta/dr$. A more accurate estimate of the heat loss of the earth is desirable. Convection currents make the conduction method ordinarily inapplicable to the sea or lakes; but under special conditions, such as fresh water between 0° and 4° C., might not the method be applicable to a lake?

Heat from Radium and Thorium in Rocks.

Lord Kelvin supposed that this heat stream, which we see amounts to 6×10^{12} calories per sec., came from the sensible heat of the earth's interior as it cooled by loss to the surface. That the heat of disintegration of radium might play an important part in cosmical physics was pointed out by Rutherford and Soddy.[6] The accurate determination of radium and thorium in rocks has shown that there is an embarrassingly large supply of heat being continuously emitted by these substances. Determinations of radium in rocks have been made by Strutt and Joly and others, but there is need for a systematic survey.

Radium in Igneous Rocks.

Number of rocks	Mean radium content in gm. per gm. of rock	Observer
28	$1{\cdot}7 \times 10^{-12}$	Strutt (Proc. Roy. Soc., May, 1906) corrected by Eve.
4	2·16 ,,	Eve and McIntosh (Phil. Mag., Aug., 1907).
19	0·79 ,,	Fletcher (Phil. Mag., July, 1909, in Joly's laboratory).
13	1·46 ,,	Farr and Florance (Phil. Mag., Nov., 1909).
Mean 64	1·3 ,,	Observers other than Joly.
126	7·01 ,,	Joly ("Radioactivity and Geology," Phil. Mag., Oct., 1909).

There is rather a wide difference between the mean of Joly's large number of determinations and the mean of other observations. There is clearly a discrepancy, which would probably be most quickly elucidated by the chief observers determining the radium in specimens of the same rock. If we give equal weight to the mean of Joly's observations 7×10^{-12}, and to $1{\cdot}3 \times 10^{-12}$ the mean of other observers, the final average is $4{\cdot}1 \times 10^{-12}$ gm. Now the heat given out by radium[7] in complete radio-active equilibrium (uranium to radium F)[8] is 0·06 calorie per sec. per gm., so that each gm. of the earth's crust, on account of the radium it contains, is the source of $4{\cdot}1 \times 10^{-12} \times 0{\cdot}06 = 2{\cdot}5 \times 10^{-13}$ calorie per sec., a source of heat unaffected, so far as experiment has shown, by temperature or pressure.

Thorium in the Earth's Crust.

But the uranium-radium series are not the only source of such heat; thorium is also widely distributed. Fewer rocks have been examined for it than for radium, but the following results have been recorded:—

Thorium in Igneous Rocks.

Number of rocks	Locality	Thorium per gm. of rock	Observer
19	Transandine	$0{\cdot}56 \times 10^{-5}$	Fletcher, Phil. Mag., July, 1910
59	St. Gothard and Lavas	1·3 ,,	Joly, Phil. Mag., July, 1909
4	European ...	5·0 ,,	Blanc, Phil. Mag., 1909
Mean for 82		$1{\cdot}3 \times 10^{-5}$	

The heat emitted by thorium in radio-active equilibrium is 5×10^{-9} calories per sec. per gm.,[9] and that by the average amount of thorium in rocks $6{\cdot}5 \times 10^{-14}$ cal. sec.$^{-1}$ gm.$^{-1}$.

Heat due to Radium and Thorium in Rocks.

Thus the heat emitted by the uranium, radium, and thorium found in surface rocks is $(24{\cdot}6+6{\cdot}5)10^{-14} = 3 \times 10^{-13}$ cal. per sec. per gm. Blanc,[10] having found nearly four times as much thorium as our mean value, concluded that thorium contributed as much heat as uranium and radium.

Distribution of Radio-active Elements.

If the whole mass of the earth (6×10^{27} gm.) were the source of as much radio-active heat as the surface rocks, the heat emitted would be $1{\cdot}8 \times 10^{15}$ calories per sec., or about 300 times the heat flowing from the interior as deduced from the conductivity and temperature gradient of the surface rocks. But if the interior of the earth gains more heat than it loses, then its temperature is rising; nor is the geological and other evidence that the earth was once

2 Geikie, Brit. Ass. Rep., 1899.
3 Joly, Brit. Ass. Rep.
4 Strutt, Proc. Roy. Soc.
5 Joly, "Radioactivity and Geology."
6 Phil. Mag., May, 1903; Proc. Roy. Soc.

7 Von Schweidler and Hess, "Le Radium," February, 1909.
8 Boltwood, *Amer. Journ. Sci.*, 1908.
9 Pegram and Webb, *Phy. Rev.*, 1908.
10 Science Abs., No. 1057, 1909.

hotter than now the only contradiction to a "heating-up" earth.

Assuming, as before, the antiquity of the earth to be at least 300 million years (t), then in that period a supply of heat of 3×10^{-13} cal. per gm. per sec. (h) would have raised the interior of the earth to a temperature given by

$$S\theta = ht$$
$$\theta = 3\times10^{-13}\times3\times10^{8}\times3\cdot2\times10^{7}/0\cdot02 = 14{,}000^{\circ}\text{ C.},$$

where S is the specific heat of the internal material. Though loss by conduction to the surface and latent heat effects are here neglected, the calculation is sufficient to show that a uniform distribution of the radio-active elements would give rise to internal temperatures too high to be reconciled with the observed temperature gradients.[11] We may safely conclude that there is very much less uranium, radium, and thorium in the inner portion of the earth than there is in the crust, and a maximum limit may be assigned to the content of radio-active elements. It would appear a minimum limit may also be set.

According to Lord Kelvin, as we have seen above, a period of cooling of more than forty million years could not have elapsed between the solidification of the terrestrial crust and the establishment of the present temperature gradient. If, however, the antiquity of the earth is more than 300 million years, then the temperature gradient has been maintained by some other source of heat, and the radio-activity of the rocks is amply sufficient for the purpose if it extends to quite moderate depths. The present temperature gradient would be maintained for an indefinite time if the stream of heat from the interior came from the radio-activity of the rocks.

There would need to be $6\times10^{12}/0\cdot06 = 10^{14}$ gm. of terrestrial radium to supply the heat lost by conduction, for a layer of the earth's crust 14 km. deep, if of density 3, has a mass of $2\cdot1\times10^{25}$, and it would give out $2\cdot1\times10^{25}\times3\times10^{-13} = 6\times10^{12}$ cal./sec., assuming the content in this surface layer of radium and thorium, and therefore the heat emission was that of the surface rocks. There is very probably at least this amount of the radio-active elements; otherwise it is not apparent why the temperature gradient of the crust has its present value, though the antiquity of the earth probably exceeds 300 million years. If the age greatly exceeds that period, then the present temperature gradient can depend but little on the secular cooling of the earth from a molten state.

Prof. Strutt[12] has determined the minimum age of thorianite by evaluating the ratio

$$\frac{\text{The quantity of helium in the mineral at present}}{\text{The rate at which the helium is produced}}$$

The refinement of the experiment will be appreciated when it is recalled that the rate of production of the helium is only 4×10^{-8} c.c. per gm. of thorianite per year. He found, as already mentioned, 280 million years for the age of one specimen and 250 millions for another.

To deduce a minimum age for a mineral in this manner it must be assumed that—

(1) There was no original store of helium in the mineral when it was formed.

(2) The mineral has not gained helium at any time except as it does now.

(3) That the present rate of accumulation of helium is the same as in the remote past, when possibly high pressures and temperatures obtained.

The observational basis for these assumptions are:—

For (1) and (2). If the helium was originally present in the mineral when it was formed, or added later, then we would expect to find helium in other minerals in which helium is not now accumulating, but no such minerals are known. Helium is only found in appreciable quantities when associated with thorium and uranium. The mechanism[13] of how it is continuously and unchangingly produced from these elements is known in great detail.

For (3). That radio-active changes are independent of temperature and pressure has been repeatedly tested and confirmed.

[11] This will be seen at once to follow from a calculation given by Strutt, Proc. Roy. Soc., p. 482, 1906.
[12] Proc. Roy. Soc., lxxxiv., 379, 1910.
[13] See for example Rutherford, Nobel lecture, 1908.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Marquise Arconati Visconti has made a donation of 500,000 francs to the University of Paris, to be employed for the benefit of the faculties of science and arts.

IN connection with the Institute of Chemistry, Mr. C. F. Cross will deliver the first of two lectures on "Cellulose" at University College, London, on Friday, January 26. Sir William Ramsay, K.C.B., F.R.S., will preside.

THE post-graduate scholarship, of the value of 200*l.* per annum, in naval architecture has been awarded by the Royal Commissioners for the Exhibition of 1851 to Mr. Arthur Cannon, of Glasgow University, and formerly of the Royal Naval College, Greenwich.

WE learn from the issue of *Science* for December 15, 1911, that nearly a hundred students from the college of engineering of the University of Wisconsin were then on their yearly tour of inspection of great engineering plants of the eastern States. Engineering plants in Chicago, Milwaukee, Niagara Falls, Pittsburg, Schenectady, N.Y., and New York City were visited. These tours are required of students of engineering during their junior and senior years, and are arranged to cover industries that illustrate the work of the course pursued by the student. Four professors accompanied the students on their tour of inspection.

THE annual meeting of the Geographical Association will be held on January 13 at University College, Gower Street, London, W.C. In the morning, at 11 a.m., a discussion on the organisation of home-work in school geography will be opened by Prof. L. W. Lyde, and a paper on the population of the world will be read by Prof. A. J. Herbertson. In the afternoon, at 3 p.m., Dr. G. R. Parkin will deliver his presidential address, and afterwards Prof. Herbertson will exhibit lantern views of typical land-forms selected by a committee of the International Geographical Congress, and Miss S. Nicholls maps and views of typical land-forms in the Near East.

IT is announced in *Science* that by the will of Mrs. Jan K. Sacher the University of California is to receive 100,000*l.* The will stipulates that 40,000*l.* is to be spent on a granite campanile tower, 300 feet in height, to be erected in the centre of the University grounds. An endowment of 100,000*l.* has been secured, we learn from the same source, by Huron College, in Huron, S.D. St. Lawrence University, too, has obtained a 40,000*l.* endowment fund, of which the General Education Board has contributed 10,000*l.* Our contemporary also states that by the will of Miss J. M. Smith the sum of 1000*l.* is given to the American Association for the Advancement of Science. Similar bequests are made to the National Geographic Society of Washington and to the American Forestry Association of Washington. Other items of interest to men of science are 2000*l.* to the University of Pittsburg, 2000*l.* to the Allegheny Observatory, and 1000*l.* to the School of Liberal Arts and Sciences.

THE Senate of the University of St. Andrews has decided to confer the honorary LL.D. degree, *in absentia*, upon the following distinguished men, who were chosen for the degree on the occasion of the celebration of the 500th anniversary of the foundation of the University last September, but were unable to be present on that occasion:—Prof. Pietro Blaserna, professor of experimental physics in the University of Rome, president R. Accademia dei Lincei; Prof. M. J. M. Hill, F.R.S., Astor professor of pure mathematics, University College, London, and lately Vice-Chancellor of the University of London; Prof. Hugo Kronecker, professor of physiology, University of Berne; Prof. G. M. Mittag-Leffler, professor of pure mathematics in the University of Stockholm and Rector of that University, founder and editor of *Acta Mathematica*; M. Paul Meyer, directeur de l'Ecole Nationale des Chartes, Paris, professeur honoraire au Collège de France; Prof. Karl Pearson, F.R.S., Galton professor of eugenics and director of the Laboratory of National Eugenics, University of London; Mr. Charles D. Walcott, secretary of the Smithsonian Institution, Washington, U.S.A.; and Prof. P. Zorn, professor of international law in the University of Bonn.

THE annual meeting of the Association of Public School Science Masters will be held on Wednesday and Thursday, January 10 and 11, at the London Day Training College, Southampton Row. The president this year is Sir J. J. Thomson, and the meeting promises to be of unusual interest. The exhibition of scientific apparatus, books, and new experiments will probably be the largest the association has yet brought together, and several subjects in the programme should promote lively discussion. During Wednesday afternoon Messrs. M. D. Hill and E. J. Lewis will read short papers on "Chemistry and Physics as a necessary Introduction to Biology" and "Plant Biology" respectively. Dr. Ludlam will also discuss the educational value of "Qualitative analysis." Sir J. J. Thomson will deliver his address on Thursday at eleven, and will be followed by Mr. C. E. Ashford, on "The Place of Electrostatics in a Science Course." On Thursday afternoon there will be a discussion, commenced by Mr. G. F. Daniell, on "Practical Examinations in Science." Mr. A. Vassall will also read a short paper on "Educational Psychology." On Wednesday evening there will be a dinner at the Trocadero in conjunction with the Mathematical Association. The secretary asks us to state that the discussions and exhibition are open to anyone interested in science teaching.

THE following courses of advanced lectures, which are free to students, in scientific subjects have been announced for delivery in connection with the University of London during the first term of 1912. Eight lectures on "The Self-government of the Pueblo Indians under Spanish and American Administration" will be given by Miss Barbara Freire-Marreco at the London School of Economics and Political Science on Thursdays at 3 p.m., beginning on January 25. Five lectures and one demonstration on "Genetics" will be given by Prof. F. Keeble at the Imperial College (Royal College of Science) on Thursdays at 5 p.m., beginning on January 18. Dr. W. N. Shaw, F.R.S., will lecture on "The Meteorology of the Globe" at the Meteorological Office, South Kensington, on Fridays at 5 p.m., beginning on January 19. Four lectures on "Recent Work in Physiology relating to the Circulation and to the Nervous System, with Special Reference to the Human Subject," will be given by Dr. A. D. Waller, F.R.S., in the Physiological Laboratory, South Kensington, beginning on Tuesday, January 23, at 5 p.m. Fourteen lectures on "The Hæmoflagellates" will be given at the Lister Institute of Preventive Medicine, Chelsea, by Prof. E. A. Minchin, F.R.S., on Tuesdays and Fridays at 5 p.m., commencing on Tuesday, January 16. Four Chadwick lectures on "Water and Water Supply" will be given by Sir Alexander R. Binnie at the Institution of Civil Engineers on Thursdays, beginning on February 1, at 5.30 p.m. Five lectures entitled "A Study of Jöhne's Bacillus of Cattle and the Lepra Bacilli of Man and Rats" will be given, under the will of the late Mr. Thomas Brown, by Mr. F. W. Twort, superintendent of the Brown Animal Sanatory Institution, in the Theatre of the Royal College of Surgeons, Lincoln's Inn Fields, W.C., on Monday, January 8, and the four following days, at 4 p.m.

SOCIETIES AND ACADEMIES.

DUBLIN.

Royal Dublin Society, December 19, 1911.—Mr. R. Lloyd Praeger in the chair.—Prof. James **Wilson**: The inheritance of the dun coat-colour in horses. In a previous paper—the inheritance of coat-colour in horses—published in 1910 (Sc. Proc. Roy. Dublin Soc.), it was shown that the ordinary colours fit into each other like a nest of Chinese boxes, chestnut being innermost, and then, coming in succession, black, bay, brown, dun, and grey and roan. The data concerning dun were few, and its position was merely suggested in a footnote. More data—500 to 600 cases—have since been collated, and these confirm the former placing. From this it follows that dun cannot be a "reversion," since it can result only from dun matings and occasionally from grey and roan. The author discussed the history of the idea that dun is a reversion. It probably originated in Lord Morton's quagga-crossing "experiments," and in Dr. Macdonald's criticism of these (both published by the Royal Society). Hamilton Smith's theory that horses are descended from five original stripes did not require a reversion theory; but Darwin's theory, expressed tentatively, that horses are descended from a single dun-coloured and striped species, required one, and to him mainly are we indebted for the opinion that dun is a reversion. Darwin relied upon Lord Morton's description of the foals his chestnut mare bore after her quagga hybrid, and on three other cases. Lord Morton said that one of the chestnut mare's foals had a faint dun tint in two places, and Darwin called two of them "partially dun"—later writers have called them dun altogether. These foals, however, were ordinary bays, and the other three cases were undoubted misdescriptions. Data are collected in the present paper from various stud-books, and these are confirmed by the progeny of two homozygous dun sires which were stationed recently on Clare Island, on the coast of Mayo.—E. A. Newell **Arber**: Contributions to our knowledge of the floras of the Irish Carboniferous rocks. Part i.—The Lower Carboniferous (Carboniferous Limestone) flora of the Ballycastle Coalfield, Antrim. Of the seven species recorded from this coalfield, *Adiantites antiquus* (Ett.), *Sphenopteris flabellata*, Baily, *Lepidodendron Veltheimi*, Sternb., and *L. Volkmannianum*, Sternb., are the more important. The evidence of the flora points to the conclusion that the coalfield is of Lower Carboniferous age, and that the rocks belong to the higher, or Carboniferous Limestone, horizon of the Lower Carboniferous.

CALCUTTA.

Asiatic Society of Bengal, December 6, 1911.—G. R. **Kaye**: A brief bibliography of Hindu mathematics. This is a list of works dealing with the history of Hindu mathematics. It is professedly incomplete, and it is difficult to decide what ought and what ought not to be included. This list requires amplification, particularly in the matter of Sanskrit texts and manuscripts. The original Hindu works do not go beyond the time of Bhāskará (twelfth century A.D.), as, after this period, Hindu mathematical works cease to have any historical interest.—Rev. H. **Hosten**: Father A. Monserrate's "Mongolicæ Legationis Commentarius." This precious manuscript, after passing successively through Fort William College, the Calcutta Public Library, and the Imperial Library, was transferred in 1903 to St. Paul's Cathedral Library, where the Rev. W. K. Firminger discovered it. It must have belonged formerly to one of the Jesuit houses of Goa. How it came to Calcutta it is impossible to say. The earliest account of northern India by a European since the days of Vasco de Gama, the manuscript contains a detailed history of the first Jesuit mission to Akbar, and more than 100 pages are consecrated to Akbar's campaign against Kābul in 1581–2. There is in it an excellent map, drawn to scale, showing all the places passed through by Monserrate between Goa, Sūrat, Agrā, Lahor, and Kābul (1580–2). It appears from the preface that Monserrate was the author of four distinct works:—(1) "Mongolicæ Legationis Commentarius"; (2) a work on the geography and natural history of India; (3) a history of his journey to Ethiopia; (4) a work on the geography and natural history of Arabia.—Prafulla Chandra **Ray** and Rasik Lal **Datta**: Contributions from the Chemical Laboratory, Presidency College. Allylammonium nitrite. A short paper dealing with the preparation and properties of allylammonium nitrite. The substance was made by double decomposition of allylamine hydrochloride and silver nitrite. Allylamine nitrite is a thick brownish liquid with the characteristic smell of all alkylamine nitrites.—Jitendra Nath **Rakshit**: Contributions from the Chemical Laboratory, Presidency College. Preliminary note on sodiumdiacetamide. This note deals very shortly with the method of preparing

$$\begin{matrix} CH_3.Co \\ CH_3.Co \end{matrix} > N.Na.$$

Acetamide (purified by recrystallisation from benzene), anhydrous thiophene, free benzene, and freshly cut metallic sodium were boiled together under a reflex condenser for twenty or thirty minutes, when a copious crop of white crystals separated.—B. L. **Chaudhuri**: Fresh-water sting-rays of the Ganges. Two species of Trygonidæ live and breed in the River Ganges above tidal influence, namely, *Hypologhus sephen* (Forscäl) and *Trygon fluviatiles* (Ham. Buch). Their Indian name is discussed, and particulars as regards their capture are given.

BOOKS RECEIVED.

Die Biologie des Donaudeltas und des Inundationsgebietes der unteren Donau. By Dr. Gr. Antipa. Pp. iv+48. (Jena: G. Fischer.) 1.50 marks.

Handbuch der Phototelegraphie und Telautographie. By Profs. A. Korn and B. Glatzel. Pp. xvi+488. (Leipzig: O. Nemnich.) 28 marks.

Neue Grundlagen der Meteorologie. By P. Hoitsy. Pp. 107. (Budapest: Franklin-Verein.) 2 marks.

Unsere Kenntnisse von den Seriengesetzen der Linienspektra. By Dr. B. Dunz. Pp. iii+186. (Leipzig: S. Hirzel.) 2 marks.

Zur Phylogenie der Primulaceenblüte. By Dr. S. Thenen. Pp. iv+131. (Jena: G. Fischer.) 8 marks.

Physiologie des Menschen. By Prof. L. Luciani. Translated by Profs. S. Baglioni and H. Winterstein. Fünfzehnte (Schluss) Lieferung. Pp. 641–782+viii. (Jena: G. Fischer.) 4 marks.

Monumentales und Dekoratives Pastell. By Prof. W. Ostwald. Pp. vi+105. (Leipzig: Akademische Verlagsgesellschaft M.B.H.) 2.40 marks.

Denkschrift über die Gründung eines Internationalen Instituts für Chemie. By Prof. W. Ostwald. Pp. 30. (Leipzig: Akademische Verlagsgesellschaft M.B.H.) 1.50 marks.

Das Pflanzenreich. Edited by Prof. A. Engler. 51 Heft: Sphagnales—Sphagnaceæ (Sphagnologia universalis). By C. Warnstorf. Pp. iv+546. (Leipzig: W. Engelmann.) 27.50 marks.

DIARY OF SOCIETIES.

FRIDAY, JANUARY 5.

GEOLOGISTS' ASSOCIATION, at 8.—On the High Terrace Gravel and on a Palæolithic Implement Factory, Dartford Heath: R. H. Chandler and A. L. Leach.—On the London Clay and Bagshot Beds (Passage Beds), and on the Gravel of Shooter's Hill, Kent: A. L. Leach.

MONDAY, JANUARY 8.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Production of Formic and Acetic Acids by the Atmospheric Oxidation of Turpentine: C. T. Kingzett and R. C. Woodcock.—A Rapid Volumetric Method for the Determination of Free Sulphur: C. Davis and J. L. Foucar.—The Relative Absorption of Dyes by Sand and Natural Fibres: W. P. Dreaper and W. A. Davis.—Ingrain Dyeing—Influence of Certain Groups on the Re-solution Factor: W. P. Dreaper.

VICTORIA INSTITUTE, at 4.30.—The Greek Papyri: Prof. G. Milligan.

TUESDAY, JANUARY 9.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Reinforced Concrete Wharves and Warehouses at Lower Pootung, Shanghai: S. H. Ellis.—The Direct Experimental Determination of the Stresses in the Steel and in the Concrete of Reinforced Concrete Columns: W. C. Popplewell.—Composite Columns of Concrete and Steel: W. H. Burr.

SOCIETY OF DYERS AND COLOURISTS, at 8.—Some Problems in Garment Dyeing: F. G. Newbury.—Aluminium in the Service of Chemical Industry: Dr. Richard Seligman.

WEDNESDAY, JANUARY 10.

GEOLOGICAL SOCIETY, at 8.—On a Late Glacial Stage in the Valley of the River Lea subsequent to the epoch of River-drift Man: S. Hazzledine Warren.

THURSDAY, JANUARY 11.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On the Propagation of Waves through a Stratified Medium, with Special Reference to the Question of Reflection: Lord Rayleigh, O.M., F.R.S.—On the Variation of the Specific Heat of Water, with Experiments by a New Method: Prof. H. L. Callendar, F.R.S.—The Mechanism of the Semipermeable Membrane and a New Method of Determining Osmotic Pressure: Prof. F. T. Trouton, F.R.S.—Mobility of the Positive and Negative Ions in Gases at High Pressures: A. L. Kovarik.—A New Method of Determining the Radiation Constant: G. A. Shakespear.—The Mechanics of the Water Molecule: Dr. R. A. Houston.

MATHEMATICAL SOCIETY, at 5.30.—Successions of Integrals and Fourier Series: W. H. Young.—A New Condition for the Truth of the Converse of Abel's Theorem: G. H. Hardy and J. E. Littlewood.—On Mersenne's Numbers: A. Cunningham.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some General Principles Involved in the Electric Driving of Rolling Mills: C. A. Ablett.

FRIDAY, JANUARY 12.

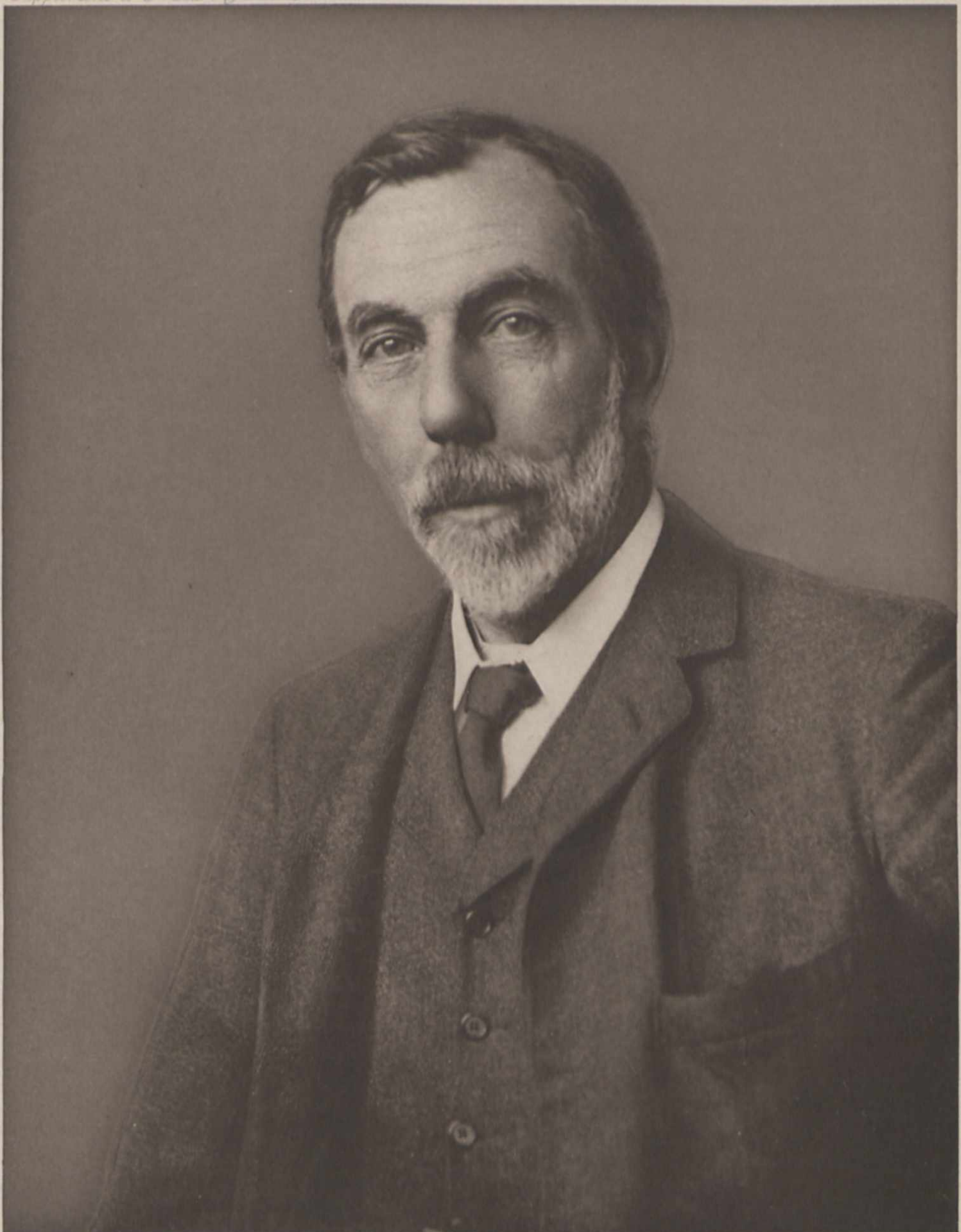
ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—Note on the Genus Panope Ménard: W. H. Dall.—Nomenclature of the Veneridæ—A Reply to Dr. W. H. Dall: A. J. Jukes-Browne, F.R.S.—The Occurrence of *Helicella heripensis* in Great Britain; Notes on Some British Non-marine Mollusca: A. W. Stelfox.—Characters of Two Undescribed Land Shells from Colombia; Explanation of the Figures Occurring in Westerlund's "Sibirien's Land och Söttvatten Mollusker," 1876; On Two Pre-occupied Specific Names in Gasteropoda: G. K. Gude.

CONTENTS.

PAGE

Supplement to "Nature" Jan. 11 1912



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