THURSDAY, DECEMBER 21, 1911.

NOTES OF A NATURALIST.

Convergence in Evolution. By Dr. A. Willey, F.R.S. Pp. xiv+177. (London: John Murray, 1911.) Price 7*s.* 6*d.* net.

DR. WILLEY has had great opportunities of studying animal life under varied conditions, and he has given us in this interesting little volume some of the fruits of his observations. Here, in brief compass, will be found a zoologist's notes—field-notes and laboratory-notes—on points which have specially attracted him. Indeed, we think that some title suggesting that the book contained the varied observations of a zoologist would have been preferable to that which has been chosen. The book has been carefully edited and is well and clearly printed. One very conspicuous slip has, however, escaped notice, the reference to p. 90 instead of to 94 on the frontispiece itself.

The author tells us in the preface that he uses "the word convergence in a wide sense, embracing habits, functions, structures, and physiognomy." The sense is indeed so wide that the force of the term becomes attenuated. Thus even the convenient Box-and-Cox sleeping arrangements of the fruit-eating bats and crows in the maritime districts of Ceylon are classed as an instance "of convergent homing, the same trees affording hospitality in regular succession to day-flying birds and night-flying mammals" (p. 25).

Speaking of the well-known Kallima butterflies, the ordinary representation of the attitude is corrected, and it is shown that, at least in the Ceylon species (*K. philarchus*), the insect rests head downwards—a fact which has also been recorded of the Indian *K. inachis*. Concerning "the extreme amount of individual variation in the markings on the under side of wings, simulating all degrees of decay and discoloration and fungus attack" (p. 58), the author speaks with somewhat unnecessary respect of the notion

"that the constant repetition of such considerable variations as are met with in leaf-like Lepidoptera and Orthoptera, from generation to generation, is a standing witness against the truth of 'Darwinism,' inasmuch as, according to the Darwinian theory, such variations ought either to become fixed by natural selection or swamped by interbreeding" (p. 61).

The tentative suggestion on p. 61, "it may be that natural selection is interested in keeping alive the variations for the benefit of the species, not for the production of new species," may be accepted with some confidence when such polymorphic forms are looked at as a whole. If it be an advantage in the struggle for existence to resemble a dead leaf or another butterfly of a distasteful group, it is clearly a still greater advantage to resemble two or more kinds of dead leaf, or two or more unpalatable "models." It must be remembered that Kallima is by no means remarkable in this respect, for such polymorphism is well known in immense numbers of both procryptic and mimetic species.

It is satisfactory to find that such an extreme supporter of the far-reaching influence of convergence does not, at any rate for the present, assail the Darwinian conclusion that the same specific form is never repeated a second time as the outcome of an independent line of evolution.

"The present state of our knowledge," he writes on p. 138, "justifies the provisional assertion that the higher combination which leads to the establishment of an animal form possessing the essential component elements of a definite morphological type, cannot be repeated. The theory of convergence is therefore not calculated to precipitate us into morphological chaos, howsoever startling its manifestations may be."

The author is certainly prepared to be startling, as, for instance, in his conclusion that the closed nephridia as a whole, flame-cells (or solenocytes) and all, arose independently in the Polychæte worms and in Amphioxus. But before adopting any such hypothesis, it is prudent to investigate the evidence that these structures were present in the probable common ancestor of both Amphioxus and Polychæta. That such nephridia did thus exist in the primitive stock is strongly supported by their occurrence in several other groups which are much nearer to the common ancestor than either Amphioxus or the Polychæta. We have reason to believe that E. S. Goodrich, who originally discovered the resemblance in minute detail between the solenocytes of these two forms, considers that his conclusions have been much strengthened by the results of investigations on other groups of the Cœlomata.

There can be no doubt, however, that the independent origin of elaborate structures has occurred again and again. There is scarcely a subject in which it is more necessary to bear in mind the commonplace saying that every case must be argued on its merits without any bias in favour of one interpretation rather than another.

An excellent example of convergence in a structure of considerable complexity was brought forward more than thirty years ago by Fritz Müller. At the same time, we must remember that the male scent-organs on the wings of butterflies, to which he was referring, are constructed of modified scales—elements which are so excessively variable in size, form, and structure that the independent appearance of anything that can be produced by a scale is probably easier than almost any other feat of convergent evolution. Speaking of the scent-organs on the wings of certain male Satyrine and Nymphaline butterflies, Fritz Müller wrote:—

"I know of no other case which proves so clearly and irrefragably, and attests with such force, the truth of a principle which should never be lost sight of in morphological studies. When in two species certain organs which serve the same function are found in the same place, are composed of the same parts, occupying the same relative positions, and exhibiting similar forms—all this by itself constitutes no sufficient proof that these organs are homologous, nor does it afford the grounds for including the two species in the same family."[1]

E. B. P.

[1] *Arch. Mus. Nac. Rio de Janeiro*, iii. (1878), pp. 1-7.

CHEMISTRY OF FLOUR.

The Technology of Bread-making, including the Chemistry and Analytical and Practical Testing of Wheat, Flour, and other Materials Employed in Bread-making and Confectionery. By Wm. Jago and Wm. C. Jago. Pp. viii+908. (London: Simpkin, Marshall and Co., Ltd., 1911.) Price 21*s.* net.

THIS, the second, edition of a well-known work has been increased greatly, both in bulk and price, over its predecessors. Mr. Jago has had the cooperation of his son in its preparation.

It is far from easy to review at all adequately a book of 893 pages, and undoubtedly the work would have been of greater value if it had been materially condensed. Like most similar technological works, it commences with a good deal of pure chemistry, which is partly of very elementary character; very nearly all this could have been omitted with advantage.

The new edition contains most of the previous issue in its original form, but supplemented very fully by the additions required to bring it up to date. Whilst this has been done in a most painstaking and satisfactory manner, the practice is a mistaken one, if a really good book is to be produced, however much it may be justified by commercial reasons. As a result, the treatment is unequal; it would be unjust, however, to base any general criticism on these sections.

The usual plan adopted by the authors is to give a full abstract of all scientific papers in any way bearing on their subject. These are ordered, as a rule, in historical sequence, occasionally with the annoying result that, after a paper has been mastered by the reader, he finds the results controverted by the next paper. It is difficult in consequence to make out the authors' own views in places or to take a clear line as to the current opinions on a controversial question. The authors' own researches are interpolated at considerable length, and, though always valuable, their insertion sometimes tends to confuse the reader seeking for definite conclusions rather than the minutiæ of experimental detail.

The chemistry of bread and flour is far from being in such a chaotic state as this work would lead us to believe; it should have been possible to give a precise account of the present position and to indicate the controversial points, leaving the discussion of these at length to separate chapters.

Apart from these defects the book is most complete, and Mr. Jago is at his best in dealing with the more technical side of the question. Such chapters as those on the composition of wheat, the strength, composition, and bleaching of flour are full of valuable information. Mr. Jago, it is interesting to note, cannot agree with the so-called food reformers in their condemnation of our present bread supply, and the evidence he quotes shows that he is supported in this view by all the authorities of repute in this and other countries. The chapters on bread-making, wheat, flour, and bread "improvers" and on the nutritive value of bread, give a complete summary of all that is known at present on these questions.

The subjects of bakehouse design and the machine bakery and its management will appeal specially to those actually engaged in the trade—a baker, seeking to modernise his equipment, will gain the very best value for his outlay by studying them here.

The commercial testing of wheats and flours constitutes a very important section of the work: the subject is a difficult one, and much of the knowledge of it is still regarded as a trade secret. The difficulty chiefly lies in translating the results of the chemical tests into facts. There is much rivalry between the respective merits of the "chemical" and "baking" tests on flour; as Mr. Jago points out, "though baking is after all the final test of flour," chemical analysis is often able, not only to point out a departure from the normal, but, what is more important, to discover the cause. Millers and bakers have been slow as yet to follow the lead of the brewing industry and introduce a chemist into the works, but where this has been done there is abundant evidence that the laboratory work has proved an actual necessity for the maintenance of a uniform product of high quality. A very flattering testimony to this effect from the Ogilvie Flour Mills Co. is quoted in the book. The authors give of their best in this chapter, the pages describing the tests made with the aid of the tintometer being of especial interest as affording a means of measuring some of the subtle changes which take place in flour on storage, and giving more than a clue to their causes.

The more purely analytical chapters which conclude the book are in some respects less successful, some of the methods described being antiquated and untrustworthy. None the less, the section is a useful one to bakers' chemists, who will appreciate also the pages devoted to the testing of confectioners' raw materials.

Perhaps the most striking thought after a perusal of the book is how much of the present knowledge of the chemistry of wheat and flour is due to the work of the last few years, particularly to investigations instituted by those only remotely connected with the subject, and performed without thought of pecuniary reward. Additional satisfaction is derived from the consideration that the advance has been mainly made in this country, or by workers in Canada and the United States.

In conclusion, the authors may be congratulated on the result of their labours; they have compiled a dictionary which leaves nothing to be desired in the fulness of its material, and they have earned the gratitude of all future workers in the field.

E. F. A.

THE COLLOIDAL STATE.

Gedenkboek aangeboden aan J. M. van Bemmelen, 1830–1910. Pp. xxix+416. (Helder: C. de Boer, 1910.)

FIFTEEN years ago the number of those investigating the colloidal state would scarcely have reached double figures, and in the text-books of the period the subject received curt dismissal in a few paragraphs. Had it not been for the connection between colloids and dialysis it would have escaped

mention altogether. The general position of the science was but little advanced beyond where Graham in especial, and others, such as Frankenheim, Lüdwig, Cloetta, and Payen, had left it half a century earlier. Outside Prof. van Bemmelen's work a few scattered papers, mainly on the precipitating power of salts, or on the imbibition of water by organic jellies, made up the literature of the period. Biologists as a class seemed to have forgotten even the name colloid.

The sixty-two original papers gathered into the volume before us is eloquent testimony to the change which has taken place. The colloidal state has become the vogue, and any departure from simple linear relationship in the equilibrium between states of matter is in danger of being called colloidal—subclass adsorption—and so receiving summary and satisfactory explanation.

The historical position is, however, strictly logical, as indeed it must be if it is, in fact, a development of ideas. In the 'fifties and 'sixties of last century much work and speculation were devoted to the colloidal state; Frankenheim's forgotten paper of 1850, for instance, deserves to rank with Graham's masterwork. But the movement soon spent itself for lack of foundations to build upon.

The present era begins in 1873 with the appearance of the remarkable synthesis which van der Waals effected between the Laplace-Young theory of self-attractive matter, purely statical in character, and the doctrines of molecular kinematics as Clausius especially had developed them; and in 1875, with the equally remarkable extension of the theory of energy to include chemical potential which was made by Willard Gibbs. These, together with van 't Hoff's extension of the gas laws to solutes and Arrhenius's conception of electrolytic dissociation, opened the way for a great mass of work on the equilibrium between different states and different kinds of matter which expanded molecular physics into what is now called physical chemistry. This movement in turn has largely spent itself, unfortunately before it has given us a trustworthy specification of the distribution of energy in the fluid and solid states, and the study of the equilibria of matter in mass has, in one direction, been largely replaced by the study of heterogeneous systems in which one at least of the states is not present in mass at all, for this is the distinctive feature of what is called the colloidal state.

The papers in the memorial volume are forcible evidence of the multitude of problems connected with the colloidal state. Surface energy, the condensation of matter on to interfaces, osmotic pressure and dialysis, the physical state of soils, colloids in geology, viscosity, precipitation, and contact potential all are dealt with. The subject-matter of the paper by M. Duhem, which opens the series, must have been peculiarly grateful to van Bemmelen, for it is a protest against the application of thermodynamics to colloids on the assumption that they are multiphase systems. Twelve years ago the writer of this notice received from Prof. van Bemmelen a long letter of protest against any attempt to apply the phase rule to colloids, and the protest was in the main just. Equally favourable must have been his reception of Malfitano's protest against certain arbitrary distinctions which have become current, chiefly the distinction between chemical combination and adsorption. The distinction may have to be made, but it needs more subtle treatment than it usually receives.

Van Bemmelen's first work on colloids was his paper of 1877 on the absorptive property of soil, his last the paper, "Die Absorption, X.," of 1909. He was nearly fifty, an age when many cease active research, before he began his life-work. As van Bemmelen was led to colloids by his study of soils, it is but fitting that the volume should contain an important group of papers on colloids of the soil and in geology. Rohland, Hissink, Leopold, van Baren, Ehrenberg and Pick, Holwerda and Hudig write on these subjects. M. le Chatelier deals with the mechanical properties of mixtures of solid and liquid in a paper which is remarkable in that it makes no mention of Osborne Reynolds's work.

It is not possible to accord even the briefest notice to all, and contributions by Pappada, Tamman, Barus, Jordis, Freundlich, Spring, Svendburg, Bredig, Ringer, Schreinemakers, Lorentz, and others must be passed by with the remark that, as many of them will not appear in print elsewhere, the volume must be consulted by all workers on colloids.

His eightieth birthday saw van Bemmelen stricken with what proved to be his last illness. His modest soul was, above all whom the writer has known, superior to the need of praise. Thirty years' patient labour in a neglected field of science proves this. Yet one likes to think that so abundant testimony to regard and esteem brought joy and courage in those last hours. W. B. HARDY.

THE ANALYSIS OF DYES AND DYED MATERIALS.

Identification of the Commercial Dyestuffs: being vol. iii. of a Method for the Identification of Pure Organic Compounds by a Systematic Analytical Procedure based on Physical Properties and Chemical Reactions. By Prof. S. P. Mulliken. Pp. vi+274. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1910.) Price 21*s.* net.

THE identification of natural or artificial dyestuffs either as such or in association with textile fibres, colour lakes, paper, food, or other articles, is a problem which at the present day presents many difficulties. Twenty or thirty years ago the number of dyestuffs was so small that their identification by an expert was a simple enough matter, but the enormously greater number of artificial dyestuffs now in use and the rapid rate at which this number is daily augmented, has not only greatly increased the difficulty, but also the need of trustworthy means of analysis. The dyer with many hundreds of dyestuffs now at his command is able to match any particular shade in a variety of different ways, but since the fastness for the purpose in view depends entirely upon a suitable choice of colouring matters, it becomes particularly important that in matching an approved pattern it should be possible not only to reproduce the shade, but also to

select the same or similar dyestuffs. It is also a desideratum for the merchant or textile manufacturer to be able to ascertain whether the colour of the materials dyed for him is always obtained with the dyestuffs specified, whether the shade dyed by one firm is or is not a chemical match for that dyed by another, and other similar questions. The analytical chemist is also frequently called upon to determine the actual dyestuff or dyestuffs employed, for example, in the composition of a lake pigment for wall-papers or lithographic printing, or to identify the material used for colouring certain food products.

With the large number of dyestuffs which come into consideration it is obvious that no satisfactory scheme of identification can be based upon individual and empirical reactions, such, for instance, as the changes of colour produced by caustic soda or concentrated sulphuric acid. Such individual tests can only be employed effectively after the genetic relationships of the dyestuff in question have been ascertained by means of suitable group reagents; and only those chemical properties can be employed as group reactions which depend upon general differences in chemical structure. Another reason why such a principle can alone prove satisfactory is that the scheme adopted must be capable of including and referring to their appropriate groups the new colouring matters which are constantly appearing, the individual reactions of which are unknown.

In the analytical scheme published by A. G. Green in 1893, which is based in part upon the earlier schemes of Witt and Weingaertner, the chief differentiation is effected by the behaviour of the dyestuff upon reduction with zinc dust, and the reaction of its reduction products with air and with chromic acid. Whilst nitro-, nitroso-, and azo-compounds are completely broken down upon reduction, and cannot therefore be reoxidised, those dyestuffs which may be regarded as having an *ortho*-quinonoid structure give leuco-compounds which are readily reoxidised to the original dyestuff by air, and those to which a *para*-quinonoid structure is attributable give leuco-compounds stable to air but reoxidised by chromic acid. Still, a further group are not reducible at all, whilst dyestuffs of the anthracene class are converted into coloured hydro-derivatives.

In 1905 and 1907, Green, assisted by Yeoman, Jones, Haley, and Stephens, published a very complete scheme for the analysis of dyestuffs upon textile fibres, in which the above principles were employed in conjunction with other group tests. In this scheme sodium hydrosulphite was substituted for zinc dust as the reducing agent, and the colourless potassium persulphate for chromic acid, all the reactions being effected upon the fibre instead of in solution. This scheme of analysis is not only applicable to dyed materials, but can also be readily applied to colouring matters in the solid form or when associated with mineral bases, food products, &c., by previously transferring the dyestuff to wool or cotton.

In the work under review the author claims to have produced a perfected scheme of analysis of general applicability. In place of employing group reactions to differentiate the dyestuffs according to their structural relationships and dyeing properties, the system adopted is largely empirical, being based upon the exact determination of colour changes effected by various reagents, the shades obtained being compared with standard shade cards and the results tabulated by a system of lettering. Although Green's reduction and oxidation tests are also employed as "generic" reactions, their indications are interpreted in a strictly formal manner under arbitrary but rigidly fixed conditions. This produces the result that the main groups or "genera" frequently contain dyestuffs which are entirely unrelated. We find, for instance, azo-colours of the benzopurpurine type classified together with rhodamine (a pyrone colour); phosphine and other acridine colours classified with annatto; auramine (a diphenylmethane derivative) in association with primuline (a compound of the thiazol class); various alizarine colours in close conjunction with rose Bengal and violamines (pyrone colours); and dyes of the azo-class, triphenylmethanes, and natural red woods amongst the azines, oxazines, and thiazines. The author's system also involves the coordination of dyestuffs of entirely different dyeing properties, irrespective of whether they are "basic," "acid," "substantive," or "mordant" colours.

The book contains colour reactions of some 1475 individual dyestuffs, which are recorded with extreme precision for the selected conditions. Although, however, it has involved much careful labour, the utility of the work has been largely sacrificed to the desire to obtain an impossible degree of accuracy and through the unscientific and inconvenient system of differentiation adopted. Such a rigid system of colour reactions does not take account of the fact that commercial dyestuffs usually contain variable impurities or are shaded with small quantities of other colouring matters. Furthermore, it may be questioned whether the exact tint obtained in the tests would not be also affected by small indeterminate factors, such as the purity of the reagents or the quality of the textile materials used in dyeing. Lastly, the scheme could not be applied to mixtures without a complete separation into the constituents, a condition which is seldom possible.

ARTHUR G. GREEN.

MUNICIPAL ENGINEERING.

A Manual of Civil Engineering Practice: Specially arranged for the Use of Municipal and County Engineers. By F. Noel Taylor. Pp. xii+809. (London: C. Griffin and Co., Ltd., 1911.) Price 25*s.* net.

THIS book has been written to supply the needs of young engineers who propose to devote themselves to those branches of engineering practice which fall to the lot of the municipal and county engineer, or the borough surveyor; the duties which have to be undertaken by such officials are of a most varied character, and involve a wide range of knowledge; books of reference are essential to such men, and Mr. Taylor, drawing largely upon his own professional experience, has dealt with the entire field of work covered by the term "municipal civil engineering."

The first six chapters are devoted to surveying and levelling, and the mensuration of earthworks, the subject being treated with special reference to the class of work which has to be carried out by municipal engineers, such as the laying out of roads, tram-lines, sewers, &c.; next follow three chapters dealing with such general problems as the stresses and strains in beams and struts under given loading, and the methods of determining the necessary scantlings of simple beams and pillars. In a special chapter on the various materials employed in constructional work, the author gives a concise description of their structure, essential properties, manufacture, and the usual methods of testing them to ensure soundness and freedom from all defects. Retaining walls and their design are fully discussed in chapter xvi., and examples are worked out to illustrate the use of the formulæ and the methods of securing safety with economy of material.

The making and repair of roads form a very important part of the duty of a municipal engineer: prior to the advent of the motor-car, the roads outside town areas had been much neglected, and they were in a totally inadequate condition to deal with fast and heavy traffic; as a consequence the questions of road maintenance and road construction have entered during the past ten years upon an entirely new phase. To mention only one of the changed conditions, with horse traffic the dust nuisance was, in country districts, a matter of slight importance; at the present day, on roads on which there is a heavy motor-car traffic, the suppression of dust becomes a factor which must be dealt with, and to which other details may have to be subordinated. In chapter xix. the author gives an excellent abstract of a report upon the proceedings of the International Road Congress, which met in Paris in 1908, prepared for the Local Government Board of Ireland by the chief engineer, Mr. Cowan. This congress agreed to a series of resolutions embodying the views of the delegates as to the lines upon which in the future roads should be constructed and maintained, and also as to how best to cope with the dust problem, though at present opinion is divided as to the respective merits of surface tarring and tar-macadam.

A valuable chapter is that devoted to the design of structures in reinforced concrete; some excellent notes are given as to the essential qualities of the two materials employed—the concrete and the steel—then a series of simple formulæ is worked out, and, finally, typical illustrations of design are given, such as floors, piles, reservoir walls, bridges, and sewers, in each case attention being directed to practical difficulties which have to be met and overcome, if thoroughly sound, durable work is to be produced. This chapter is appropriately followed by one on masonry road bridges and similar work.

The problem of the removal of domestic and trade refuse, solid and liquid, is dealt with in six very complete chapters—one of the best sections, in fact, of the book. All the most modern and efficient methods are discussed and explained, both in regard to the laying out and the construction of sewers, and in regard to the ultimate treatment of the sewage at the outfall works. An abstract is given of the report of the Royal Commission on Sewage Disposal of 1908, a report which embodies the views of chemists, biologists, and engineers, and is a storehouse of information upon a subject which is of vital importance to the general public, and the layman is as much concerned with the efficient solution of this knotty problem as the engineers who have to design and maintain the necessary works. To make this section of the book complete, the author has added a chapter on the ventilation of buildings and house drainage, in which the best types of modern sanitary house fittings are described, with the help of a series of good illustrations.

Waterworks, their design and maintenance, form the subject of three chapters. Full details are given of the best system of filtration, of methods of softening hard waters so as to render them more suitable for domestic purposes, and of detecting and checking waste of water, a constant source of worry to the engineer in charge of such works; some figures are given to show how excessive this waste by leakage and by the culpable negligence of householders may be, and how important it is to put a stop to it, if needless expense in constructional works is to be avoided, and a shortage of supply in periods of drought prevented.

Constructional steel work is discussed in a very complete chapter. The examples chosen cover a wide range of such class of work—overhead water tanks, roofs, and bridges of various type. The illustrations in this chapter are clear and not overburdened with detail, and are, therefore, much more likely to prove useful to a designer who consults them than is often the case with plates reproducing engineering drawings. For the guidance of young engineers, Mr. Taylor has given a special chapter to the subject of the preparation and drafting of specifications, a chapter which will no doubt be constantly consulted, as it is full of the most useful hints and advice.

Mr. Taylor is to be congratulated on the production of a book which will find a place on the desk and in the drawing office of every civil engineer, and the publishers, too, must be given a word of praise for the excellence of the numerous plates and woodcuts. T. H. B.

CHEMICAL PHENOMENA OF LIFE.

Chemical Phenomena in Life. By Prof. F. Czapek. Pp. ix+152. (Harper's Library of Living Thought.) (London and New York: Harper and Bros., 1911.) Price 2*s.* 6*d.* net.

MESSRS. HARPER could not have secured a more authoritative or a clearer writer than Prof. Czapek, of Prague, to present to the public the most recent views of biochemistry. The chemistry of protoplasm and its behaviour, as well as that of its constituents, have been greatly illuminated since that branch of chemistry known as the chemistry of colloids has been subjected to investigation. The main properties of colloids were discovered by Thomas Graham in 1861, and the conception of ions we owe to Faraday. Nevertheless, the science of physical

chemistry remained in a dormant condition until van 't Hoff and Le Bel, twenty-one years ago, laid down the famous law named after them, and put forward their views on the nature of solutions. Exact and even mathematical researches in this region were thus rendered possible, and physical chemistry since then has grown at a prodigious rate, and has increased the boundaries of knowledge, not only so far as chemistry and physics are concerned, but also in the biological field as well.

Unfortunately the growth of a new science means the introduction of a new language, and those who write in it are not always able to realise that it is unintelligible even to those who have received a scientific training a few years previously. Such a book as Prof. Czapek's is therefore a godsend, for it explains in the clearest manner the new language as well as the new facts. Although the author is a professor of plant physiology, he treats his subject in a wide manner, so as to be helpful to animal physiologists as well. The properties of colloids, the use of the ultra-microscope, the significance of the protoplasmic membrane, the velocity of reactions, catalysis and the enzymes, and the general laws of immunity are among the subjects treated in somewhat less than 150 small pages. Each page is rich with information and full of thoughtful and pregnant suggestions.

Prof. Czapek concludes that, so far as chemical and physical phenomena are concerned, our knowledge is now sufficiently advanced for us to be quite sure that it is unnecessary to call in the assistance of any mysterious "vital force" in order to explain the activities of protoplasm. The filling in of the still numerous gaps are mostly the working out of points of detail, and that is only a matter of time.

"There is only one part of physiology which is not yet accessible to our methods, and which we cannot prove to be ruled by the well-known laws of inanimate nature. These are the psychological phenomena."

When we remember that less than a century ago organic chemistry was regarded as equally inaccessible to experimental methods, there is some hope that in the future even psychological phenomena may yield their secrets to the investigator. W. D. H.

OUR BOOK SHELF.

Where Do We Come From? Is Darwin Correct? A Philosophical and Critical Study of Darwin's Theory of "Natural Selection." By Herbert Morse. Pp. iv+344. (London: Kegan Paul and Co., Ltd., 1911.) Price 7*s.* 6*d.* net.

HAVING read many of the eulogistic articles on Darwin's work which appeared at the time of his centenary, Mr. Morse was prompted to look into the matter for himself. He does not claim for his work any higher authority than that to be granted to the opinion of the man in the street. "Anyone who can read and write, who has the ordinary powers of reasoning, and is possessed of some knowledge of the nature and value of evidence, is as capable of passing as sound an opinion on the value of the theory, that, that evidence endeavours to corroborate as any scientist of them all."

Let us give a few quotations to illustrate the competence and temper of this new philosophical critic. "Man is a self-improving organism, no other organism is. Every other organism is the mere sport of nature, at the mercy of environment, a mere physical puppet." The struggle for existence "was the great promoter and agent of variation." This, which is stated as one of Darwin's fundamental propositions, reveals an abyss of misunderstanding. We are treated, as usual, to the old chestnut: "If these new creations were all similar at the outset, it seems inconceivable that any period of time, however prodigious, or any set of circumstances, however extravagant, could by any process of slow accretion have converted, say, a flea into a flamingo."

The author is therefore led to suppose that there were many independently originating primitive organisms. He appears to believe that a theory of polyphyletic evolution is quite anti-Darwinian, and he brings back old times by dividing the animal kingdom into four classes. There have been many stern critics of Darwinism who have done service to evolution-theory, advancing it a little beyond the stage at which Darwin left it, but these have been men careful to understand what Darwin meant, careful not to credit him with conclusions he did not hold, careful to acquaint themselves with the facts of the case. We cannot rank Mr. Morse among these.

The World's Minerals. By Leonard J. Spencer. Pp. xi+212+40 coloured plates. (London and Edinburgh: W. and R. Chambers, Ltd., 1911.) Price 5*s.*

AT first sight one gains the impression that this is merely a remarkably cheap picture-book, published in time to be handy as a Christmas gift. The forty coloured plates exhibit an Oriental splendour and a daring which does not hesitate to represent the play of colours of labradorite and precious opal, or even the metallic lustre of native gold and silver. These dazzling pictures, prepared under Dr. Hans Lenk, of Erlangen, are themselves worth the price of the book, which, however, is far more than a mere album of German chromo-lithographs. For the editor of *The Mineralogical Magazine* has written descriptive text around the pictures, and has preceded this by an excellent introduction to the study of minerals, which makes the book something more than a pretty volume for collectors of pretty stones. Thus in only twenty-two pages the author manages to give a clear and wonderfully comprehensive survey of the difficult subject of crystallography, not even omitting to deal with Miller's notation.

On p. 16 the choice of 2 for the axial ratio of a dimetric crystal is unfortunate, suggesting as it does a simplicity comparable to that of indices, dealt with in the same paragraph. A figure like the 1·771 of anatase would have avoided any such implication. On p. 20 the drawings of rhombohedra are apparently printed upside down, and the hexagonal prism is not satisfactory. These are, however, minor points, and the fact that one can find no worse faults in what amounts to a text-book of systematic mineralogy comprised in the first forty pages, on the forms, physical characters, chemical composition, and classification of minerals, speaks well for the value and accuracy of the work. R. F. G.

The Rubber-Planter's Notebook. By Frank Braham. Pp. viii+108. (London: Crosby Lockwood and Son, 1911.) Price 2*s.* 6*d.* net.

THIS book is what it purports to be, a handy book of reference on Para rubber planting, with hints on the maintenance of health in the tropics and other general information of utility to the rubber planter. It is well written, and the condensed information contained in

it, so far as it goes, is well selected and in the main correct.

Many a "creeper" and new hand on Eastern estates and elsewhere will owe Mr. Frank Braham a debt of gratitude for this handy little volume, which doubtless is the nucleus of a future work of more extended scope, not one with large type on art paper, but a planter's "Molesworth," of use to the old hand as well as to the beginner.

The author's section on general information will be found specially useful, and his essential rules for the preservation of health in tropical climates are admirable if intended for the young planter going out to the East for the first time; but for the older resident in the tropics "drink as little as possible—fluids inflate the bowel" is dangerous advice. The ingestion of a sufficient quantity of water or other bland liquid is essential if for no other reason than to counterbalance the effects of excessive perspiration. In hot weather the kidneys are very largely relieved of their excretory duties by the skin. If then the individual for years has been in the habit of still further relieving them by drinking as little as possible, it is not astonishing that in cases of emergency they are unable to return to their normal state of efficiency, and if blackwater fever is encountered death in such cases may be the result.

In these essential rules also mention of the all-important hot bath and change at sundown would have added to their completeness. The book, however, should command a ready sale.

Die moderne graphische Reproduktion. Ein Führer und Ratgeber durch das Gebiet des Illustrationswesens unter Berücksichtigung der für die Wiedergabe bestimmten Originale. Gemeinverständlich dargestellt von L. P. Mosler. Pp. vi+52+xiv plates. (Jena: Gustav Fischer, 1911.) Price 2 marks.

In this booklet the author gives a concise description of the methods of illustration as at present practised, so that those who desire to avail themselves of such methods may have some idea of their characteristics and possibilities, and be guided as to their choice. He refers also, shortly, to methods of making drawings and photographs for reproduction. Following the text are fourteen plates. Nine of these are impressions from half-tone blocks made from the same original to show the effect of the fineness of the screen, a reproduction of a reproduction, a "duplex" print, &c. There are also a four-colour print, a collotype, and a photogravure.

LETTERS TO THE EDITOR.

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

The Distastefulness of *Anosia plexippus*.

REFERRING to the interesting note on "The Distastefulness of *Anosia plexippus*" in NATURE of October 12, I should like to suggest that the experiment, though interesting in itself, does not materially strengthen the case for the usefulness of mimicry. To make a good case for mimicry in the sense in which that term is ordinarily used, the mimic *Basilarchia archippus* should be tested and found palatable. Further, if mimicry means anything at all with reference to these two species, North American birds should eat some butterflies but not molest *Basilarchia archippus*. So far as observations have been reported, American birds eat butterflies *very* rarely, and there is no evidence, so far as I know, either from direct observation or from the thousands of stomach-content examinations made by the United States Department of Agriculture, that its non-mimetic relatives are eaten more often than *Basilarchia archippus*.

If European birds show the same indifference towards butterflies as is manifested by North American birds, either the "model," *Anosia plexippus*, or the mimic, *Basilarchia archippus*, might with impunity become widely disseminated in Europe. A. M. BANTA.

Cold Spring Harbor, N.Y., November 20.

I HAVE a shrewd suspicion that if the result of my experiments upon *Anosia plexippus* had proved this butterfly to be highly palatable, the dwindling minority of mimicry sceptics would have made the very most of the fact, and claimed that it "materially strengthened the case" against Bates's theory of mimetic resemblances; and in this they would have been perfectly right, so far, at all events, as the particular instance is concerned. But since the experiments proved the precise opposite, those who believe in the theory may reasonably maintain that the case for the usefulness of the mimicry to *Basilarchia archippus* is thereby materially strengthened. It appears to me that few more important items of evidence in favour of the theory of mimicry can be established than demonstration of the distastefulness of "models."

Again, I think Mr. Banta overrates the negative evidence he cites in support of the view that birds seldom prey upon butterflies under natural conditions. My opinion to the contrary is based upon a large number of experiments made in the gardens of the Zoological Society of London, and published in the Proceedings of the society for September. I can recollect no exception to the rule that insectivorous birds were roused to attention at once by the sight of butterflies, their keenness suggesting very forcibly that they knew them, either by instinct or by experience, to be part of their natural diet.

Not less strongly suggestive was the determination with which they pursued, and the precision with which they generally caught, the butterflies on the wing when let loose in the shelterless aviary. Conversely, the skill evinced by the butterflies in dodging their pursuers in mid air was one of the most striking features of the experiments. Just as one is compelled to believe that the instinctive doubling of the coursed hare when overtaken by greyhounds indicates the habitual method of escape of the species from fleet-footed foes, so must one believe that the evasive twist of a butterfly when pursued by a bird is an inherited habit that has proved a means of salvation to members of that species in the past when chased by similar enemies. If, as is maintained, birds do not under natural conditions prey upon butterflies to a sufficient extent to be reckoned as serious enemies, what explanation is to be offered of the marked reaction observable between the two sets of animals when pitted against one another? R. I. POCOCK.

Zoological Society, December 6.

The Weather of 1911.

I HAVE studied with great care and interest Dr. Shaw's letter in NATURE of November 30 disclosing a promising field of inquiry into the causes of such abnormalities of weather as we have, for example, experienced during the summer and first half of the autumn of the present year. Seizing hold of the very fact Dr. Shaw's letter refers to, which has apparently induced him to look in the direction of the upper atmosphere above 9 kilometres for new lines of investigation, namely, that certain types of distribution of barometric pressure, normally rainy, occasioned little or no rainfall in the summer of 1911, I had before reading his letter entertained the idea that somehow or other the persistent, parching drought might have been due to an abnormally reduced *absolute* humidity of the atmosphere (at least of those strata not immediately in contact with surface water supplies) over these islands, so much reduced that the convection currents adequate to produce rain in more normal conditions failed to do so in the present year. I admit, of course, that a decreased absolute humidity of the air in hot summer weather, with the ocean all round us, would be a very different thing to account for, and perhaps could only be brought about by a persistent flow

of the air currents to our region from some arid continental region like the interior of Asia, which would be very unlikely in summer.

But the suggestions embodied in Dr. Shaw's communication no longer render necessary such an assumption as small vapour-content of the air to account for the circumstances of the drought. For I take it that if a barometric depression were transmitted to the surface strata entirely by variations of pressure occurring beyond the convection region at a height of about 9 kilometres, there would not be engendered the powerful rain-producing convection currents usually associated with cyclonic circulation when a barometric depression takes its origin wholly or partly in causes residing in the lower layers themselves.

Should this proposition not follow on the lines indicated in Dr. Shaw's letter, I should be glad if he would correct it. L. C. W. BONACINA.

Hampstead, N.W., December 2.

MR. BONACINA would draw a distinction between barometric depressions transmitted from above and those which take their origin wholly or partly in causes residing in the lower layers themselves, and he would attribute a peculiarly rainy character to the latter. I know of no facts which enable us to draw with certainty the distinction in individual cases, and I should have been glad if Mr. Bonacina had cited some examples which were demonstrably of the second type. I cannot speak very positively on the subject. There is a certain hyperbolic region, sometimes shown on weather maps, between a pair of cyclones and alternating anticyclones where I think such depressions may occur. The weather associations of that particular distribution are peculiar; in the words of a well-known verse:

> When it is good, it is very very good,
> But when it is bad it is horrid.

In summer, thunderstorms with copious rainfall may occur with such a distribution. They are associated with areas of shallow depression—local secondaries—which may be entirely surface-bred; but the pressure differences involved are so slight that they must be regarded as belonging rather to the embroidery than to the outlines of the pressure distribution of the globe.

Let me take the opportunity to add that the further study of the physics of rainfall might contribute to the clearing up of some misconceptions about its meteorological significance. Suppose that we regard rainfall as incidental to convection, that is, to the process of righting instability in the lower or middle layers of the atmosphere, which may be caused by the superposition of layers of inverted density. Consider the effect of variations of pressure imposed entirely from above. If the lower layers contain a stratum of floating cloud, it follows from the difference of adiabatic temperature-change in cloudy and dry air that compression will produce instability at the lower surface of the cloud and rarefaction will produce instability at the upper surface. Alternate compression and rarefaction, such as would be imposed from above if some giant were playing upon the middle and lower layers of the atmosphere, with their cloud strata, like a concertina, would give alternating instability of different types. With one type rain would be produced. What would happen with the other I have not fully made out; perhaps the mammato-cumulus cloud may illustrate it. A good deal depends upon the vertical temperature gradient, of the causes of which at present we know little.

Certainly if there were no cloud layer to form a locus of instability, compression would simply raise the temperature of the air, and hence its potential dryness. The other stroke of the concertina, the rarefaction, might itself produce cloud, possibly at more than one level, and its continuance would maintain the cloud and the instability necessary for continuous, but fluctuating, rainfall if supplies of suitable air were forthcoming. We have here an explanation of cloud layers at different levels and of the well-known tendency towards cloud and rainfall with a falling barometer that is satisfactorily independent of surface conditions. Looking into the details, we can also see that a falling barometer alone is not necessarily a sufficient cause.

Parenthetically, may I express the hope that Mr. Bonacina or some other student of weather will refer to the figures for the dryness of the air of the past summer as compared with air under similar conditions of wind direction, &c., in previous summers? The facts are available and well worth investigation. There is, I have reason to think, a high negative correlation between humidity at 9 a.m. and the duration of sunshine for the day, and this may point to another factor in the cause of the brilliant summer.

I hope Mr. Dines will make good his view that the distribution of temperature in the upper layers is not related to the direction of the air currents. When I wrote I had in mind particularly a cold invasion in the upper air of July 29, 1908, with a northerly wind, and the apparent increase in intensity of the phenomena of a line squall at higher levels. But if we can be assured that cold invasions begin at the bottom, it will free us from much difficulty.

In the interesting letter from Dr. Carl Ramsauer published in your issue of December 14 the argument is based upon the assumption that during the past summer condensation in the atmosphere was inhibited for want of nuclei. The assumption requires proof before it can be accepted as a basis of physical reasoning. Supersaturation of air in the free atmosphere is often assumed, but, so far as I know, it has never been demonstrated, and meteorologists, as a rule, do not feel themselves at liberty to use it. W. N. SHAW.

December 19.

THE contributions in your columns to this subject are of great interest. I will venture, with your permission, to propound one or two questions suggested by the letter of Dr. Carl Ramsauer. On his hypothesis, would it not follow that all periods of minimum solar activity would be marked by weather of the 1911 type? Is this the case?

On the same assumption, it would seem to follow that the same type of weather would extend over the whole earth: has this been the case? We have, I think, heard of torrential rains in northern Italy in the beginning of summer, and of the early onset of winter in Canada.

Again, assuming this hypothesis, not the earth only, but all the planets would have been affected. Have the supposed snow-caps of Mars shown any shrinkage?

Failand, December 15. EDW. FRY.

The Photography of Hα during Solar Eclipses.

IN NATURE for December 7 (p. 182) the report of the council of the Royal Society is said to state that at the total solar eclipse of April 28 the observers sent out by the Joint Permanent Eclipse Expedition secured observations with a short-focus prismatic camera showing the whole of the hydrogen series, with the additional remark that "this is the first time Hα has been photographed at an eclipse."

In the interest of accurate annotation, however, this statement of the council must be modified, as reference to the reports presented to the Royal Society of the eclipse of 1893 (West Africa) and 1898 (Viziadrug) will show that the Hα line was recorded as a strong line on the photographs obtained with prismatic cameras at both these eclipses by the expeditions from the Solar Physics Observatory. It was also recorded by other observers at the Indian eclipse of 1898. CHARLES P. BUTLER.

The Nematodes of the Thames.

REFERRING to my former communication on this subject, I am happy to say that I have at last discovered the host of at least one of the species of nematode found in the Thames. Mr. Chas. Todd, of Tottenham, has kindly sent me a sample of mud from near the Tower Bridge containing vast numbers of Tubificidæ. Among these are *Limnodrilus hoffmeisteri*, *Tubifex campanulatus*, and other interesting fresh- or brackish-water worms. The nematode has so far been found only in Tubifex. It gains an entrance into the spermathecæ, where it develops to the great inconvenience of its host. HILDERIC FRIEND.

Swadlincote.

MICROSCOPE STANDS.

CONSIDERABLE attention is now being directed by those interested in microscopy to various questions connected with the build of the instrument irrespective of the purely optical parts. We have thought it desirable, therefore, to ask the opinions of those with large experience in the designing and production of stands both here and on the Continent. These opinions are given below.

CLAIM FOR SUPERIORITY FOR THE ENGLISH STAND.

By the term "English microscope" is meant the distinctive type of instrument which has been built to embody conveniences for working with modern high-class objectives and condensers, which conveniences cannot be found in combination in any other microscopes than those of British origin. Among them are the following:—(1) *The tripod foot; (2) *a long range of coarse adjustment for the use of low-power objectives; (3) *the body tube fitted with mechanical draw tube to allow for the adjustment of objectives for thickness of cover-glass; (4) the mechanical stage scientifically constructed as a part of the whole instrument; (5) the compound substage with rackwork to focus and screws to render the substage condenser axial with any objective that may be in use; (6) *fine adjustment to substage; (7) *the Wenham binocular body; (8) the various fittings for substage apparatus, eyepieces, and objectives of the Royal Microscopical Society's standard gauge; (9) *all the working parts fitted with sprung bearings and controlling screws so that compensation for wear and tear may be readily effected.

In the English microscope alone are all these conveniences to be found in combination. In isolated instances one or two of the fittings are included in microscopes of foreign origin, but none are provided with those marked with an asterisk, in the manner that is usual in the English instrument.

Numerous microscopes are made in Great Britain which are not of the typical English model, designed for students and special uses, but even in these it is customary to incorporate some of the qualities and conveniences enumerated above, and they permit of greater latitude in individual working on the part of the intelligent user than is possible with a microscope which must of necessity be used as a tool that magnifies on account of its limitations.

The English microscope has never suffered from want of appreciation on the part of those who have had leisure or taken sufficient interest to use its many refinements, and it is significant that it is the prevailing type that is employed by the thousands of amateur workers throughout the world to-day.

To the professional worker it has not appealed in the same degree, but gradually he is appreciating the fact that to do the best he must have the many facilities that the English microscope affords, and it is in consequence gradually displacing instruments of simpler construction.

The English microscope has always been of substantial proportions, but a definite advance in its precision took place when between twenty and thirty years ago it was recognised by the leading exponents of microscopy, and especially Dr. Dallinger and Mr. E. M. Nelson, that the improved optical means then introduced could not be advantageously employed without adequate mechanical conveniences. A slower acting fine adjustment suitable to the increased numerical aperture of objectives was the earliest step, and after many years' insistence that the now almost extinct direct-acting fine adjustment was sufficient for all requirements, the Continental makers fell into line with the English makers.

Then followed the mechanical draw tube, and only those who have seen the beautiful manipulative effects obtained by leading workers, can realise what can be done by its use in correcting for slightly different thicknesses of cover-glass. It has been stated that a difference of draw-tube length of 5 mm. is of no practical importance, but this is not the experience of the modern worker. His critical effects are obtained within closer limits.

Improvements were simultaneously introduced into the general design of microscopes, refinements which advanced workers found desirable were incorporated, and British manufacturers produced instruments which are to this day known by the name of the microscopist who provided the specification.

The result has been that the English microscope is a distinctive one, and is unlike its contemporaries of other countries in several important features.

The mechanical stage of the English microscope, built as part of the instrument, has very forcibly revealed its advantages in connection with the recent introduction of immersion paraboloids and reflecting condensers. The attachable mechanical stage of the Continent carries the object slip along the surface of the stage. For these immersion paraboloids it is essential that the under-side of the object slip shall be in contact, by means of immersion oil, with the top lens of the paraboloid. It will be obvious that as the mechanical screws carry the object slip along the surface of the stage the oil from the under-side of the object slip will pass on to the stage surface. The immersion oil is thus drawn away and the contact is no longer maintained. The same effect is produced with any immersion condenser, so that in effect the attachable form of mechanical stage largely interferes with the proper working of any condenser or paraboloid which may be of the immersion type.

It should be borne in mind in this connection that the Abbe illuminator, if used in its full efficiency, must be immersed. This fact is generally overlooked, and it is exceedingly rare for an Abbe illuminator to have its maximum numerical aperture developed by means of oil immersion.

The English mechanical stage has each plate working independently, and the object is carried in a fixed position on the top moving plate. The oil therefore does not run on to the stage surface as in the pattern just mentioned.

The compound substage is typically English. The necessity for centring screws to enable the optical centre of the substage condenser to be adjusted to the objectives in use has to this day not been recognised by Continental opticians.

A fine adjustment to the substage was the accompaniment to the more general use of the oil-immersion condenser, the absolute focussing that this required being realised better by this means than by coarse adjustment only.

There is still want of conformity with the Royal Microscopical Society's substage size on the part of non-British makers, and the condensers are not interchangeable without alteration.

The advantages associated with the tripod foot which, properly proportioned, is light in weight, and yet imparts rigidity which is not possessed by any other shape, the convenience of being able to use low-power objectives, and the Wenham's binocular body with its exquisite stereoscopic effects, and, finally, the obviously better construction from a mechanical point of view of fittings that are adjustable in consequence of wear, all unite to make the British microscope an instrument of precision.

It is admitted that many of the refinements which are referred to here are of but small use to the man who does not make himself acquainted with elementary principles of microscopical theory and manipulation; but any worker who intends to wrest from his instrument the best it is capable of yielding and desires to make himself proficient in its use will find that the English microscope must be employed.

A Defence of the Continental Form.

The Continental microscopes are of a shorter build than the original English pattern, and are normally supplied with a tube length of 160 mm. (6 inches), while the English tube length normally supplied is 250 mm. (10 inches).

The short Continental microscopes are more convenient to use on a table of normal height, and, owing to their compactness and portability, are mostly used in laboratories of universities, institutions, &c., in this country.

The equipment of these microscopes varies considerably, and the better microscopes of the leading makers are fitted with all the modern appliances demanded with an up-to-date fully equipped microscope.

The stands are often fitted with mechanical stages of exquisite design and large opening, being revolvable, and having a displacement for the cross motion large enough to allow for searching over an entire slide; they are very convenient if serial slides are to be examined. Verniers are provided to locate the exact position of the object, thus saving a great deal of time in finding the exact spot noted on any previous day.

The substage arrangement is of the usual Abbe form, with sliding sleeve to receive either a fixed ordinary Abbe condenser or an achromatic condenser with centring device.

The iris diaphragm carrier on the substage is of a very ingenious construction, being provided with rackwork to place the iris out of centre, up to a range to meet the extreme margin of a numerical aperture of 1·40, and, owing to the iris diaphragm carried being revolvable around the optical axis of the microscope, specimens can be illuminated from any azimuth and obliquity with the greatest ease.

The recess in the iris diaphragm carrier takes a polariser, also mica films, in a convenient manner should the microscope be used with polarised light.

The complete substage with condenser is provided with a rack and pinion work, and the best make acts with such precision, having no back-lash whatsoever in the rack and pinion movement, that the fine adjustment of the substage is absolutely superfluous.

The horseshoe foot, provided with three resting points on the extremity of the horseshoe, has been much improved of late in order to ensure great firmness of the stand for visual observation. For horizontal use, as is the case in photomicrography, the Continental models are chiefly used with a suitably prepared sole plate with levelling screws and clamping device; this mode has also proved to be of great service even with the larger tripod stands of best English make.

The body tube of some of the Continental stands are exceptionally wide in order to allow the use of low-power objectives without cutting down the field, and also to avoid internal reflection.

The fine adjustment is placed near the stage in the most convenient position, and is of the greatest sensitiveness, an interval on the scale representing a movement of 2/1000 of a millimetre. The rackwork is sufficiently large to meet even low powers of 4-inch focus.

All important sliding parts are not sprung but carefully ground in and free from back-lash, which is essential if the microscope is expected to remain in focus, chiefly with high powers. Sprung motions, however carefully done, are bound to counteract.

First-class Continental makers do not spare expense in making these carefully ground-in sliding parts, and this is the best and surest manner to guarantee a first-class microscope to be steady in focus. With the cheaper Continental models the sprung sliding sytem is used to some extent, but less accuracy in this motion is required with such microscopes, which are chiefly designed for low powers.

For binocular vision, even with oil-immersion lenses, the Abbe stereoscopic eyepiece of latest form is simply unique.

To sum up the advantage of the Continental model, it is only fair to say that the instruments, though simple in construction, are certainly most efficient for the highest class of research work in microscopy.

English and Continental Microscopes.

The average English microscope of the present day is a representation of a simplified instrument of what in former days presented a complicated and massive piece of mechanism. The Continental model, on the other hand, has gradually been evolved from an exceedingly simple design to an efficient and practical instrument better adapted to the requirements of the serious worker than is the typical English model possessing the multiplicity of racks and screws and milled heads so much admired by a certain class of dilettanti. The serious worker in science has not the time to play with the large variety of unnecessary fittings embodied in the typical English microscope, while the dilettante finds a whole day may be well spent in a variety of manipulations effecting mechanical and optical adjustments (mainly mechanical) to enable him to examine only a few objects, and such a day's work often proves to be more exhausting physically than mentally.

The tripod base is more rigid than the typical Continental "horseshoe" base, but of recent years the leading Continental makers have so modified the "horseshoe" in that the "toes" are spread outwards and the "heel" prolonged to an extent that the instrument is sufficiently rigid for all practical purposes. When using the microscope in the horizontal position for photomicrography the tripod base gives greater rigidity when not fixed by screws or clamps to the photographic apparatus, but it is not wise to employ the microscope in photomicrographic work without having it securely clamped to the base plate of the apparatus, and therefore in this respect the Continental "horseshoe" is equal to the English tripod.

There are Continental microscopes made with "horseshoes" giving equal rigidity in vertical and horizontal positions to the tripod, and possessing the great advantage of free access to the substage, a feature generally lacking in the typical English model.

The substage with centring arrangement is rarely met with in Continental models, but instead, centring adjustment is provided in the nosepiece, which is undoubtedly a more accurate method of obtaining optical alignment than by displacing the condenser to suit a change of objective. Indeed in photomicrography the absence of centring screws in the substage means a considerable saving of time and greater accuracy is obtained by employing centring screws, or the Continental objective sliders, attached to the body tube of the microscope.

As regards the stage: at one period the principal difference existing between the two makes was that the Continental was provided with an attachment giving mechanical motion, while the English mechan-

ical stage formed an integral part of the instrument. Now we find a "built in" mechanical stage in the best Continental microscopes, and they, as instruments of precision, are of a higher order than is obtained in the English models.

The fine adjustments in the Continental models are made in a variety of patterns, but in their best form we have as yet nothing in this country to compare in quality of mechanism and slowness of motion.

The mechanical draw-tube is provided in only a few Continental models, a feature more common in the English. Instead of this adjustment the Continental makers provide the objective with correction collars to allow of adjustment for varying thicknesses in cover glasses, and this is considered more accurate than the mechanical draw-tube.

It is often claimed by English makers that one of the advantages in possessing an English microscope is that certain fittings are made to the Royal Microscopical Society's standard measurements. As regards objectives and eyepieces there is little or no difficulty in getting the products of all reputable makers interchangeable, whether English or foreign; but a different state of affairs prevails in respect to substage sleeves, for it is generally found that not only does one English maker's condenser refuse to fit into the substage of another, but it is a common fault to find substage sleeves of English microscopes varying so much in diameter that the ideal of R.M.S. standardisation has yet to be reached.

Neither the society nor the makers have met the needs of English microscopists in this respect, so it may be left to the National Physical Laboratory to step in and fill the gap, which is a wide one.

Sprung fittings is another feature claimed for certain English models, yet a curious contrast is shown respecting the durability of these adjustments as compared with the Continental.

The screwdriver is a tool frequently used by owners of the former class of instrument, while the leading Continental instruments require adjustments only once in many years of daily usage.

Accordingly it would appear that fewer sprung fittings add to the durability of the instrument.

When choosing a microscope to embody the greatest possible facilities for the present-day needs of the serious worker, it will be found to be a product of one of the best German houses.

SLEEPING SICKNESS AND BIG GAME.

IN spite of the fact that a commission has been sent out to Nyasaland to investigate the problem of the relations of the big game to the spread of sleeping sickness, under the direction of Sir David Bruce, the most eminent authority on this subject in this or any other country, persistent efforts continue to be made to force the Colonial Office to prejudge the issue and to cause the game to be exterminated before its relation to the disease has been determined accurately. The latest of these efforts was made in the House of Commons on December 13, by Dr. Chapple, member for Stirlingshire, who urged the Secretary for the Colonies to relax the severity of the game laws so as "to permit of the natives hunting *game known to harbour the trypanosome in their blood* in order that both the *game and the infecting fly which invariably accompanied it* might be driven off from the populous centres." We have italicised two statements in Dr. Chapple's speech, as reported in *The Times* of December 14, in order to direct attention to points in which scientific knowledge at the present time does not confirm, or is at variance with, the grounds on which he bases his plea for extermination. His argument is but another instance of the lamentable ignorance of our legislators in scientific matters.

The question under consideration has been discussed at some length in the last three numbers of NATURE, and it will be sufficient here to summarise briefly the present position of the problem. The extermination of the game is urged by its advocates on the following grounds:—(1) That antelopes and other wild animals harbour *Trypanosoma gambiense* in their blood, and are therefore dangerous as a source of infection; (2) that the tsetse-flies instrumental in the transmission of sleeping sickness are dependent upon, and accompany, the big game, and would disappear if the game were destroyed.

With regard to the first point, it has never yet been shown that the big game, in a natural state, harbours the trypanosome in its blood, but only that antelopes can be infected with *T. gambiense* in the laboratory; and this has been shown also for *practically all the common domestic animals*. It may be left to common sense to judge whether, in a region in which the tsetse-flies abound, the domestic animals surrounding the villages and homesteads, or the shy and timid antelopes keeping their distance in the jungles, are likely to be the greater danger to human beings as a source of infection.

With regard to the second point, those who are acquainted with the tsetse-fly in its native haunts are by no means agreed that it is dependent on big game, or that it necessarily accompanies it; on the contrary, many instances have been adduced of tsetse-flies swarming in places where there is no big game of any kind. If, however, it were admitted for the sake of argument that the flies follow the big game, what effect is likely to be produced by the destruction of their natural food? Is it to be supposed that the flies would sit down and die helplessly of starvation? Is it not far more likely that they would be attracted by the food supply offered by the domestic animals surrounding the homesteads, animals which almost without exception are potential hosts of the trypanosome just as much as the big game? If such an effect were produced, the danger to human life might be increased tenfold.

The whole question is one beset with dangers and difficulties, calling for full investigation of the complex factors of the case and for the utmost caution before proceeding to take action. To carry out the extermination of the game in the present state of our knowledge would be simply a leap in the dark, an experiment which, so far as can be foreseen, would lead to no amelioration of the conditions, but might, on the contrary, be fraught with disastrous results. The Colonial Secretary must be commended for having refused, so far, to allow his hand to be forced in the matter. The wisest course in the circumstances is surely to "wait and see" what are the conclusions reached by Sir David Bruce's Commission.

EXPLORATION IN THE DEPARTMENT OF PETEN, GUATEMALA.[1]

THE ruins of Tikal, completely hidden in the forest in the northern part of Guatemala, distant about thirty miles from the Lake of Peten, and forty miles from the nearest habitation, are among the most important and interesting in Central America.

Since my second visit to these ruins in 1882, I have been anxiously awaiting the result of further explorations on this attractive site, and at last it has come in a handsome volume published by the Peabody

[1] Memoirs of the Peabody Museum of American Archæology and Ethnology, Harvard University. Vol. v., Nos. 1 and 2:—"Explorations in the Department of Peten, Guatemala: Tikal," by Teobert Maler; "Preliminary Study of the Ruins of Tikal, Guatemala," by A. M. Tozzer. Pp. 135+28 plates+2 maps. (Cambridge, U.S.A.: The Museum, 1911.)

Museum of Harvard University, under the auspices of which the explorations were undertaken. The first and second of these expeditions were conducted by that veteran explorer, Mr. Teobert Maler, and the third by one of the most prominent of the younger generation of Americanists, Dr. Alfred M. Tozzer. Owing to some unfortunate friction between Mr. Maler and the Peabody Museum, Mr. Maler's plan of the ruins and some of the detail plans of the buildings he describes were not obtained for this volume, and it is therefore difficult to do full justice to his share of the work.

FIG. 1.—View from Temple No. 1 looking west.

During Mr. Maler's preliminary expedition (1895) he remained only eight days at the ruins. On his next expedition (1904) he was camped there for four months, from August to November. As these are the rainy months, he certainly avoided the great difficulty attending a residence at Tikal during the dry season, which is the scarcity of water; on the other hand, four months' camping in a tropical forest during the rains must have entailed great hardship, and it must often have been very difficult to carry on any work at all.

It is to be regretted that Dr. Tozzer's report is not accompanied, as is Mr. Maler's, by a personal narrative; moreover, he gives no indication of the length of his stay at the ruins. Personal narrative may be of no particular scientific interest to the archæologist, but it is of the greatest value to future explorers to know what difficulties have to be overcome and how much work can be accomplished within a specified time.

Mr. Maler discovered a considerable number of hitherto unknown sculptured stelæ, and both his report and Dr. Tozzer's are furnished with many detailed plans of buildings.

Dr. Tozzer was accompanied by Mr. Merwin, who observed the azimuths of the front and back walls of the five principal temples with a transit instrument, but the sketch plan printed in this volume does not show the buildings plotted according to these bearings, and although it shows much that was previously unrecorded, a more accurate survey of the site is to be desired; in fact, although the work accomplished by Mr. Maler and Dr. Tozzer adds considerably to our knowledge, much yet remains to be done at Tikal.

Dr. Tozzer does not say whether he made paper squeezes of the carvings and inscriptions, but it is to be hoped that moulds were made, for, excellent as Mr. Maler's photographs are, photographs alone do not suffice for a careful study of the carving, and plaster casts are absolutely necessary.

Mr. Maler says that Tikal covered an area of four to five kilometres square, but surely this requires verification by further measurements. Dr. Tozzer's sketch map, which includes all the buildings described in the reports, measures less than $1 \times 1\frac{1}{4}$ kilometres. Isolated buildings may be found at a distance of two kilometres from the centre of the city, but this does

FIG. 2.—Circular Stone Altar at Tikal.

not prove that the city proper covered such a great area as Mr. Maler states.

To those who have not studied American archæology, it is a surprise to learn that the remains of a city covering nearly a square mile, with five great stone-built temples, raised on pyramidal foundations, the highest reaching an elevation of nearly two hundred feet from the ground, as well as many smaller temples of similar form, and well-built stone houses containing numerous small, stone-roofed chambers, are to be found hidden away in the depths of a tropical forest in America. However, American archæology is still in its infancy, and may have some strange developments in store for us; it is a vast field, and as the interest in it is rapidly increasing, there is every hope that the rising enthusiasm of students and explorers will result in dispelling much of the mist which obscures the curious civilisations, some of which developed and waned many hundreds of years before the first Spaniard set foot on the American continent. Mr. Maler probably closes a long career of exploration in the forests of Guatemala and Yucatan with his last journey to Tikal, but from Dr. Tozzer one can happily look for useful and conscientious work, both in the field and in the study for many years to come. ALFRED P. MAUDSLAY.

THE ECOLOGY OF DESERT PLANTS.

IN a publication of the Carnegie Institution of Washington, entitled "The Water-Balance of Succulent Plants," Mrs. E. S. Spalding adds to the statistics that she had previously given concerning the reversible changes in dimensions and form of *Cereus giganteus*, the massive stem of which acts as an expanding and contracting water-reservoir. Her observations on the rate of growth of this "giant cactus" lead to the conclusion that it requires a hundred years to attain a height of ten metres. Mrs. Spalding shows that analogous reversible change in volume takes place in *Echinocactus Wisliz-e-ni*, and *Opuntia* spp., and gives the interesting information that the former, at first spherical in form, becomes irregularly columnar, lop-sided, and top-heavy, so that it readily topples over or is uprooted by the wind. She suggests that the inefficiency of the root-system thus revealed represents a case of incomplete adaptation, which accounts for the "sparse occurrence" of the plant.

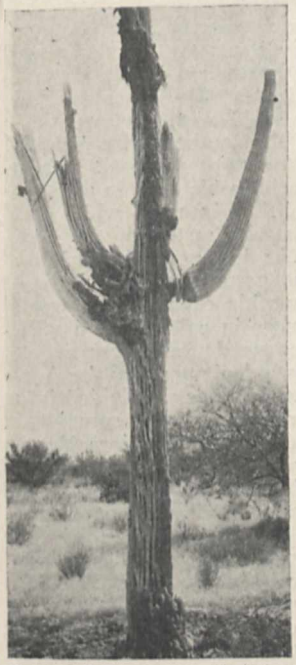


FIG. 1.—*Cereus giganteus* having a dead trunk and living branches which bore flowers one year after the death of the trunk.

By the somewhat cryptic and certainly inelegant expression "water-balance," Mrs. Spalding and her co-author, Prof. D. T. Macdougal, mean the amount of water stored in the plant. The latter author's contribution to the work includes statistics as to the rate and amount of loss of water of certain succulent plants, including the three species mentioned above; for instance, he concludes that individuals of *Cereus giganteus* "12 to 20 metres in height would contain from 2000 to 3000 litres of water," and that "such individuals might lose from 1000 to 1600 litres of water . . . and still survive." As an excellent example of the power of endurance displayed by this species under net loss of water, Prof. Macdougal mentions that branches may remain alive and even bear flowers many months after the death of the main trunk. A number of successful photographs illustrate the work, and one of these is reproduced here.

SIR JOSEPH DALTON HOOKER, O.M., G.C.S.I., F.R.S.

THE most distinguished son of a very distinguished father, Joseph Dalton Hooker was born at Halesworth, in Suffolk, on June 30, 1817. Early in 1820 his father was appointed by the Crown to fill the chair of botany in the University of Glasgow, a post which he held until, in 1841, he became director of the Royal Gardens at Kew. As a consequence Hooker was educated in Glasgow, passing through the High School to the University, from which he obtained the degree of M.D. in 1839. Devoted as a lad to the reading of works of travel, we learn from Hooker himself that he was especially impressed by Turner's description of the Himalayan peak of Chumlari, and by the account of the Antarctic island of Kerguelen contained in Cook's voyages. An opportunity of investigating the latter came to him very early in his career. When he completed his medical studies, Hooker entered the Royal Navy as an assistant surgeon, and was gazetted to the *Erebus*, then about to start, along with the *Terror*, on the famous Antarctic expedition led by the eminent navigator Sir James Clark Ross. Throughout this expedition the young assistant surgeon held the post of botanist, and during its three years' cruise in the southern seas he was able to visit New Zealand, Australia, Tasmania, Kerguelen, Tierra del Fuego, and the Falkland Islands, amassing large collections and acquiring a vast amount of botanical information.

Shortly after the close of this expedition, Hooker, in 1843, became assistant to Graham, then professor of botany in the University of Edinburgh, and in 1845, when Graham was succeeded by the elder Balfour, Hooker was appointed botanist to the Geological Survey of Great Britain. Much of his time during this period was devoted to the preparation for publication of the results obtained during the course of his Antarctic voyages. But in 1847 this work was temporarily suspended, and his appointment on the Geological Survey was relinquished, in order that Hooker might add, by further travel, to his first-hand knowledge of the vegetation of sub-Antarctic and temperate regions, a corresponding acquaintance with the botany of tropical countries. The region selected was north-eastern India, then a practically unexplored tract. The undertaking, originally designed as a private enterprise, through a series of happy accidents received official recognition, and the expenses involved were to a partial extent met from public funds. Hooker left England in November, 1847, reaching India in January, 1848. After some three months spent in the Gangetic Plain and Behar, during which he ascended the sacred hill of Parasnath, Hooker made his way to the Himalayas, reaching Darjeeling in Sikkim in the middle of April. The next two years were devoted to the botanical exploration and topographical survey of the Himalayan state of Sikkim and of a number of the passes which lead from that

country into Tibet; if he did not actually reach he at least had opportunities of seeing the noble peak of Chumlari, which had helped to fire his youthful ambition to become a great traveller. Towards the close of the year 1848 Hooker had an opportunity, which has come to no one since, of crossing the western frontier of Sikkim and exploring a portion of eastern Nepal. During the greater part of the time spent in the eastern Himalayas, Hooker travelled and surveyed alone, but in October, 1849, he was joined by Dr. Campbell, the superintendent of Darjeeling, who had obtained official authority to visit Sikkim. Shortly after Campbell joined him, the Sikkim authorities seized the opportunity thus offered to imprison and maltreat Campbell, at the same time confining Hooker, whom, however, they refrained from injuring. The captives were released towards the end of December, 1849, and the next three months were spent by Hooker in arranging at Darjeeling his vast collections.

Early in 1847 Dr. Thomas Thomson, of the Indian Medical Service, son of a colleague of the elder Hooker in the University of Glasgow, and an old classmate and intimate friend of his own, had been deputed by Lord Hardinge to visit and report upon certain portions of the western Himalaya and Tibet. This mission completed, Thomson made his way to Darjeeling in order to join Hooker, and the year 1850 was devoted by the two friends to the botanical investigation of eastern Bengal, Chittagong, Silhet and the Khasia Hills.

On his return to England in 1851 Hooker resumed the task of publishing his Antarctic results, and began, in conjunction with Thomson, to elaborate those of the Indian journeys. The collaboration of the two friends in the preparation of a "Flora Indica," the first and only volume of which appeared in 1855, ceased when Thomson returned to India, and the appointment of Hooker in that year to the post of assistant director at Kew under his father brought with it duties more than adequate to occupy the time and attention of an ordinary official. The performance of these duties, however, did not impede his Antarctic studies, and in 1860, which saw the completion of the great work on the botany of the Antarctic voyage, Hooker was able to add still further to his extensive knowledge of topographical botany. In the autumn of that year he was asked by Captain Washington, hydrographer of the Royal Navy, to take part in a scientific visit to Syria and Palestine. In the course of this journey he ascended Lebanon and investigated the history, position, and age of the cedar grove which has made that mountain a household word, but of which until then nothing was accurately known.

On the death of the venerable Sir William Jackson Hooker in 1865, Hooker was appointed director of the Royal Gardens, Kew, in succession to his father. This position he held during the next twenty years. The engrossing work and added responsibilities of this period did not, however, prevent Hooker from taking his full share of those public duties which naturally fall to the lot of men of his eminence. He presided over the thirty-eighth meeting of the British Association held at Norwich in 1868, and over the Department of Zoology and Botany in the Biological Section at the meeting held at Belfast in 1874. In 1873 he undertook the arduous duties of president of the Royal Society, and occupied the presidential chair for the next five years. Nor did these duties entirely debar him from further botanical travel. In 1871 he undertook, in company with the late Mr. Ball and Mr. G. Maw, a botanical expedition to Morocco and the Atlas range; in 1877, in company with his intimate friend, Dr. Asa Gray, and with Dr. Hayden, of the United States Survey, he took part in an important botanical journey to Colorado, Wyoming, Utah, the Rocky Mountains, the Sierra Nevada, and California.

From the time of his retirement in 1885, Hooker's life was spent at The Camp, near Sunningdale, where he had built for himself a home, the grounds of which, furnished with all the advantages that knowledge and taste can provide, contain one of the most interesting collections of plant forms in this country. Here he devoted himself with the energy and enthusiasm of one commencing his career to the completion of tasks already in hand and to the initiation of new ones. His critical acumen, which remained unaffected by advancing age, and his physical vigour, which became seriously impaired only a few weeks before his death, enabled him, in the freedom from administrative duties which retirement had brought, to accomplish work which as regards its amount must be considered the ample harvest of a lifetime, and as regards its quality, and no higher tribute could well be bestowed, fully sustained the reputation of his earlier publications.

The work which Hooker accomplished can be but briefly outlined here. Space forbids a complete enumeration of his many contributions to natural knowledge; all that can be done is to endeavour to indicate the various lines of his intellectual activity, and to note how these were affected by the leading events in his personal history. While still an undergraduate, Hooker had been at work in his father's herbarium in Glasgow. The earliest of his results appear in a paper on Indian mosses, written in collaboration with the late Prof. Harvey, which was published in 1840, shortly after he had joined the expedition under Ross. Work connected with cryptogamic plants was one of his strongest early inclinations, for some of the most important of his papers, prepared during the years 1844 to 1847, when he had returned from the Antarctic, deal with the hepatics, lichens, mosses, and algæ of the southern circumpolar regions. But a predilection for work on fossil botany manifested itself almost as early in his career; another early paper, written and published in 1842, while still botanist on the *Erebus*, deals with an examination of a Tasmanian fossil wood. As his general work on the Antarctic material he had accumulated made progress, we find, however, that his cryptogamic work came to be done more and more in collaboration with workers who had made some particular lower group their special province. The botanical results of the Antarctic voyage occupy six quarto volumes subdivided into three sections: (1) the "Flora Antarctica," completed in 1847, before he left for India; (2) the "Flora Novæ Zelandiæ," issued in 1853, after his return from the East; and (3) the "Flora Tasmaniæ," published in 1860, after he had become assistant director at Kew.

But the preparation of the first section of the Antarctic work did not impede his activities while connected with the Geological Survey between 1845 and 1847. Before undertaking the duties of the post he had already given attention to problems connected with fossil botany; while attached to the Survey he prepared during 1846–7 several important papers on the subject, the most notable of these being a discussion of the vegetation of the Carboniferous period as compared with that of the present day, which was printed in 1848. But his interest in the subject did not end with the severance of his connection with the Geological Department; two interesting papers on fossil botany from his pen were published in 1855. After his appointment as assistant director, however, he made no further formal contribution to knowledge in this particular field. His Antarctic work and his

duties in connection with the Geological Survey did not, however, suffice to occupy all his time prior to his departure for India. He drew up an "Enumeration of the Plants of the Galapagos Archipelago," issued in 1847, and collaborated with the late Mr. Bentham in preparing the "Flora Nigritiana," incorporated by Sir W. J. Hooker in the "Niger Flora," published in 1849.

Some of the results of Hooker's Indian observations, notably those relating to his journeys in the Indian plains, were published by the Asiatic Society of Bengal in 1848. But if on his return to England in 1851 he reverted with energy to the elaboration of his Antarctic results, the Indian material was not neglected. He began, in collaboration with Thomson, that "Flora Indica" the issue of which in 1855 has already been alluded to. In connection with this work two sumptuous illustrated folios were issued; the first, on "The Rhododendrons of the Sikkim-Himalaya," was edited from Hooker's notes, sketches, and material, by his father, between 1849 and 1851; the second, "Illustrations of Himalayan Plants," chiefly made for an Indian friend, Mr. Cathcart, in the Darjeeling neighbourhood, was edited, with descriptions by Hooker himself, in 1855.

This was, however, by no means all that he was able to accomplish. In addition to the families formally described in the solitary volume of their "Flora Indica," Hooker and Thomson discussed in the Linnean Society's Journal various problems of interest relating to individual Indian plants, and issued a series of papers, "Prærcursores ad Floram Indicam," dealing more completely with a number of important natural families. Finally, Hooker's "Himalayan Journals," one of the most fascinating books of travel in our language, in which his Indian journeys are dealt with generally, was issued in two octavo volumes in 1854. Probably no botanical field work has proved more fertile in interest or provided material of greater value in the discussion of biological and phytogeographical problems than that done by Hooker. Yet great as were his botanical results and pardonable as it is in the botanical worker to look upon these as Hooker's highest achievement, it is doubtful whether the topographical results were not of even greater moment. These results, reduced by Hooker himself, with the assistance, as he tells us, of various Anglo-Indian friends who came under the magic spell of his personality, were arranged at Darjeeling during the early months of 1851. They formed the basis of a map, published by the Indian Trigonometrical Survey, with the aid of which, such is its accuracy and its detail, the operations of various campaigns and political missions have been carried to a successful issue.

The ten years during which Hooker was assistant director at Kew were marked by extraordinary activity. The time that could be spared from executive duties was far from being entirely absorbed in Antarctic and Indian work. In 1862, and again in 1864, he dealt with important collections of plants from Fernando Po and the Cameroons in papers valuable in themselves and in the evidence they afford that his interest in the flora of the Dark Continent, first evinced in 1847, had never abated. This interest showed itself once more in a paper of 1875, which may be mentioned out of sequence, on the subalpine vegetation of Kilimanjaro. In this case, however, the interest was associated with another which had guided much of his Antarctic study and had manifested itself in 1856 and in 1861 in dealing with the Arctic plants collected during the Franklin searches and the McClintock expedition. The problems involved were dealt with in a comprehensive fashion in 1861 in Hooker's classic, "Outlines of the Distribution of Arctic Plants." A group of kindred problems had presented themselves to Hooker when engaged in the study of the vegetation of the more outlying Antarctic and sub-Antarctic islands, and subsequently when dealing with the plants of Galapagos. To this period therefore we may most properly ascribe the formation of the views enunciated in a notable discourse on "Insular Floras," delivered at the meeting of the British Association at Norwich in 1866. Yet another allied group of problems called for consideration in connection with his Antarctic, Indian, and African studies; his conclusions with regard to these are stated in his "Introductory Essay to the Flora of Tasmania," published in 1860; the opinions there expressed on the origination and distribution of species suffice to explain the action which Hooker took when, in conjunction with Lyell, he had induced Darwin, in 1858, to publish a preliminary sketch of his famous hypothesis.

To the same period of his activities belongs the share taken by Hooker between 1858 and 1864 in the preparation of Thwaites's enumeration of the plants of Ceylon. To this period we owe, moreover, the codification of the results given in the second portion of the Antarctic flora in the form of a "Handbook of the New Zealand Flora," contributed to the series of Colonial floras published under Government authority. The work was issued in part in 1863; the concluding portion was published in 1867, shortly after the period had come to an end. But to this period we owe, in addition, various important special studies on the structure and affinities of Balanophoreæ, published in 1856; on the origin and development of the pitchers of Nepenthes, in 1859; and on *Welwitschia*, in 1863. The most obvious result of Hooker's visit to Syria in 1860 is a paper on the cedars of Lebanon, Taurus, Algeria, and India, published in 1862. In this article a subject of great interest and considerable difficulty is handled with masterly skill. But the journey bore further fruit in the form of a singularly pleasing sketch of the botany of Syria and Palestine, contributed in 1863 to "Smith's Bible Dictionary." Extensive and important as these various contributions to botanical knowledge are, they do not include all that Hooker accomplished while assistant director; the most onerous and important undertaking initiated during this period has still to be mentioned. In renewed collaboration with Mr. Bentham was commenced one of the outstanding botanical monuments of the nineteenth century, in the form of a great "Genera Plantarum"; of the three volumes which this work includes the first was completed in 1865.

Hooker's succession in that year to the directorship of Kew brought with it all the responsibilities connected with the administration of that national institution. These, however, did not prevent him from continuing to take his share in the preparation of the "Genera Plantarum," the second volume of which was completed in 1876, the third and concluding one in 1883. The directorship, however, brought with it the duties of continuing the *Botanical Magazine* and the *Icones Plantarum*, edited by his predecessor. These duties Hooker continued to fulfil even after his retirement in 1885; in the case of the *Icones* until 1889, in that of the *Magazine* until 1902, and with the collaboration of Mr. W. B. Hemsley for two years longer, his connection with this historic serial ending in 1904, with the completion of the one hundred and thirtieth volume. The death of his father imposed on Hooker yet another filial duty of the most arduous character, that of replacing in 1870, by his own "Student's Flora," the "British Flora" of his predecessor. In 1873 he annotated and rearranged the natural families of plants in an English version of the "Traité général" of Le Maout and Decaisne, and in 1876 he wrote for the series of science primers that on "Botany."

The results of Hooker's journeys in North Africa in 1871 are given in "A Journal of a Tour in Marocco and the Great Atlas," written in collaboration with Ball and published in 1873; those of his visit to North America in 1877 were summarised by himself in our pages (NATURE, vol. xvi., p. 539).

Of the addresses and discourses delivered by Hooker during this period that on "Insular Floras" of 1866 has already been alluded to. That delivered from the president's chair to the British Association in 1868, with its whole-hearted advocacy of an acceptance of the hypothesis of Mr. Darwin as the surest means of promoting natural knowledge, was perhaps more important in its effect on scientific thought generally. His British Association sectional address of 1874, on "The Carnivorous Habits of Plants," was an illuminating review of those problems to which his own observations and researches on Nepenthes in 1859 had directed attention.

It has recently been remarked that "so broad-based were the foundations of Kew as laid by Sir William Hooker that they have been but little extended by his followers. Their work has been to build a noble superstructure. Viewed in detail Kew is hardly anywhere the same as it was in 1865. But the framework is very much the same." These remarks are so just that no useful purpose could be served by any attempt to enumerate here the various manifestations of Hooker's activity as an administrator, or to detail the alterations and additions which marked his directorship. That activity, as was said in this journal by Prof. Asa Gray in the article on Hooker in our "Scientific Worthies" series (vol. xvi., p. 538), was exercised "in such wise as to win, along with national applause, the gratitude of the scientific world." Nor is more than a passing allusion due to a bitter controversy in 1872, Hooker's unsought share in which the world of science made its own. Those whose curiosity extends to the unedifying may find the details in a parliamentary paper; it is sufficient to remark that in the following session the Royal Society chose Hooker to preside over their councils.

We have yet to allude to what was the heaviest and the most prolonged task of Hooker's life, the publication of the "Flora of British India." During his collaboration with Thomson, prior to 1855, in the elaboration of the results of their Indian journeys, the two friends had been able to render available for scientific study the botanical treasures preserved in the East India House. The heavy but essential task of distributing these involved as a corollary the preparation and issue of a catalogue of the specimens dealt with. This catalogue Hooker was able to publish in 1865. A similar necessity subsequently arose in connection with the Peninsular Indian herbarium brought together by the late Dr. Wight. This subsidiary distribution was completed and the requisite ancillary catalogue was prepared by 1870. The task of preparing for British India a flora on the lines of those written at Kew on behalf of the various colonies could at last be undertaken. This task was at once begun; the opening part of the initial volume appeared in 1872 and the volume was completed in 1875. It was followed by the second volume, finished in 1879, by the third, finished in 1882, and by the fourth, the concluding part of which was issued, just as Hooker retired, in 1885.

Nearly half of the gigantic task had still to be accomplished, so that in Hooker's case retirement, if it brought relief from administrative cares, did not bring leisure. The heavy labour was faced without flinching; the progress of the work remained unchecked. The fifth volume, containing four parts, was completed in 1890; the sixth, also a volume of four parts, in 1894; the seventh and concluding volume appeared in 1897.

In the meantime, however, Hooker undertook a new and onerous task. Shortly before his death the late Mr. Darwin informed Hooker of his intention to devote a considerable sum to be expended in providing some work of utility to biological science, and to arrange that its completion be assured should this not be accomplished during his lifetime. The difficulties which he had experienced in his own studies led Darwin to suggest that this work might take the form of an index to the names, authorities, and countries of all flowering plants. At Darwin's request the direction and supervision of the work was undertaken by Hooker; the actual preparation was entrusted to Mr. B. D. Jackson. The result is the "Index Kewensis," of which the publication alone occupied the period from 1892 to 1895. During the period devoted to its preparation and publication the work received the unremitting care and attention of its director and its compiler. Other works, however valuable they may be, admit, as a rule, of some relative estimate. To the "Index Kewensis" no such mode of judgment is applicable; it is simply invaluable, and stands a lasting monument to the wisdom and generosity of Darwin, the piety and sagacity of Hooker, the care and fidelity of Jackson. While this "Index" was in progress, Hooker arranged for publication in 1895 a century of drawings of orchids, for which he provided descriptions, from among the manuscript figures placed at his disposal by the Calcutta herbarium in connection with his own work on the "Flora of British India." Scarcely had the responsibility attaching to the preparation of the "Index" been laid aside ere Hooker undertook, as an act of justice to the memory of a distinguished predecessor, to edit the "Journal of the Right Hon. Sir Joseph Banks, during Captain Cook's first voyage, 1768–71"; this work was published in 1896.

The time-consuming and exacting labour which the preparation of the Indian flora entailed had barely ended when the chivalrous generosity of Hooker was once more invoked. The late Dr. Trimen had undertaken the preparation of a "Handbook of the Flora of Ceylon." Three volumes of this work were issued between 1893 and 1895. While it was in progress Trimen was mortally stricken; the third volume was issued with the hand of death upon the author. When Trimen died the Government of Ceylon sought Hooker's aid. With indomitable courage the veteran of over eighty undertook the heavy task of completing the work of another author who had fallen a victim in the prime of life, under restrictions as to scope and style which, whether they met with his approval or not, were at any rate different from those hitherto observed by himself. Perhaps no more touching token of regard than this was ever paid to the memory of a friend. The fourth volume of the Ceylon flora, to some extent edited from material left by Trimen, appeared in 1898; the fifth and concluding volume, which it fell to Hooker to prepare himself, was issued in 1900. Still, as he himself once expressed it, "dragging the lengthening chain" of the *Botanical Magazine*, Hooker devoted the next two years of his own life to writing that of his father, which appeared in the "Annals of Botany" in December, 1902. Coincident with the appearance of this tribute of filial piety came the arrangement which relieved him of some of the pressure which the editing of the *Magazine* entailed, but not the anticipated freedom. At the request of the Government of India, Hooker undertook to prepare for the "Imperial Gazetteer" a sketch of the vegetation of the Indian Empire. This task, one of the most difficult, when regard is had to the limitation of space almost necessarily

imposed, that could well be undertaken, was successfully accomplished, and has resulted in an essay comparable with that on the botany of Syria and Palestine, written thirty years earlier.

The active intellect which had for five and sixty years taken a fierce delight in laborious days, and had throughout found a task to be more congenial in proportion to its difficulty, was not likely to seek satisfaction in an unbroken round of quiet breathing. If new worlds need not be sought for conquest, at least some unregulated province might be reduced to order. Among the families of Indian plants dealt with by Hooker and Thomson in their "Præcursores" one of the most fascinating, whether for the variety of its forms or the intricacy of their relationships, had been the Balsamineæ. Since 1859, when their paper appeared, a host of new Indian and Chinese forms had been reported; the characters met with in some of these appeared to invalidate earlier conclusions. To the study of this interesting group Hooker devoted his attention from 1904 onwards, evolving order out of an apparent chaos, and in the course of his studies placed those in charge of most of the important herbaria in Europe under a deep obligation, by supplying them with a uniform nomenclature for their specimens. On this work, which, so far at least as the Asiatic forms are concerned, had been practically completed, Hooker was engaged almost to the last.

Shortly summarised, and omitting here any reference to excursions into the domain of economic, morphological, and physiological botany, or to systematic studies of material from countries in which he did not himself travel, we find evidence of the existence of several definite lines of active interest, athwart which fell the shadow of various outstanding events in Hooker's career. The record indicates that Hooker's strongest and earliest predilections were perhaps towards the study of cryptogamic plants and work on fossil botany. The first predilection reached its culmination in 1844, when he returned from the circumpolar expedition on which he had started in 1839. The pressure exercised by problems, to the elucidation of which the evidence of flowering plants with their more special organisation and more restricted distribution is of greater value, gradually led to the abandonment of this field of study, which was not re-entered after he left for India in 1847. The predilection for work on fossil botany naturally reached its culmination while Hooker was attached to the Geological Survey. Its influence, though not entirely inhibited, was less active after Hooker's return from the East, and this field of study was abandoned when he became assistant director of Kew in 1855.

The predilection for the study of those problems that relate to the origination and distribution of species, to which his experience as a field naturalist on circumpolar islands and among the peaks and valleys of the Himalayas had given so great an impetus, reached its culmination while he was assistant director at Kew, and is manifested most strongly in the classical essays which date from 1860 to 1866. Without attempting to estimate the interaction effects of the work of Darwin on that of Hooker and *vice versa*, we may here direct attention to the fact of their existence. Nor could it be otherwise; the two men studied and wrote, on terms of intimate and affectionate friendship, in an atmosphere surcharged with great and pregnant thought.

With Hooker's succession to the directorship of Kew in 1865, the Antarctic work had practically ended, for the concluding moiety of the New Zealand handbook appeared in 1867. He was now able to do for India what he had already done for Tasmania and New Zealand, and if, when he retired in 1885, only half of his Indian systematic work had been accomplished, there was no break in its continuity. If we except his masterly sketch of the vegetation of India, prepared after the "Indian Flora" had been completed, we are without a record of his conclusions from Indian botanical evidence, comparable with the brilliant generalisations based on his study of the Arctic, Antarctic, and insular floras of the globe. This may be a cause for regret; it can be no cause for surprise. Not only is the Indian field the wider of the two; Hooker completed the essential preliminary spade-work in the other during the sixteen years between 1844 and 1860, whereas the corresponding Indian toil exacted over forty years of labour between 1854 and 1897. When the Indian preliminary work was done it only served to prove that the relationships of the Indian, Malayan, and Chinese floras are so intimate as to demand their conjoint consideration.

The completion of the "Indian Flora" in 1897, rather than the demission of the directorship at Kew, marks the close of a period in Hooker's work. The next epoch, a comparatively brief one, was devoted to the performance of acts of piety to the memory and regard for the wishes of predecessors or of contemporaries whom he had outlived. These tasks ended, the evening of his life was devoted by Hooker to work which in many respects was, even for one so wide in his range and so varied in his interests, a new departure. His great "Antarctic Flora," his still greater Indian one, are splendid examples of broad canvases upon which in bold and striking lines the hand of a master has depicted the salient and essential features of a highly diversified landscape, and no one has ever portrayed with a surer touch. In the work to which Hooker devoted the closing years of his life, he has treated a single natural family as a precious gem, upon which, with a hand as sure as the one that has given us the ample atmosphere of his great pictures, he has engraved an exquisite intaglio.

To offer here an estimate of the quality of Hooker's work would surely be out of place. That task has already been performed in the pages of NATURE by one who was in the strictest sense Hooker's contemporary, and who, if he had not the advantage of such perspective as time affords, at least had all the benefit of distance in space to aid his judgment. It is sufficient here to say that the estimate made in 1877 has been fully sustained by all that has happened since; it is, moreover, interesting to reflect that the hope then so fondly expressed that Hooker, already in his sixtieth year, might still be only in mid-career has been fulfilled almost to a day. If it be urged that in one respect the judgment of 1877 is at a disadvantage as being from the pen of one who, like Darwin, was bound to Hooker by the ties of almost lifelong affection, then we can only say that no one now alive who has enjoyed the privilege of Hooker's acquaintance may venture to judge his work, because to know Hooker was to love him. The breadth of his interests, the depth of his knowledge, and the wisdom of his counsel combined to inspire reverence and regard. But above all these qualities, and beyond the singular charm of his manner, shone the unstudied and unstinted kindness which compelled affection.

A member of the Linnean Society since 1842, Hooker was a member of the council during twenty-four years, and for fifteen of these was one of its vice-presidents. He was also a member of the Geological Society, which he joined in 1846. He was elected a fellow of the Royal Society in 1847, and served on the council during seventeen years, for six of these as a vice-president and for five as president. A correspondent of the Institute and a member of the Academies of Berlin, Bologna, Boston, Brussels, Copenhagen, Florence, Göttingen, Munich, Rome, St. Petersburg,

Stockholm, and Vienna, he enjoyed, in addition, the freedom of practically every society or corporation devoted to the promotion of natural or technical knowledge within and beyond the British Empire. Not a few of these bodies have bestowed on Hooker still further distinctions. On the recommendation of the Royal Society he received a Royal medal in 1854; by the same society he was awarded the Copley medal, its highest honour, in 1887, and the Darwin medal in 1892. From the Society of Arts he received their Albert medal in 1883; from the Geographical Society their Founder's medal in 1884; from the Linnean Society their Linnean medal in 1888, a medal struck to celebrate his own eightieth birthday in 1897, and one of the medals struck in 1908 to commemorate the fiftieth anniversary of the publication of the joint communication of Darwin and Wallace on natural selection, in the original presentation of which to the society he had played so important a part. The Manchester Philosophical Society awarded him a medal in 1898, and in 1907 he received, in circumstances of singular dignity, from the Swedish Academy, what he himself has characterised as the crowning honour of his long life—the solitary medal, struck especially for the occasion, to commemorate the two hundredth anniversary of the birth of the great Linnæus.

Among his academic distinctions were the honorary degree of D.C.L., conferred upon him by the University of Oxford, and that of LL.D. from the Universities of Cambridge, Edinburgh, Dublin, and his own *alma mater*, Glasgow.

His foreign distinctions have included membership of the Royal Swedish Order of the Polar Star and the Royal Prussian Order "Pour le Mérite." By his own Government he was made a C.B. in 1869, the year following his presidentship of the British Association; he was made a K.C.S.I. in 1877, towards the close of his presidentship of the Royal Society. He was in 1897 promoted to the grade of G.C.S.I., when, in his eightieth year, the "Flora of British India" was completed; and in 1907, on his ninetieth birthday, he received the Order of Merit.

Hale and robust in his venerable old age, the veteran Hooker not only attended the Darwin-Wallace celebration organised by the Linnean Society in 1908, addressing the delegates and fellows present in a speech which recounted the part played by himself half a century earlier; he also attended the celebration at Cambridge in 1909 which commemorated the centenary of the birth of his friend Darwin. At work until within a few weeks of his death, and keenly interested in current topics to the last, Hooker passed peacefully away in his sleep, at his residence, The Camp, near Sunningdale, at midnight on Sunday, December 10. As was befitting, an invitation was offered to receive his remains in Westminster Abbey. Hooker had, however, expressed his wish that they should rest in the tomb in which his illustrious father's body was laid. This wish was fulfilled, and on Friday, December 15, he was buried in the family grave in the old churchyard of Kew. The *cortège* followed the coffin to the church, as was meet, from the house so long occupied by, and so full of memories connected with, his father and himself. At Kew, where so much of what he accomplished was done, he sleeps with his people, and Kew with its old churchyard is now more sacred even than it was to botanical pilgrims.

Among the mourners were the following members of the family, representatives of scientific societies and other institutions, and fellows of the Royal and the Linnean Societies:—

Lady Hooker (widow), Miss Grace Hooker (daughter), Mr. William Hooker, Dr. and Mrs. Charles Hooker, Mr. R. H. Hooker, Mr. R. S. Hooker, Sir W. T. Thiselton-Dyer, Miss Thiselton-Dyer, Mr. G. H. Thiselton-Dyer, Miss Symonds, Mr. R. Symonds, Mrs. Calverley-Bewicke, Mr. R. Woodward, Mr. R. Woodward, jun., Rev. G. Barker, Mr. G. Barker, Mrs. Crowder, Captain A. L. Henslow, Mr. Malleson, Mr. Murray, Miss Palgrave, Mrs. Paul Waterhouse, Miss M. Smith, Sir Arthur and Lady Rücker, the Hon. Mrs. H. Darwin, Mrs. Prain, Miss Younghusband, Mr. A. H. Lyell, Captain F. H. Lyell, Dr. Trail, Rev. A. G. Musgrave; the servants from The Camp, Sunningdale. Royal Society: Sir A. Geikie (president), Sir J. Larmor and Sir J. R. Bradford (secretaries), Lieut.-Colonel A. W. Alcock (council), and Prof. Bayley Balfour, Regius Keeper of the Botanic Garden, Edinburgh. Society of Antiquaries: Dr. C. H. Read (president). Linnean Society: Dr. D. H. Scott (president), Dr. B. D. Jackson and Dr. O. Stapf (secretaries). Geological Society: Prof. W. W. Watts (president), Prof. J. W. Judd (past-president). Royal Geographical Society: Mr. W. E. Darwin, Lieut.-Colonel H. H. Godwin-Austen. British Science Guild: Sir Norman and Lady Lockyer. Entomological Society: Prof. Meldola. British Medical Association: Mr. G. A. Peake. Royal Horticultural Society: Sir D. Morris, Mr. J. H. Veitch. Pharmaceutical Society: Mr. E. M. Holmes. University of Glasgow: Prof. F. O. Bower. Natural History Museum: Mr. E. G. Baker. West Indies: Mr. W. Fawcett. Royal Botanic Gardens, Kew: The Director, with the whole of the permanent staff, and with detachments representing the constabulary and the labour departments. Sir G. Darwin, Dr. F. Darwin, Sir A. Church, Prof. S. H. Vines, Mr. G. C. Druce, Prof. D. Oliver, Prof. F. W. Oliver, Mr. A. Henry, Dr. A. Günther, Prof. G. S. Boulger, Mr. J. S. Gamble, Mr. W. B. Hemsley, Mr. J. Britten, Mr. J. R. Drummond, and Dr. F. N. Williams.

NOTES.

We are pleased to be able to report that Dr. R. T. Glazebrook, the director of the National Physical Laboratory, who has for some time been seriously ill with enteric fever, has recently been making good progress towards recovery. A marked improvement has been shown during the last few days, and it is hoped that he may shortly be regarded as convalescent.

The Rt. Hon. the Earl of Cromer, G.C.B., and the Hon. Lionel Walter Rothschild, have been elected fellows of the Royal Society under the statute which empowers the council once in every two years to recommend to the society for election not more than two persons who in their opinion have rendered conspicuous service to the cause of science. The following have been elected foreign members of the Royal Society:—Dr. Johann Oscar Backlund, of Pulkowa, Imperial Astronomer of Russia; Dr. Heinrich Ritter von Groth, professor of mineralogy in the University of Munich; Heinrich Kayser, professor of physics in the University of Bonn; M. Joseph Achille Le Bel, of Paris, the distinguished chemist; and Klement A. Timiriazeff, professor of botany in the University of Moscow.

At a meeting of the executive committee of the British Science Guild, held on December 13, it was decided that the lecture scheme recently proposed should be commenced at the end of January. Sir Edward Brabrook agreed to read the first paper, on the scientific aspects of charitable effort. Prof. Perry will give a paper on problems in technical education in connection with national industries, and Mr. Frederick Verney on agricultural problems. After the reading of papers the meetings will be open for discussion. The meetings will be held in the rooms of the Chemical Society at dates to be announced later.

The conditions just issued by the War Office for the Military Aëroplane Competition have met with general

approval, and as they are frankly based on the recent French competition rules, and call in some instances for more difficult tests, it is felt that the winning machines will represent the best productions at present obtainable. The prizes are divided into two classes: (*a*) For aëroplanes made in any country (open to the world), first prize, 4000*l.*; second prize, 2000*l.* (*b*) For aëroplanes manufactured wholly in Great Britain, except the engines (open to British subjects), first prize, 1500*l.*; two second prizes, 1000*l.* each; three third prizes, 500*l.* each. There are, in addition, consolation awards of 100*l.* each for ten machines which undergo all tests and do not receive a prize, and the War Office is to have the option of buying any of the prize machines at 1000*l.* apiece. The chief conditions to be fulfilled are as follows:—The machine, which must be a two-seater fitted with dual controls, must rise without damage from long grass, clover, or harrowed land in 100 yards in a calm, carrying a live load of 350 lb. in addition to instruments and oil and fuel for 4½ hours' running. In rising, the height of 1000 feet must be reached in five minutes, and it must fly for three hours continuously, of which time one hour must be passed at an altitude of 4500 feet. Before landing, a glide of not more than 1000 feet will be required, and the angle must be not less than 1 in 6. The landing must be made without damage on any cultivated ground, including rough plough. Among the desirable attributes of the aëroplane are mentioned a silencer to the engine, flexibility of speed, and an engine capable of being started from on board.

It is with much regret that we see the announcement of the sudden death of Prof. Andrew G. Ashcroft, of the City and Guilds (Engineering) College, South Kensington, S.W., at fifty-two years of age. Prof. Ashcroft was a student at University College, London, and at the conclusion of his student career he was attached to the staff of the Engineering School. For some time he was engaged in constructional engineering work at the Alexandra Palace, and in other practical work of a similar nature. He returned to the Engineering School of University College, London, to act as assistant to Prof. T. H. Beare and Prof. (now Sir) Alexander Kennedy. Whilst acting in this capacity he lectured on engineering subjects at the East London College, then the People's Palace. At this period of his career, coincident with the recognition of the importance of technical education, he was appointed head of the Woolwich Polytechnic, and his work in this position showed that he was a shrewd and capable organiser. He left Woolwich to take up the work of assistant professor of civil and mechanical engineering at the Central Technical College, London. Prof. Ashcroft was keenly interested in the subject of the strength of materials, and was an expert in the measurement of small strains. Amongst other instruments, he designed an extensometer for measuring elastic strains; a delicate cross-strain measurer for the determination of Poisson's ratio; and a hand-testing machine for small tension pieces with a specially delicate autographic recorder. His written contributions to various societies include papers on properties of malleable iron, instruments of precision, and the measurement of air supply to internal-combustion engines. Prof. Ashcroft was a member of many societies, and took an active interest in the welfare of each one of the numerous social clubs which exist at the college where he worked. He was universally popular with the students, and the engineering profession is the poorer for the loss of so attractive a personality.

A serious explosion, resulting in injury to eighteen officers and men, occurred on December 12 during certain trials which were being carried out on board H.M.S. *Orion* at Portsmouth. From the newspaper accounts it appears that official tests of one of the dynamos were in progress when the explosion took place. The explanations put forward attribute the accident to the ignition of inflammable vapour given off from the oil used as a lubricant of the dynamo. One suggestion is that the production of vapour was due to overheating of the bearings: this would imply either that the lubricant was unsuitable or that it was not properly applied. Whether in this particular case the explanation is the true one or not, it seems at least probable. Lubricating oils are generally composed of high-density petroleum products, used either alone or mixed with a proportion of vegetable or animal oil. Numerous varieties are made to suit different types of machinery. For each type, of course, it is important to choose the appropriate lubricant. As regards inflammability, it is well known that petrol and ordinary petroleum oil for burning give off vapour at relatively low temperatures, but it is probably not so well recognised that at higher temperatures some lubricating oils may do the same. In fact, a determination of the flashing point, or at least a proof that the oil does not "flash" below a given temperature, is usually required in deciding upon the suitability of certain kinds of mineral oil for use as lubricants.

The annual Christmas course of juvenile lectures at the Royal Institution will begin on Thursday next, December 28, at three o'clock, when Dr. P. Chalmers Mitchell will deliver the first of six lectures on "The Childhood of Animals."

At the recent annual meeting of the Yorkshire Numismatic Fellowship, held at Leeds, Mr. T. Sheppard, of the Municipal Museum, Hull, was elected the president for the year 1912, and editor of the society's Proceedings.

A joint meeting of the Institution of Mining and Metallurgy and the Canadian Mining Institute will be held at Toronto on March 6, 1912, and the following days. The meetings for the reading and discussion of papers will occupy three days, March 6, 7, and 8. The annual dinner of the Canadian Institute will be held on March 8, and on March 9 an excursion to the mining districts of Cobalt and Porcupine will be arranged, provided a sufficient number of the members of the English institution wish to visit those localities. Further details of the arrangements may be obtained from the secretary of the institution, Mr. C. McDermid, at Salisbury House, London, E.C.

In proposing the toast of "The Institution of Mining and Metallurgy" at the annual dinner of the institution, held on December 15 at the Savoy Hotel, Sir Alfred Keogh announced that the Bessemer Memorial Committee will, in January, hand over to the Royal School of Mines the laboratory which it has presented to the Imperial College of Science and Technology. Mr. Sulman, in responding to the toast, said that the world's production of gold in the form of standard metal since 1880 has exceeded 1,000,000,000*l.* sterling, more than one-half of which has been won from mines within the British Dominions. The British capital involved in metalliferous mining, apart from coal and iron, during the past twenty-five years exceeds 900,000,000*l.* sterling. During the past four years there has been subscribed as working capital for metalliferous mining, outside coal and iron, above 4,500,000*l.* sterling.

It is well known that the late Mr. J. R. Mortimer, the Driffield antiquary, was an authority on the prehistoric and other earthworks of East Yorkshire, and during the past half-century he made a careful survey of all that

remains relating to the military and domestic life of the early people who built them, a subject upon which he wrote many papers. Several of the structures which were known to Mr. Mortimer forty or fifty years ago, or less, have since entirely disappeared, as a result of agricultural and other operations. Fortunately, Mr. Mortimer carefully recorded his observations upon a large series of Ordnance maps of the district, and also particulars of the barrows, the Roman remains, the pits from which he obtained his geological specimens (most of which are now closed), &c. This valuable collection of maps has been presented by Major Mortimer to the Municipal Museum at Hull, where it can be referred to by students and others interested. In addition are large numbers of sketches, plans, photographs, negatives, &c., bearing upon East Yorkshire antiquities.

THE second annual general meeting of the Society of Engineers (Incorporated) was held on December 11, Mr. John Kennedy, vice-president, being in the chair. The following were elected as the council and officers for 1912:—*President*, J. Kennedy; *vice-presidents*, A. Valon, H. C. H. Shenton, N. Scorgie; *members of council*, H. Adams, C. T. Walrond, P. Griffith, T. E. Bower, H. C. Adams, J. R. Bell, S. Cowper-Coles, H. P. Maybury, B. H. M. Hewett, F. H. Hummel; *associate member of council*, E. Scott-Snell; *hon. secretary and treasurer*, D. B. Butler. It was announced that premiums for papers read at meetings and published in the Journal during 1911 had been awarded as follows:—the president's gold medal to Mr. W. R. Baldwin-Wiseman, for his paper on the administrative aspect of water conservancy; the Bessemer premium of books or instruments, to the value of 5*l*. 5*s*., to Mr. R. W. A. Brewer, for his paper on two-stroke cycle engines; the Clarke premium, value 5*l*. 5*s*., to Mr. T. J. Gueritte, for his paper on the mechanical installation and upkeep of permanent way on railways; a society's premium, value 3*l*. 3*s*., to Mr. E. Kilburn Scott, for his paper on nitrogen products made with the aid of electric power; a society's premium, value 3*l*. 3*s*., to Mr. Frank G. Woollard, for his paper entitled "Some Notes on Drawing-office Organisation."

THE annual general meeting of the Scottish Meteorological Society was held on December 12. From the report of the council, which was adopted at the meeting, we learn that during the past twelve months several additions have been made to the society's system of stations. A fully equipped station has been established by Mr. G. Craig Sellar at Ardtornish, on the Sound of Mull, and represents effectively an interesting region from which observations were greatly needed. New stations have also been established at Aviemore by the Aviemore Station Hotel Company, and at Carrbridge by the Rev. Andrew Doak, and these will add to the scanty knowledge of the meteorology of the Central Highlands. The council points out once more that there is urgent need for additional information regarding the rainfall of the Highland area and the north of Scotland. Apart from the purely scientific value of rainfall records, the rainfall of a district touches practical and sporting interests at many points, and it seems to the council that it may reasonably look to large landowners and shooting tenants for help. It may be pointed out that the final report of the recent committee of inquiry on grouse disease has something to say on the importance of meteorological conditions in relation to the distribution and the health of grouse. It appears that where rainfall is very heavy there is little disease, but grouse are few, the scarcity of the birds being due probably to the deleterious effect on heather of a high rainfall. The council elected for the ensuing twelve months is as follows:—*President*, Prof. A. Crum Brown, F.R.S.; *vice-presidents*, Ralph Richardson, W.S., Dr. C. G. Knott; *council*, Sir David Paulin, Gilbert Thomson, H. M. Cadell, Sir A. Buchan-Hepburn, Bart., G. G. Chisholm, M. M'Callum Fairgrieve, J. Mackay Bernard, Dr. J. R. Milne, T. S. Muir; *hon. secretaries*, R. T. Omond, E. M. Wedderburn, W.S.; *hon. treasurer*, W. B. Wilson, W.S.

IN a report presented to the French Institute of Anthropology, published in *Comptes rendus* for March-June, M. Boule discusses the morphology of the mammoth as displayed in recent discoveries of Palæolithic art. He points out that certain physical peculiarities of the animal, which were only recently established by the discovery of a specimen by M. Wollosowitch at Sanga-Iurach in 1908, already appear in stone carvings dating from the Palæolithic age.

IN vol. xxii., Nos. 4–5, of *L'Anthropologie*, Dr. Lalanne and L'Abbé H. Breuil describe a series of remarkable Palæolithic sculptures on a cliff at Cap-Blanc, Laussel, Dordogne. Among the animals represented are a bison and a pair of horses, depicted in the usual vigorous style of the art of that period. This discovery supplies a welcome addition to the cave sculptures of a similar class already familiar to archæologists. It is now proved that these early artists, in addition to work carried out by torchlight in dark, damp caves, executed similar sculptures in the open air.

THE work of the modern school of French anthropology is largely devoted to the preparation of elaborate memoirs in which the results of the investigation of specially interesting races are summed up and criticised, with a complete apparatus of facts and statistics. Such is the admirable account contributed to vol. xxii., Nos. 4–5, of *L'Anthropologie* by Dr. Poutrin, entitled "Les Négrilles du Centre Africain (type sous-dolichocéphale)," in which he has collected all the information at present available on the Pygmy races. The introduction, illustrated by a map, shows the distribution of these people, and is followed by a historical account of exploration and an elaborate survey of the physical characteristics. Probably no account of this remarkable race, already available to students, contains a more complete survey of the ethnological problems connected with the Pygmies of Africa.

ACCORDING to the fourth annual report (1910–11) of the National Museum of Wales, the designs for the new building have been considerably modified, with, it is believed, a great improvement in the general appearance of the structure. Illustrations are given of the exterior and of the entrance hall, together with plans of the ground-floor and the two floors above. A contract has been signed for the construction of the basement and sub-basement for that portion of the building proposed to be erected in the first instance, which includes the south block and the lecture theatre and gallery above, and work on this was commenced in September last. Considerable progress has been made in collecting specimens for exhibition and study.

WE have received a copy of a petition from the natives of India presented to H.M. the King at the Delhi Durbar (together with a covering appeal signed by K. S. Jassawalla, of 45 Courthope Road, Hampstead), praying that the supply of beef required for the British Army in India may in future be obtained from Australia in place of India itself. The petition is accompanied by a large illustration showing the various uses to which Indian cattle are put. So great is the demand in the country for cattle for purposes of draught and agriculture that, according to the petition, cows are chiefly slaughtered for beef. This practice is one of the causes which have led to a great diminu-

tion in the number of cattle in the country, with a corresponding rise in the price of milk and ghi (native butter). It is further urged that the quality of Indian beef is far inferior to that of Australian beef, and likewise that the use of the latter in the Army commissariat would not entail any very great additional cost.

MR. A. H. THAYER'S suggestive observations upon protective coloration in nature have been described in these columns on more than one occasion, and his son's beautifully illustrated work upon it was reviewed in detail a little more than a year ago (October 27, 1910). A number of illustrations from that work are reproduced in colour in the December number of *Pearson's Magazine*, and the principle they exemplify is described in an instructive article by Mr. Marcus Woodward. Mr. Thayer's view is that it is the rule for animals to be coloured like the background which most concerns their feeding and escape from attack. There are limitations to the application of this interpretation of obliterative colouring throughout the animal kingdom; but there is no question as to the great importance of the principle of countershading in nature, and the article and pictures in *Pearson's Magazine* should be the means of interesting many people in it.

THE latest issue of *The Kew Bulletin* (No. 9) is mainly occupied by systematic articles. The most interesting is a description of six new species of Impatiens from Travancore and Cochin, contributed by the late Sir Joseph Hooker. The list of additions to the wild fauna and flora of the gardens is due in great measure to the collection of specimens by members of the garden staff. Noteworthy is the announcement of a heath from Cornwall which appears to be a natural hybrid between *Erica tetralix* and *E. vagans*.

THE annual Kew list of seeds of hardy herbaceous plants and of trees and shrubs available for exchange with botanic gardens and regular correspondents has been published as Appendix I. to *The Kew Bulletin* (1912). The list reflects in some measure the outcome of the remarkably fine summer, notably in the ripening of the seeds of trees and shrubs; thus there are offered for exchange the seeds of *Clerodendron dichotomum*, which has fruited at Kew for the first time on record, *Koelreuteria paniculata*, *Buddleia globosa*, and two species of Halesia.

BOTANICAL exploration in India is summarised by Major Gage, as director of the botanical survey, in his report for the year 1910–11. An expedition to the south-east corner of Sikkim was undertaken by Mr. W. W. Smith. Captain R. W. Macgregor presented an interesting collection of specimens from the Southern Shan States, and a smaller collection was forwarded by Mr. Burns from Bombay. In the south, the most important contribution was made by Mr. A. Meebold, as the result of an extensive tour through the States of Cochin and Travancore. A second fasciculus of the catalogue of non-herbaceous phanerogams cultivated in the Calcutta Botanical Gardens has been published as vol. v., No. 2, of the Records of the Botanical Survey of India.

ON Monday, December 18, Dr. D. T. Macdougal, director of the department of botanical research of the Carnegie Institution of Washington, lectured before the Royal Geographical Society on the North American deserts. After describing the general characters of desert areas, and explaining the importance of the various factors involved, he passed on to give a short account of the study of such regions which is being carried on by the Carnegie Institution. A large series of lantern-slides, many of them in colour, showed very instructively the character of the desert regions of Arizona and California, and of the types of vegetation which are able to flourish there both under normal conditions and also by the aid of artificial constructions, such as the concrete walls which are sunk in the detritus-filling valley floors in order to hold up to a higher level the water, which otherwise flows at a depth which is out of the reach of surface vegetation. The formation of the Salton Lake was also described, and its effect on the vegetation of the basin was illustrated. Dr. Macdougal is leaving shortly to visit the deserts of Egypt and the northern Sudan.

IN the Monthly Meteorological Chart of the Indian Ocean for December, issued by authority of the Meteorological Committee, a considerable space (as in previous months) is devoted to a useful discussion of ice reports, relating to the southern hemisphere, which subject has for many years occupied the serious attention of the office. In the Southern Ocean icebergs are most frequently met with to the north-east of Cape Horn, south-east of the Cape of Good Hope, midway between Kerguelen and the meridian of Cape Leeuwin, and midway between New Zealand and Cape Horn. Tables of the monthly and annual frequency of the bergs from 1885 to 1910 show that the periods of maxima and minima vary irregularly; the years of greatest frequency were 1893 and 1906. In the chart for the North Atlantic the ice conditions are also discussed. A sub-chart of the exceptional drifts and heights of bergs shows that the latter were most frequent in the ten-degree square of lat. 40°–50° N. and long. 40°–50° W., but some few were observed nearly so far south as lat. 30° N. The first ice seen in 1911 was on January 28, near lat. 47° N. and long. 52° W.

IN an interesting paper recently published in the *Bollettino* of the Italian Seismological Society (vol. xv., 1911, pp. 144–53), Prof. G. Grablovitz has traced the variations in the mean level of the sea at Ischia during more than twenty years. From 1890 to 1894 the mean level furnished by the mareograph records remained not far from constant, but from 1895 onwards there has been a marked change, after the effects of barometric variation have been allowed for. The change is not always in one direction; but during the sixteen years from 1895 to 1910 there has been, on the whole, a rise in the sea-level, the average annual amount being 3 or 4 millimetres a year. The mareograph records at Genoa also indicate a gradual, though much less pronounced, rise in the apparent level of the sea.

IN his well-known investigations on the after-shocks of earthquakes Prof. Omori finds that the law of decline in frequency is of the form $y=k/(x+h)$, where y is the daily number of after-shocks at time x after the parent earthquake, and h and k are constants which vary with every earthquake. Mr. A. Cavasino has recently examined the validity of this formula in regard to the after-shocks of the Riviera earthquake of 1887, one of the first earthquakes in which the after-shocks were studied in detail (*Boll. della Soc. Sismol. Ital.*, vol. xv., 1911, pp. 129–43). Determining the values of the constants from the recorded numbers of sensible shocks during the first five days, he shows that the agreement between the numbers furnished by the formula and of those actually observed is at first fairly close, but that, after the lapse of a few years, the formula fails to give correct results. The discrepancy may be due partly, as he suggests, to the difficulty of determining the average seismicity of the district. It may also be due to the small number of records used in determining the constants of the equation.

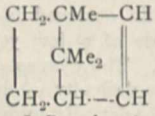
In the *Atti dei Lincei*, xx. (2), 6, Prof. A. Garhasso describes a repetition, with modern apparatus, of the classical experiment of Volta and Bennet, according to which the flame of a candle discharges the conductor of an electroscope. In this case a Ramsden's electric machine and an Exner electroscope were used at a distance of 15 metres apart, and it was observed that on working the machine the electroscope readings increased; on stopping it they decreased, then rose to a maximum, and then again fell.

Sir George Greenhill, writing in *The American Journal for Mathematics*, xxxiii., 4, develops the result obtained by G. W. Hill, according to which the potential of a homogeneous spherical segment (*e.g.* a flat lens) at any point can be made to depend on elliptic integrals. This result depends on the method of dissection employed; in this case the segment must be supposed cut into slices perpendicular to the line joining the centre to the point at which the potential is required.

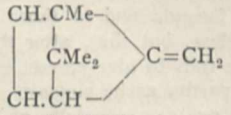
According to a paper by Messrs. Kinoshita and Ichinohe in vol. iii. of the Memoirs of the Science and Engineering College of the University of Kyoto, the ionisation current from a metal filament when heated above 2400° absolute ceases to be represented by Prof. Richardson's equation $C=A\sqrt{\theta}.e^{-b/\theta}$, where C is the value of the saturation current, θ the absolute temperature, and A and b constants depending on the nature of the metal. They put this down to the fact that the equation is deduced on the assumption that the whole of the saturation current is carried by the ions emitted by the heated filament. At the high temperatures they attained they consider the kinetic energy of the moving electrons sufficient to enable them to ionise the gas molecules with which they come into contact. The magnitude of the current thus produced appears to be roughly half that of the total current observed.

The *Verhandlungen der Deutschen Physikalischen Gesellschaft* for November 15 contains a short report laid before the meeting of the Naturforscher und Aerzte at Karlsruhe by Drs. Scheel and Heuse, on the measurements of the specific heat of air at ordinary and at very low temperatures recently made at the Reichsanstalt. The method used was that of "continuous flow," the air passing through a vacuum-protected tube in which it was heated by a wire carrying an electric current, its temperature on entering and in leaving being measured by platinum thermometers. The results for the specific heat are as follows:—at 20° C., 0·241; at −78° C., 0·243; at −183° C., 0·252. There is, therefore, a distinct increase of the specific heat as the temperature decreases. The result at 20° C. agrees to within 1 part in 1000 with that obtained by the same method by Dr. Swann, and published in the Proceedings of the Royal Society of London in 1909. The complete account of the work of Drs. Scheel and Heuse is to appear in the *Annalen der Physik*.

The November issue of the Chemical Society's Journal contains a paper by Prof. G. G. Henderson and Mr. I. M. Heilbron on the constitution of camphene. It is now generally recognised that the formula I.,



I. Bornylene.



II. Camphene.

originally proposed by Bredt, is in reality that of the closely related bornylene, as is shown by its preparation from borneol through the xanthate, and by the ease with which it is converted into camphoric acid by oxidation. A great many of the reactions of camphene indicate the presence of the methylene group $>C=CH_2$ in this compound, and on the basis of much experimental evidence the authors consider the formula II., originally proposed by Seminler, to be the best expression of the known facts.

An interesting case of isomerism is discussed by Messrs. Laws and Sidgwick in the November number of the Chemical Society's Journal. The phenylhydrazone of acetaldehyde possesses the remarkable property that the α-form, melting at 98°, and the β-form, melting at 56°, can be converted almost quantitatively one into the other by the action of a mere trace of acid or alkali; thus crystallisation from aqueous alcohol containing a trace of potassium hydroxide gave the high-melting α-form, whilst recrystallisation from aqueous alcohol containing a trace of sulphur dioxide gave the low-melting β-form. This peculiarity of the isomerism is obviously connected with a very small difference in the energy-content (and therefore in the stability) of the two forms. This factor is usually overbalanced by a marked difference in the solubility of the two forms, a difference which sometimes favours either the one or the other form according to the solvent from which the material is crystallised. But in the case under consideration the difference of solubility almost disappears on account of the fact that the two forms are isomorphous. Their interconversion can therefore take place with peculiar facility, and in the case of the solids may be brought about by gaseous acids and alkalis without producing any alteration in the appearance of the crystals.

Engineering for December 15 contains an account of some valuable experiments on the strength of thick hollow cylinders under internal pressure, carried out by Messrs. Gilbert Cook and Andrew Robertson at the University of Manchester. The object of the experiments was to test the various theories for the manner of failure, and cylinders both of cast iron and of mild steel were tested. In the case of cast iron, elastic limit and rupture are practically coincident; the results of the experiments show that the failure is determined solely by the maximum principal stress, and Lamé's formula,

$$p=f\frac{k^2-1}{k^2+1},$$

may be used directly. In this formula f is the stress at failure in simple tension, and k is the initial ratio of the diameters. In the mild-steel cylinders tested, initial yield took place when the pressure was about 20 per cent. in excess of that required by the shear-stress theory (Guest's law); the pressure may be calculated very nearly by the equation

$$p=0{\cdot}6f\frac{k^2-1}{k^2}.$$

Tests were also made on the ultimate strength of mild-steel cylinders. The results may be denoted empirically by the same formula that applies to cast iron.

We have received from Messrs. James Woolley, Sons and Co., Ltd., of Victoria Bridge, Manchester, a copy of their "Scientists' Reference Book and Diary for 1912." In addition to a conveniently arranged diary, in which each week of the year is given a page, a reference book containing useful information as to important facts and constants continually required by workers in science is provided. The tables and other data have been carefully revised, and will prove of great service. The price of the publication is 1*s.* 6*d.*

THE report of the Clifton College Scientific Society for the year 1910–11 has been received. This year, for the first time, the report is illustrated. The numerous sections of the society were very active during the period under review, but the attendance at general meetings does not appear to have been so good as in previous sessions. The report shows that many of the masters join with the boys in their practical study, in leisure hours, of various branches of science. Great prominence is given to outdoor work of a kind likely to engender a love for scientific observation and research among the boys.

THE issue of "Hazell's Annual" for 1912 maintains the high character for usefulness which previous editions of this work of reference have gained. The contents have been revised to November 25 last, and the editor, Mr. Hammond Hall, claims that the compilation gives "the most recent and authoritative information on the topics of the day." One section of the volume, running to forty-two pages, is entitled "The March of Science," and deals, among other subjects, with scientific progress in 1911, imperial research, and aërial navigation. This is the twenty-seventh year of issue of the annual. The price of the volume is 3*s*. 6*d*. net.

COPIES of the 1912 issues of the well-known works of reference published annually by Messrs. A. and C. Black have been received. "Who's Who" is larger than ever; the 1911 edition ran to 2246 pages, but the new volume contains 2364 pages. There is a remarkable variation in the lengths of the autobiographies contained in this indispensable volume; some consist of two or three lines only, while others take up nearly a page. It is satisfactory to find, in view of the important part which science takes in modern States, that due prominence is given to men of science in this record of living notabilities. "Who's Who Year-book" contains, as usual, the well-arranged tables which were formerly a popular feature in "Who's Who" itself. "The Englishwoman's Year-book and Directory" should be in the hands of every woman who is engaged in public work; it is crammed with useful information of a trustworthy kind. "The Writers' and Artists' Year-book" is, its editor says, chiefly for the use of those persons who wish to make money by their pen or brush.

OUR ASTRONOMICAL COLUMN.

MARS.—In a telegram, dated November 29, from Sétif, to the *Astronomische Nachrichten*, M. Jarry-Desloges states that Mare Sirenum is persistently seen cut into three parts, and that Elison is easily perceptible. Later, on December 4, he reports that Juventæ Fons is now an easy object, L. Phœnicis is triple, Bathys is apparently effaced, the Aonius Sinus encroaches on Thaumasia, and the south polar spot, in 95°, is 0·7″ in diameter.

The December number of *L'Astronomie* contains several drawings of the planet by M. Quénisset and others, with descriptions of the different features observed during October and November. The outstanding feature on October 17 was Tartarus, which, leaving the M. Sirenum at its eastern point, traversed nearly the complete disc and joined up with Trivium Charontis.

On photographs taken on one plate by Prof. Lowell on October 11, M. Flammarion has recognised fifteen different Martian features in the L. Solis region, including several canals.

BORRELLY'S COMET, 1911*e*.—Dr. Ristenpart communicates the position of comet 1911*e*, as observed at Santiago on November 26, to No. 4541 of the *Astronomische Nachrichten*, and adds that the comet was round, was less than 1′ in diameter, had a nucleus and a tail, the latter less than 30′ long, and that its magnitude was 9·0; the corrections to the ephemeris at 10h. 57·6m. (Santiago M.T.) on November 26 were +0·3′ and +0·2′.

SPIRAL STRUCTURE IN NEBULÆ.—In an interesting article published in No. 3, vol. xxxiv., of the *Astrophysical Journal*, Mr. William Sutherland discusses the relation between the distribution of the planets and the probability of their origin in a spiral nebula. He shows that the equation expressing Bode's law may be developed to show that the planetary distances are derived from two equiangular spirals, thus leading to the idea that the solar system in its evolution passed through the spiral form so common among nebulæ, the spiral being of a simple logarithmic form. He pictures the elementary nebula as made up of meteorites rotating about a centre, the meteorites being uniformly distributed. Collisions occur, reducing the rotational velocity of the colliding bodies, and the latter fall towards the centre; but they will fall spirally, owing to the common rotation of the mass, and thus spirals of condensation would be formed. Mr. Sutherland shows how these might finally agglomerate into two-armed spirals, in which local condensations might account for the considerable variation of mass among the planets; according to this scheme, the moon and other satellites were formed from subsidiary branches to the spiral arms. Comparisons between the calculated spirality of several nebulæ and that calculated for the solar nebula from the law of distribution of the planets shows the values to be of the same order, and thus lends support to Mr. Sutherland's theory.

PERMANENT DESIGNATIONS FOR RECENTLY DISCOVERED VARIABLE STARS.—In No. 4540 of the *Astronomische Nachrichten* the commission for the A.G. catalogue for variable stars publishes the permanent names allotted to variable stars discovered recently. From the notes it is seen that most of the discoveries were photographic, and that many of them were made at Harvard. A glance at the tabulated maxima and minima suggests that the field of discovery for variable-star observers is not yet closed, for we find ranges of three or four magnitudes, *e.g.* 9·5 to 12·8, among the fainter objects.

LUMINOSITIES AND RADII OF VARIOUS STARS.—Answering a question as to the relative sizes of the stars, Mr. J. B. Cannon, of the Dominion Observatory, gives some interesting figures in No. 5, vol. v., of the Journal of the Royal Astronomical Society of Canada; he also outlines the method whereby the figures were derived.

As the surface intensities of the various spectral types, taking that of the sun as unity, he adopts 12 for types A and B, 3 for type F, 1 for type G, and 0·5 for types K and M, and derives the luminosities and radii of eighteen well-known stars. Rigel, with a radius 41·5, has a luminosity 20,614 times that of the sun. Only two stars, α Aquilæ and β Leonis, are calculated to be the same size as the sun, and are just over twelve times as luminous. The radius of the Pole Star is 5·9, and its luminosity 102, while Regulus, with six times the radius of the sun, is 423 times as luminous.

THE PHYSICAL SOCIETY'S EXHIBITION.

THE seventh annual exhibition of physical apparatus under the auspices of the Physical Society of London was held on Tuesday afternoon and evening, December 19, at the Imperial College of Science and Technology. The very large attendances at both sessions was evidence that the exhibition continues to serve a very useful purpose in bringing a knowledge of new apparatus to teachers and others interested in scientific work.

A discourse was given by the Hon. R. J. Strutt, F.R.S., at each session on electric discharge and the luminosity that survives it, in which the lecturer displayed some interesting and very pretty experiments on the afterglow which succeeds the passage of an electric discharge through nitrogen. A current of pure nitrogen was maintained through the discharge tube and passed into a large globe, in which it still maintained a yellow glow. The interaction of nitrogen in this state with nitric oxide and stannic chloride vapours was shown by the change in the colour of the glow to green and blue respectively when the vapours

were mingled with the nitrogen in the globe. Further experiments on the effect of pressure were made, and the causes of the phenomena briefly discussed.

Thirty-three firms exhibited their latest forms of physical apparatus. Only a few of the various new forms of instruments can be mentioned. A new galvanometer of the moving-magnet type was shown by the Cambridge Scientific Instrument Co., who claim for it a sensitiveness forty times that of their Broca type. The magnet system consists of two groups of very small magnets arranged on a fine glass stem, which is suspended from a quartz fibre. The coils are arranged in pairs similar to a Thomson galvanometer, and are designed to secure the maximum effect for a given resistance of copper by winding with different sizes of wire, beginning with the smallest size, and winding each layer so that it lies within the surface of which the polar equation is $r^2 = d^2 \sin\theta$, where r is the length of radius, making an angle θ with the axis of the coil. The company displayed several other exhibits of their instruments for advanced work, including a Duddell oscillograph outfit for a 50,000-volt circuit. A new design of extensometer was shown by W. G. Pye and Co., for use in conjunction with a testing machine on bars and thick specimens. It was composed of the Ewing extensometer with the microscope replaced by an optical lever, and was designed to measure extensions of 1/100,000 of an inch. Several new designs of students' apparatus and a Kohlrausch bridge of new form were included among their other exhibits. A new vibragraph was shown by Siemens Brothers and Co., Ltd., consisting of a mercury reservoir with a floating mirror, by means of which a beam of light from a small glow-lamp is reflected on to a ground glass screen or photographic plate. The mercury ripples set up by the vibration of the body on which the reservoir is placed give an angular movement to the mirror, which thus produces on the plate or screen a clearly defined diagram of the vibration. The same company also showed a demonstration wireless-telegraphy set on the singing-spark system, and a number of frequency indicators.

New projection apparatus and a new level for very accurate surveying was shown by Carl Zeiss, Ltd. Photomicrographic apparatus, and an ultra-condenser for rendering an ordinary microscope suitable for ultra-microscopic observations were among the exhibits of Messrs. E. Leitz. Their latest pattern of high-vacuum oil pump was shown by A. C. Cossor, Ltd. The piston of the high-vacuum cylinder is actuated from outside by an electro-magnet, which is caused to move up and down, thus avoiding the use of a piston rod and possible leak at the stuffing boxes. The Foster Instrument Co. exhibited a simple strain-meter for observation of strains in any part of a structure, such as a girder of a bridge or frame of a ship.

Various types of switchboard instruments were shown by Nalder Bros., R. W. Paul, and the Weston Instrument Co. Among the exhibits of the last-named was a new line of alternating-current dynamometers, including wattmeters, frequency meters, and synchroscopes. R. W. Paul also exhibited a new and inexpensive form of potentiometer, various inductionless resistances, and a number of thermocouple pyrometers and temperature indicators. Messrs. Gambrell Bros. exhibited a new potentiometer for thermoelectric work, and instruments of various kinds for students' use. The Silica Syndicate displayed some wonderful examples of their wares. Electric furnaces were shown by J. J. Griffin and Sons, Ltd., together with quartz glass mercury thermometers for temperatures up to 750° C.

Demonstrations of Dr. Leonard Hill's colour vision apparatus were made at the stand of Messrs. Newton and Co. The degree of sensitivity of the eye for colours is ascertained by means of two identical spectra projected by an optical lantern from one and the same prism, and provided with separate adjustable screens for matching. Electrical apparatus for medical purposes was shown by the Sanitas Electrical Co., and X-ray apparatus by H. W. Cox and Co. E. Raymond-Barker's two-tone transmitter, exhibited by the India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd., and F. Harrison Glew's radio-active preparations, are two of many other interesting exhibits, of which our space does not permit us to give more detailed account.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.[1]

FOR the first time in its history the Astronomical and Astrophysical Society of America this year held its annual meeting outside the United States, and it speaks well for the progress of the comparatively young Dominion Observatory that the *locale* was Ottawa. This feeling was made the subject of a special resolution, in which a very favourable opinion as to the character of the work done in every department was united with a recommendation that a more powerful telescope may soon be provided for use in the important radial-velocity work now being executed at this observatory.

Prof. E. C. Pickering was elected president, Profs. Frost and Campbell vice-presidents, and Mr. Plaskett, of the Dominion Observatory, was elected a councillor. A great number of papers were read during the five sessions held on August 23, 24, and 25, and the general feeling was that in every respect this twelfth annual meeting was eminently successful. We briefly note a few of the papers here.

Prof. Pickering read a paper in connection with the symposium on photographic astrometry, showing how the first point of Aries might be determined photographically.

Miss Cannon announced that the spectra of 762 double stars of magnitude 7·5 and brighter had been especially examined on the Harvard photographs, and also explained that an examination of some 131 stellar spectrograms taken with slit spectrographs was being made, in order to see whether the same system of classification can be applied to such spectra as was applied to the store of objective-prism spectra at Harvard. It is difficult to see why the classification should differ, although more details may be seen and so give finer divisions; but we hope that this work will not lead to further complications in the already complicated nomenclature of the Harvard system.

Mr. Parkhurst examined a number of stars given in a list by Prof. Pickering purporting to comprise "Fourth Type Stars not Red" (class R), and extended to include some ordinary red stars (class N). By his photo-visual magnitude method he finds that with one exception the stars are all redder than Aldebaran, and therefore no sharp line should be drawn between classes R and N.

Mr. Harper, of the Dominion Observatory, read a paper on the orbits of the spectroscopic components of *d* Bootis, and Mr. Joel Stebbins explained how the selenium photometer had revealed a range of 0·2 mag. in the brightness of Betelgeuse during 1910–11, and had shown δ Orionis (range 0·10 mag.) and β Aurigæ (range <0·10 mag.) to be eclipsing variables. Polaris too, as shown by Mr. E. S. King's examination of Harvard plates, has a variability of 0·108 mag.

Some results of a study of visual binary stars by Dr. H. N. Russell suggest that the whiter stars are very much brighter, for equal masses, than the redder stars, and that the stars of a given type are of equal mass and of equal luminosity. Examining some 349 stars of various spectral types, he finds that about half of them are very much brighter in proportion to their mass than the others. This half includes all the stars of the B type, among those examined, and some of every other type, and these stars may probably be classed as the "giant" stars of Hertzsprung's division, a class in which the systems are more or less uniformly of about ten times the sun's mass; no such uniformity is found in the average masses of the "dwarf" stars, which appear, in the average, to become less massive as they become redder. A pair of "giant" stars would emit some 150 to 250 times the light emitted by the sun—the higher value being for class B stars—whereas a pair of "dwarfs" if of the A class might give 30 times, and if of the K_5, or M, class, one-hundredth, the light emitted by the sun.

The 6-inch transit circle of the U.S. Naval Observatory has attacked its programme of fundamental stars, both the old ones and those for the International Chart, and its behaviour was described by Prof. Littell.

Dr. Humphrey's papers showed (1) that the various zones of the earth are not equally efficient radiators; both the

[1] Condensed from the secretary's report in *Science*, N.S., vol. xxxiv., No. 877, pp. 520–536.

equatorial and the polar zones are inefficient as compared with the middle latitude: this result is produced by the unequal distribution of cirrus clouds, which are the effective factors in determining the outgoing radiation; (2) where d is the depth of the water layer in millimetres, and e the partial pressure of the water vapour in millimetres of mercury, the thickness that would accrue if all the water vapour above any given level in the atmosphere, on cloudless days, were condensed, is expressed approximately by $d=2e$; this is some 13 per cent. less than the value, Hann's, heretofore commonly employed in bolometric work.

The reality of astronomical teaching in America was well illustrated by a thoughtful paper by Prof. Sarah F. Whiting, in which she urged the importance of daytime laboratory work in astronomy.

Prof. Very explained an attempt to form a standardised scale of intensities for the lines in the solar spectrum, and Miss Leavitt contributed a paper on the variable stars in the Small Magellanic Cloud; the stars are too faint for our present spectroscopic equipments, but the spectroscopic investigation of brighter stars having similar light-curves—*e.g.* UY Cygni—might prove very profitable. Prof. S. A. Mitchell described the radial velocities of 96 Herculis, which has four components, all measurable on some plates; the velocities range from −98 to +74 km. per sec. and the period is 50·2 days.

Prof. Tucker's description of the San Luis Observatory of the Carnegie Institution produces a feeling somewhat akin to envy for the facilities afforded by such an institution. The expedition left New York in August, 1908, and six months later the observatory and a dwelling for the ten observers were completed. Observations with the Pistor and Martins meridian circle of the Dudley Observatory were commenced in April, 1909, and 87,000 observations were completed when the work was brought to a close in January this year; the reductions will be completed at the Dudley Observatory.

The preliminary work done at the Dominion Observatory, sharing in the international cooperative scheme, on the rotation of the sun was explained by Mr. Plaskett. The mean of twenty-three plates taken during June and July this year gives an equatorial velocity of 2·034±0·004 km., the probable error of a single plate being ±0·017 km.; all the elements represented between λ 5500 and λ 5700 appear to share in a common velocity.

Halley's comet was the subject of papers by Prof. Barnard and Prof. Frost, respectively, the former giving the preliminary results determined from Mr. Ellerman's photographs taken at Hawaii, the second finding +55 km. per sec. as the radial velocity of the comet on May 24, 1910; this value was obtained from measurements of the displacements of the Fraunhofer lines, and agrees, within 1 km., with the value given by the ephemeris.

Dr. Slocum described the spectroscopic effects produced by the large solar prominence of October 10, 1910. The prominence rose to a height of 105,000 km., and the local relative displacement of the absorption and emission lines represented a radial velocity of 15 km. per sec. Dr. O. J. Lee finds that, for reversal, the lines λ 4427 and H (λ 3968) require vapour densities one-seventh and 1·5 times as great, respectively, as that necessary for the reversal of K, when the vapour is observed at 2500° C. and at atmospheric pressure.

Prof. S. I. Bailey discussed the magnitudes of the stars in the cluster Messier 3, the discussion being based on a photograph, taken by Ritchey with the 60-inch reflector, showing some 30,000 stars down to magnitude 21·5: the total light of 2542 stars the magnitudes of which were determined is approximately equal to that of a star of magnitude 10·4. Dr. Albrecht reported on his work in determining the effective wave-lengths of lines in various types of stellar spectra, and also reported the results secured in a determination of the definite wave-lengths of the silicon lines at λλ 4552·7, 4567·9, and 4574·9 in stellar and in laboratory spectra. His stellar values are 4552·762, 4567·967, and 4574·918 respectively, and these are compared with similar values obtained by Gill and McClean, and laboratory values secured by Exner and Haschek, Frost and Brown, Lockyer, and Lunt. He emphasises the necessity for more laboratory work in order to investigate the causes producing the present lack of close agreement. In a third paper the same worker directs attention to the grave importance of investigating the change of wave-length of fundamental lines in passing from one spectral type to another. Such differences might, *inter alia*, account for certain systematic errors in the wave-length of the B type stars, and the elimination of these errors might directly affect the position of stars of this type in any discussion of the structure of the universe.

The list of papers concluded with one by Dr. Russell dealing with the photographic determination of the moon's position, a note on the five Ellicott astronomical instruments which were constructed about 1780–90 and are now on view in the U.S. National Museum, and a report from the committee on photographic astrometry. The resolutions of the latter strongly express the opinion that photographic methods can be applied successfully to absolute, as well as to differential, determinations of star positions, thereby gaining the advantage of independent observations with instruments of entirely different characters.

BIOMETRICIANS AS ANTHROPOLOGISTS.

IT is only necessary to turn to the current issue of *Biometrika*[1] to see the extent to which modern biometricians are devoting themselves to anthropology. About two years ago Dr. Crewdson Bennington died, leaving behind him a mass of observations and notes he had made in connection with the biometrical laboratory of University College. Prof. Pearson has systematised Dr. Bennington's observations and notes, and with the help of other workers in his laboratory brought Dr. Bennington's work to completion.

Dr. Bennington's aim was to obtain type-contours of the skull and of the living head of various races of mankind—contours which might serve as racial types. For instance, exact tracings were made in three planes of 100 crania of ancient Egyptian men. These contours were plotted out and combined by a method suggested by Prof. Pearson, and in this manner type contours were obtained for the ancient Egyptians of the twenty-sixth and thirtieth dynasties.

The results which interest us most are those contours prepared from the Whitechapel plague-pit skulls (seventeenth century) and those made from the heads of 118 men of the Royal Engineers of the present day. When these ancient and modern forms are compared, Prof. Pearson finds that there is no reason to believe that there is "any substantial difference between the English head of to-day and our plague-pit crania, which we have been told are not typical English." The editor of *Biometrika* has issued with this paper copies of Dr. Bennington's type-contours on transparent paper, so that they can be utilised by other workers for purposes of comparison.

Besides the important paper just noted, in parts i.–ii. of *Biometrika* there are others which will prove of value to the student of mankind. Dr. David Macdonald's inquiry seems to show that the acute infections of childhood favour the children with dark skin and eyes; they survive the effects of infection better than children with fair skin and blue eyes; the dark-skinned children are therefore being preserved or selected. Dr. Schuster's observations on the undergraduates of Oxford show that the students there have longer and narrower heads than those at Cambridge or at Aberdeen. The Oxford men are also considerably taller. Another important anthropological paper in the same number is Mr. J. I. Craig's "Anthropometry of Modern Egyptians."

ROCK CRYSTAL: ITS STRUCTURE AND USES.[2]

ROCK crystal, quartz, the common crystallised form of dioxide of silicon SiO_2, is, from many points of view, the most interesting of all minerals and the most instructive example of crystalline structure known to us. "What is a crystal?" The evidence is now overwhelmingly complete that a crystal is a homogeneous structure built up on the plan of a space-lattice, each of the unit

[1] *Biometrika*, parts i. and ii., July, 1911. Edited by Prof. Karl Pearson. Price 20*s.* net.

[2] From four Cantor Lectures delivered in May, 1911, to the Royal Society of Arts by Dr. Alfred E. H. Tutton, F.R.S.

cells of which is the habitat of a chemical molecule of the substance of which the crystal is composed, and of which it is the most highly organised solid form. It was shown by Frankenheim and Bravais that there are fourteen such space-lattices possible, all of which exhibit the full symmetry of one or other of the seven crystal systems, the cubic, trigonal, tetragonal, hexagonal, rhombic, monoclinic,

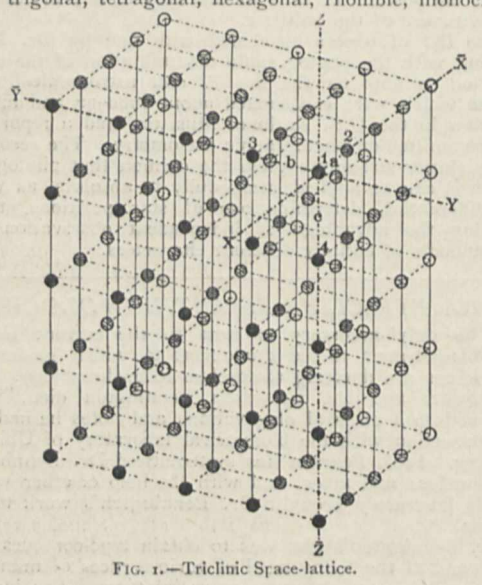


FIG. 1.—Triclinic Space-lattice.

or triclinic. As a typical example of a space-lattice, and the one of most general form, the triclinic space-lattice is shown in Fig. 1.

But the chemical molecules, the arrangement of which thus determines the crystal system, are not the ultimate units, being composed of elementary atoms, and it is the arrangement of these latter, the ultimate structural units, which determines the class of the system.

Quartz crystallises in the trigonal system of symmetry. It does not develop, however, the full holohedral trigonal symmetry, but that of the trapezohedral class of the system, no plane of symmetry being present, and the three digonal axes of symmetry occupying positions in the horizontal plane midway between those of the holohedral class.

Now in the most general case six faces are required to be present by the symmetry elements in operation, when one face is given as present, and they make up a double

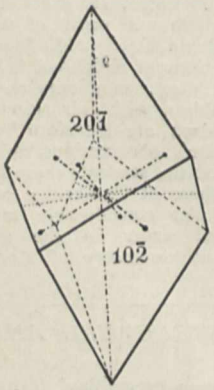


FIG. 2.—Right Trigonal Trapezohedron.

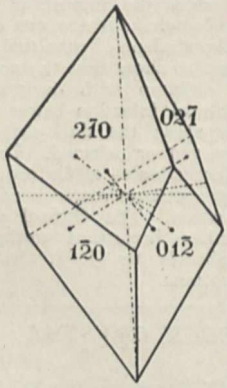


FIG. 3.—Left Trigonal Trapezohedron.

trigonal pyramid, of which the lower half is rotated somewhat with respect to the upper, screw-wise, the solid thus produced being known as a trigonal trapezohedron.

In actual fact two such trigonal trapezohedra, which are the mirror-images of each other, are possible, and the two solids are quite distinct, for no amount of rotation will bring either to resemble the other. That corresponding to Fig. 2 is called the right trigonal trapezohedron, and that represented by Fig. 3 the left variety. This fundamental fact respecting the general form of this class of trigonal symmetry affords the explanation of the two varieties, right- and left-handed, of quartz, which mineral shows characteristic development, in the well-known little *x* faces, of the two trapezohedra.

Two characteristic crystals of quartz, a right-handed and a left-handed one, are shown in Figs. 4 and 5, on which the small faces *x* are those of the right and left trigonal trapezohedra respectively. Also, the little adjoining faces *s* are those of another pair of mirror-image complementary forms of the trapezohedral class of trigonal symmetry, the right and left trigonal bipyramids. The other faces shown on Figs. 4 and 5 are those of the hexagonal prism *m*, a form common to both the hexagonal and trigonal systems, and also common to both varieties of crystals of the trigonal trapezohedral class; also those of the two complementary rhombohedra *r* and *r'*, which together make up what appears to be the hexagonal pyramid terminating each end of a fully-developed quartz crystal. Alternate faces of the pyramid belong, however, to different rhombohedra, three to *r* and three to *r'*; and they are often characteristically different, either in amount of development or in polish, the faces of the rhombohedron *r* being much more brilliant than those of *r'*. Moreover, the quartz crystals from a particular locality in Ireland show one rhombohedron only, without a trace of the other.

It will be observed, further, that the little *s* and *x* faces occur replacing right solid angles on a right-handed crystal, and left solid angles on a left-handed crystal. Also, if *x* faces be absent, a good little *s* face is often present, and

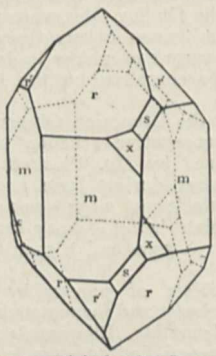


FIG. 4.—Right-handed Quartz.

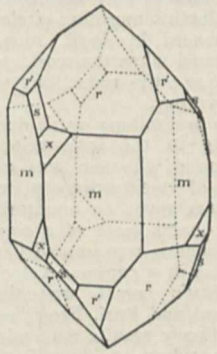


FIG. 5.—Left-handed Quartz.

it is usually marked by striæ parallel to the edge *sr*, which enable the location of the face, and its nature, to be recognised.

We are next attracted by the further problem of the internal structure, which is the prime cause of this outward development. The evidence afforded by cleavage is very emphatic, in spite of the fact that quartz cleaves only with the greatest difficulty. Indeed, this difficulty of provoking cleavage in quartz enhances wonderfully the importance and use of the mineral, both for scientific and industrial purposes, for it enables lenses, prisms, and plates of this clear, transparent mineral to be cut, ground, and polished with the greatest ease, without risk of flaw. But when a quartz crystal is heated, and then suddenly cooled by plunging it into cold water, it breaks up into rhombohedra closely resembling cubes, the angle of which is 85° 46′, that of the primary rhombohedron *r* of Figs. 4 and 5. Now it is interesting, also, that simple apparent cubes, really these rhombohedra, of quartz are occasionally discovered, quite a number having been found in the neighbourhood of Bristol.

These facts not only confirm the trigonal, as distinguished from possible hexagonal, symmetry of quartz, but also indicate that the space-lattice structure present is that of the rhombohedron, the elementary cell of which is represented in Fig. 6.

Thus we conclude that if each molecule SiO_2 were represented by a point, the points would be arranged in the form of a rhombohedral space-lattice having the angle of the rhombohedron of quartz, 85° 46′.

If we take, next, a hexagonal section of a prism of

quartz and heat it gently and evenly over a small Bunsen flame or other source of heat, and then allow it to cool, electrical excitation is developed, positive and negative electricity being produced, respectively, at alternate corners of the hexagon. Now the three digonal axes of symmetry emerge at the six corners, and the little trigonal pyramid and trapezohedron faces s and x are present at alternate corners corresponding to one end only of each axis; and it is interesting that these corners where the little distinctive faces are present are those which become negatively electrified, while those corners where no s and x faces are developed become positively electrified. This disposition of the pyroelectric poles is precisely in accordance with the symmetry of the trapezohedral class of trigonal symmetry.

If we treat a pair of quartz crystals, right- and left-handed respectively, with a small quantity of aqueous hydrofluoric acid, a chemical solvent for silica, characteristic little markings, or "etch-figures," are produced on the faces. They are little depressions, of the shape of a candle flame blown to one side by a draught of air, to the right on a right-handed crystal and to the left on a left-handed crystal, and are pointing upwards and downwards, respectively, on alternate faces. Thus we have trigonal rather than hexagonal symmetry again demonstrated, and a screw structure, clockwise in one variety and anti-clockwise in the other, such as corresponds to the trapezohedral class of the trigonal system, also most clearly indicated.

Now it has been definitely proved that specific atoms of the chemical molecule are definitely orientated in the crystal, and that if such atoms, say those of potassium or of sulphur in potassium sulphate, be replaced by others of the same family group of chemical elements, for instance, the potassium by rubidium or cæsium, and the sulphur by selenium, specific directional changes in the crystal angles are observed to occur. In the cases just referred to, the replacement of the metal brings about an alteration in the length of the vertical axis of the rhombic crystal of the sulphate or selenate, while replacement of the sulphur by selenium causes an equatorial change. If, therefore, we accept the view of Barlow, and represent the atoms by their spheres of influence, we are only logically following up this important experimental fact.

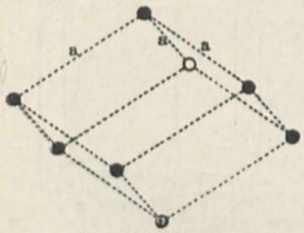


FIG. 6.—Unit Cell of Rhombohedral Space-lattice.

Barlow has recently propounded the view, in collaboration with Pope, that the relative size of the sphere of influence of an atom in any one compound, compared with that of any other atom in the same compound, is intimately connected with the chemical valency of the element, being proportional to the fundamental valency. This is rarely the maximum valency, although in the case of carbon it would appear to be so, atomic spheres of influence of carbon having apparently four times the volume of those of hydrogen or chlorine present in the same compound. The relative size of the atomic sphere of influence of oxygen appears to conform to its usual dyad character. Silicon might, perhaps, from its occurrence in the same family group of elements as carbon, be expected to behave also as a tetrad, but there is much more evidence that its fundamental valency is only dyadic. Now Barlow has shown that if we accept the view that the fundamental valencies of both silicon and oxygen are dyadic, and therefore that the spheres of influence of the two elements in quartz are of the same size, the whole of the properties of quartz can be explained on the assumption that the two structures, right-handed and left-handed, are composed of such assemblages as are shown in Figs. 7 and 8, in which the white spheres represent silicon and the black ones oxygen atoms, there being two of the latter to every one of the former, corresponding to the formula SiO_2.

The helical character is clearly shown by these assemblages of silicon and oxygen atoms, the white spheres of the former being obviously arranged in a right-handed screw in Fig. 7 and in a left-handed helix in Fig. 8, the two arrangements being the mirror-images of each other, as a right-hand glove is to a left-hand one. That some such structural arrangements of the chemical atoms as these are really present in the two varieties of quartz is, indeed, highly probable

The most important and convincing evidence of the right- and left-handed screw structure of quartz is afforded, however, by the optical properties of the mineral.

We may study, first, the effect of passing the light from the lantern, an image of a slit in front of which is focussed on the screen by a lens, through either of two 60° prisms, one cut so that the light passes through the crystal at minimum deviation parallel to the axis, as shown in Fig. 9, and another with the refracting edge parallel to the axis, as shown in Fig. 10. In the latter case we see two spectra on the screen, which are separately extinguished by a large Nicol prism placed in the path of the rays, when rotated to two positions 90° apart; while in the former case only a single spectrum is produced on the screen, and remains permanent when the Nicol is placed in position and rotated, just, in fact, as if the quartz prism were made of glass. This is the mode of cutting quartz prisms employed for use in experiments with ultra-violet light, such as the investigation of the ultra-violet spectrum, quartz being remarkably transparent to these ultra-violet rays of short wave-length, which are entirely cut off by glass.

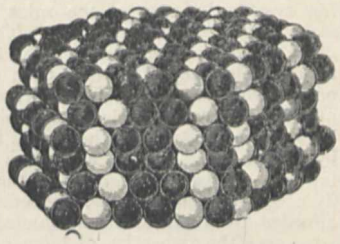


FIG. 7.—Barlow's Conception for Right-handed Quartz.

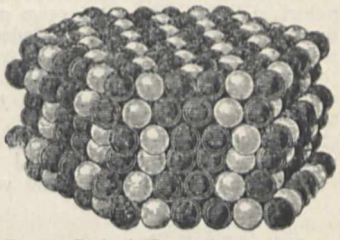


FIG. 8.—Barlow's Conception for Left-handed Quartz.

We may next investigate plates of quartz in polarised light. Placing a plate of quartz 1 millimetre thick in the polariscope arranged for convergent light, we perceive a more or less normal uniaxial figure, although the rings are large and diffuse and the dark cross present is also very diffuse. If we now take a thicker plate, conveniently one 3·75 millimetres thick, the coloured rings are more numerous, the innermost being smaller; the arms of the cross are also sharper near the margin of the field, but they have entirely disappeared from the centre of the figure, and the whole of the interior of the innermost ring is filled instead with yellow light. Moreover, if we rotate the analysing Nicol clockwise, this ring expands if the plate has been cut from a right-handed crystal of quartz, but contracts if the crystal be a left-handed one, the circular nature of the ring also altering until it is nearly square. If, now, we superpose two such plates 3·75 millimetres thick, one of right-handed quartz and the other of left-

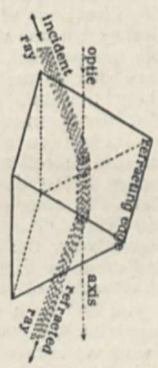


FIG. 9.—60° Prism Cut for Light to Traverse Axis.

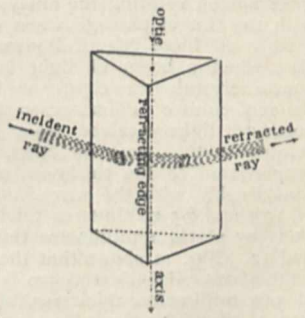


FIG. 10.—60° Prism with Refracting Edge Parallel Axis.

handed, we obtain a remarkable change in the figure, namely, the production of the celebrated spirals of Airy.

Now these phenomena suggest a spiral, and a complementarily helical, arrangement of the atoms composing the chemical molecules of silica in the two forms of quartz crystals. That the supposition is correct may be proved, as first shown by Reusch, by reproducing the effects by means of a spirally arranged pile of biaxial mica films. Twenty-four equally thin films of ordinary muscovite mica are laid over each other so that the direction of the line joining the two optic axes of the mica regularly rotates by the same angle, conveniently 60°. The biaxial figure normally given by muscovite mica will be found, on placing the pile in the polariscope, to have been converted into a uniaxial one. Moreover, the figure resembles that afforded by quartz to a remarkable degree of precision, for if the pile be a right-handed one the figure is similar to that afforded by right-handed quartz, and gives the same effects on rotating the analyser; whereas, if the pile had been arranged in a left-handed manner, the effects would resemble those afforded by a plate of left-handed quartz. Further, if we superpose the two piles of mica plates, the left-handed and the right-handed, and place them together in the polariscope, Airy's spirals are at once produced on the screen.

Let us now study quartz plates in a parallel beam of polarised light. If we take two plates, one of right-handed quartz and the other of left-handed, each of 7·5 millimetres thickness, we find that they each give with crossed Nicols the well-known rose-violet tint of passage between the first and second orders of Newton's spectra. But on rotating the analysing Nicol clockwise, the right-handed plate changes colour first to red, then to orange, yellow, green, and blue, while the left-handed plate becomes first blue, then passes through green and yellow to orange and red.

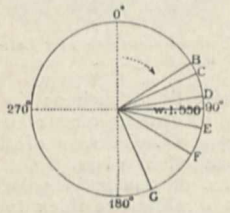


FIG. 11.—Rotations by 3·75 mm. of Quartz.

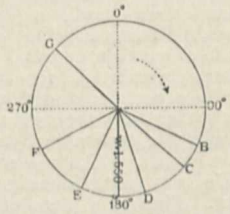


FIG. 12.—Rotations by 7·5 mm. of Quartz.

On the other hand, the two plates of 3·75 millimetres thickness appear yellow under crossed Nicols, just as were the centres of the interference figures in convergent polarised light, and they change colour in opposite directions of the spectrum on rotating the analyser, until they become violet with the tint of passage when the Nicols are parallel.

Now all these beautiful phenomena are due to the fact that when a beam of light is sent along the axis of a quartz crystal, the right- or left-handed arrangement of the molecules of silica causes the plane of vibration of the polarised light received from the polarising Nicol to be rotated in the same direction, the amount being directly proportional to the thickness of the plate. It also varies considerably with the wave-length of the light. For plates of 3·75 and 7·5 millimetres thickness, respectively, the rotations by plates 1 millimetre thick are indicated in Figs. 11 and 12. Fig. 11 shows that the plane of vibration of yellow light of wave-length 0·000550 is rotated just 90° by a plate of 3·75 millimetres thickness, and this explains the production of the violet tint of passage when we have rotated the analysing Nicol 90°, that is, until it is parallel to the polarising Nicol. For the extinction of this yellow light leaves the complementary colour, the violet transition tint, predominant. And when we double the thickness of the plate to 7·5 millimetres, the yellow ray, of 0·000550 millimetre wave-length, is rotated just 180°, as shown in Fig. 12, which, when followed (by rotation of the analyser), brings the Nicols into the crossed position again, and thus the violet transition tint is at once given by such a plate under crossed Nicols.

The colour produced by thick plates of quartz in polarised light is thus due to optical rotation, and it is quite as brilliant as that due to double refraction shown by thin plates of quartz, such as those of rock-sections, which vary from a twenty-fifth to a fiftieth of a millimetre in thickness. The phenomenon of optical activity is confined to crystals belonging to those eleven classes of symmetry which exhibit right- and left-handed forms, that is, in which there is no plane of symmetry developed.

Now besides the right- and left-handed forms, showing dextro and lævo rotation, chemists have discovered many cases in which the optical activity is either neutralised or destroyed by intimate lamellar twinning of the two complementary varieties, or by chemical combination of the two sets of molecules in which the atoms are oppositely spirally arranged. In the former case of regularly repeated twinning the symmetry is apparently enhanced by the introduction of a plane of symmetry, the composite crystal showing the characteristic faces of both right- and left-handed forms. In the latter case chemical combination results in the production of a new substance, and the crystalline form is altogether different, and may even belong to another system. This is the case with tartaric acid, for the combination of the two sets of molecules produces racemic acid, which crystallises in the triclinic system with a molecule of water of crystallisation, totally unlike the crystals of either ordinary dextro (right-handed) tartaric acid or the complementary lævo (left-handed) tartaric acid, both of which belong to the sphenoidal class of the monoclinic system, and are anhydrous.

Now the racemic form of optical inactivity is often

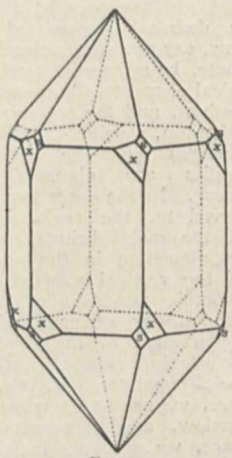


FIG. 13.

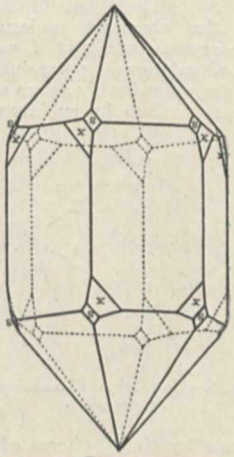


FIG. 14.

The Two Types of Quartz Twins.

simulated to a most remarkable extent by the repeated twinning already referred to; but such a "pseudo-racemic" form can generally be readily distinguished from a truly racemic form by the fact that it still exhibits the symmetry of the same system, although that of a class of higher symmetry in the system, owing to the introduction of a plane of symmetry, about which the twinned individuals are disposed in mirror-image fashion. This case of the mechanical enhancement of the symmetry by repetition twinning is beautifully illustrated by quartz, especially in the exquisite form of the mineral known as twins, one, illustrated in Fig. 13, in which the two individuals are of the same right- or left-handed variety, and another, represented in Fig. 14 by an example in which also complete interpenetration has occurred, in which a right-handed crystal is twinned with a left-handed one.

This latter kind of quartz twin is frequently found occurring among specimens from Brazil. The twin plane is a face of the hexagonal prism of the second order, perpendicular to a pair of the faces of the hexagonal prism present, which is of the first order. The little *s* and *x* faces are shown on every corner, as in the case of Fig. 13, but symmetrically.

Now if a plate of such a crystal be cut perpendicularly to the axis, the polarisation phenomena, due to the opposite optical activity of the two different varieties present, will vary according to their mode of internal disposition. When the whole of one half of the crystal is of right-handed and the other of left-handed quartz, and the surface of junction is a plane parallel to the axis, we have a natural biquartz

produced on cutting such a section-plate which shows absolutely no trace of a junction-plane in ordinary light or when the Nicols are crossed or parallel, but exhibits different colours in the two halves the moment either Nicol is rotated to even the slightest extent.

If the plane of junction be oblique, however, the biquartz shows a black band between the two halves when the Nicols are crossed, and a white one when they are parallel, as in the case of a natural biquartz projected on the screen, the obliquity of the junction plane in which is not great. When the junction-plane is of greater obliquity, not only the central black band, but a white one and a spectrum on each side of it, are exhibited, as illustrated on the screen by an example.

A very instructive case is that of a natural quartz twin-combination, which by its picture on the screen in polarised light, illustrated in Fig. 15, is seen to be composed of one half of left-handed quartz, which polarises in a rich crimson lake with crossed Nicols, and a second half which is made up of alternating right- and left-handed quartz, the strips being joined obliquely to the plate, so that a black band is produced in each case as the central line of a ribbon, being flanked by a white band and a spectrum band on each side.

Such a banded structure of alternately right- and left-handed quartz affords an instance on a larger scale of the finely laminated twinning of the two varieties present in

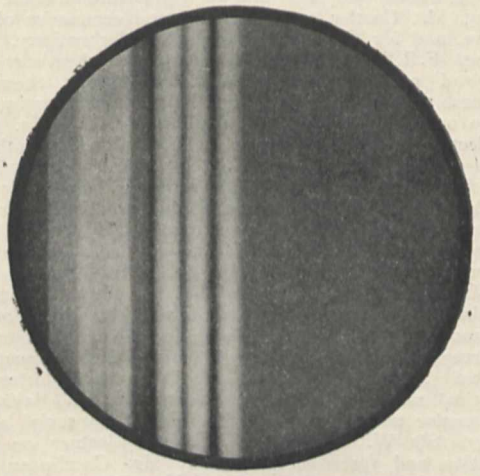


FIG. 15.—Banded Quartz Twinning.

amethyst. The case of a section-plate of amethyst is an exceedingly beautiful one. The marginal parts show polarisation colours in three sectors, indicating the presence of right- or left-handed quartz. The alternate sectors, however, show a natural violet colour, which is the distinctive feature of most amethysts: hence the name; and in the central part of the plate these sectors exhibit the beautiful laminated twinning effect, under crossed Nicols a delicate slate-coloured line marking the junction of each pair of right and left laminæ, each lamina itself appearing as a thin white band bordered by traces of spectra. On rotating the analysing Nicol the laminæ exhibit the most beautiful shades of greys and browns, with delicate linings of rose and other tints. This central part of the plate, moreover, is unique among quartz crystals in exhibiting a normal uniaxial interference figure in convergent polarised light, that is, with the black cross complete to the centre.

Thus the intimate lamellar twinning of the two varieties of quartz in amethyst results in the production of a crystal which simulates holohedral trigonal symmetry, and is apparently optically inactive, the optical activity of the lower-class pair of varieties being neutralised by their intimate blending. Amethyst, therefore, is not a case of true optical inactivity, but of mechanically and naturally produced pseudo-inactivity. It is thus an excellent illustration on a large scale of the still more intimate blending of microscopic or even submicroscopic laminæ of the two varieties in the organic substances known to chemists as pseudo-racemic compounds, a large number of which have been studied by Kipping and Pope. In many of these cases the blending of the two varieties by regular intercalation and alternation of the two varieties, one within the other, is so intimate that the laminæ approach the molecular dimensions in thinness. It is easy to see that if the approach be continued until this fascinating region of molecular forces be penetrated—for we know that within four or five molecular diameters these intermolecular forces come into play—chemical affinity will be developed with the production of a molecular compound—a racemic compound—of the two varieties, the individuality of each variety being no longer preserved, but a new compound, due to the double molecule, being produced and crystallographically developed according to its own crystalline form.

The investigation of the twinning of quartz, as seen in its most beautiful development in amethyst, has thus enabled us to elucidate some of the most interesting and complicated phenomena of optical rotation and of chemical crystallography.[1]

THE VALUE OF BIRDS TO MAN.[2]

VEGETATION is the prime requisite for the perpetuity of all other forms of life upon the earth. The greatest known enemy to vegetation is insect life, while bird life, by virtue of its predominating insect diet, wields a most important balance of power against the ravages of this the chief pest of vegetation.

The number of insect species is greater by far than that of the species of all other living creatures combined. The voracity of insect life is as astonishing as its power of reproduction. Many caterpillars consume twice their weight in leaves per day, which corresponds to a horse eating daily a ton of hay.

The development of young birds is so rapid, and the demand upon the vitality of older ones so great, that an enormous amount of food is necessary to sustain the vital processes. Digestion is exceedingly rapid in birds; and they feed for the most part throughout the day, especially when rearing young. The number of insects daily passed into the insatiable maws of the nestlings during this period almost exceeds belief. But the most valuable services of the adult bird are rendered when it is feeding in winter or early spring, for then it destroys countless numbers of insects in the embryo state, and thus prevents myriads of depredators from coming forth. Grave and far-reaching results invariably follow the suppression of this perennial regulative influence which is exerted by birds individually everywhere as a check on insect life.

Forest trees have their natural insect foes, to which they give food and shelter; and these insects in turn have their natural enemies among the birds, to which the tree also gives food and shelter. Birds are not only essential to the well-being of the tree, but the tree is necessary to the life of the bird. It is because of this most delicate adjustment between the tree, the insect, and the bird that Mr. Frank M. Chapman's statement "that it can be clearly demonstrated that if we should lose our birds we should also lose our forests," must be regarded as profoundly true. Call the bird in the orchard an evil if you will. But it is a necessary evil, and the fruit-grower must make up his mind to pay the bird its wages, even though at times they may seem exorbitant.

Each season, until hay-making commences, the grass offers cover and shelter for the nests of such birds as breed on the ground. The fields also provide food for birds, and for the insects on which birds feed. Where the birds of the field are undisturbed they tend to hold the grass insects in check. On the other hand, when the numbers of birds in the field are, for any reason, insufficient, the insects increase.

Without birds grass could not be grown. The grub of a single species of beetle, if unchecked, could destroy all the grass roots of our meadows, or any one of the several

[1] The concluding lecture, which concerned the scientific and artistic uses of quartz, does not lend itself to abbreviation, and for an account of it the Journal of the Royal Society of Arts of October 27 (vol. lix., p. 1091) should be consulted.

[2] From a paper read before the British Empire Naturalists' Association on December 1 by James Buckland.

species of cut-worms might be sufficient to destroy all the verdure above ground.

The destructive habits of the small rodents, which are the natural prey of hawks and owls, are much the same all the world round. Here in England—though on account of their small size and secretive habits they are often undiscerned by man's dull eyes—they swarm in such numbers in the fields and hedgerows that the damage they do must prove a steady drain on the resources of the farmer. The number of small rodents eaten by the rapacious birds is almost as remarkable in proportion to their size as is the number of insects eaten by small insectivorous birds.

The young of hawks and owls remain a long time in the nest, and require a great quantity of food. During this period the resources of the parents must be taxed excessively in the effort to satisfy the hunger cravings of their offspring, and it is not to be wondered at if some individuals are forced occasionally to snap up a chicken. But what is the worth of the chicken, or of the young pheasant, occasionally taken compared with the hundreds of thousands of pounds' worth of damage that is wrought in the orchards and fields by rodents that hawks and owls, had they been spared, would have fed upon for the maintenance of their species?

The destruction of the white heron for its scapular plumes has robbed half the world of a bird which is most useful to man. Its loss to India and to China is most serious. It never touches grain, but feeds solely near water and over damp ground, the breeding-places of innumerable batrachians, small crustaceans, and pestiferous insects, all of which directly or indirectly injuriously affect crops in the neighbourhood. The presence of the white heron in the rice-fields, for instance, is distinctly beneficial to the farmer, and rice is one of the most extensively grown crops of India and of China.

Turning to Australia, it may be mentioned that the slaughter of this and other wading birds for their plumage is causing in that country a decline in its fish resources. As these birds grow fewer in numbers, so do the crustaceans that destroy the fish spawn increase in hosts.

The gull is a surface feeder. It may occasionally levy toll on useful fish when they are indiscreet enough to come to the surface of the water, but to say that they do any appreciable injury to the fishery business is absurd. On the other hand, the presence of the gull is essential to man's health. While the bird fulfils many useful minor offices, such as destroying larvæ in land along the seaboard, and in eating enemies of fish that are exposed during low tide, its chief function in the economy of nature is that of scavenger of the harbours and of the littoral, just as vultures are the scavengers of the mainland.

Birds, unquestionably, are one of man's greatest possessions; yet it is just the possession on which he often sets the least value.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—At the meeting of the Senate on December 13 an anonymous gift of 30,000*l.* was announced, to be devoted to the erection at University College of the buildings for the new School of Architecture, resulting from the amalgamation of the architectural department of University College and King's College. Any balance is to be used for providing studios for the teaching of sculpture and the rearrangement of the School of Fine Art and for the Department of Applied Statistics, including the Laboratory of Eugenics. The gift was accepted by the Senate with cordial thanks. The frontage of the new building will be towards Gower Street; and it is expected that the new building, together with the new chemical laboratories, which will be to the north of the college, will much improve the architectural effect of the college buildings.

OXFORD.—The following lectures and practical courses, in addition to those already noticed in NATURE, have been announced for next term, beginning on January 22, 1912. In human anatomy, Prof. A. Thomson will lecture on joints and the muscles which move them, and will give special demonstrations. Demonstrations will also be given by Messrs. Whitnall and Foster. Mr. Dodds-Parker will lecture on the thorax, and Mr. Doyne on the human eye. In the department of comparative anatomy, Prof. Bourne, F.R.S., will lecture on the Echinodermata and on principles of zoology; Mr. E. S. Goodrich, F.R.S., on the general morphology of Vertebrata, Amphibia, Reptilia, and Aves; Mr. G. W. Smith, on elementary zoology. Practical instruction will be given by the professor, assisted by Messrs. Smith, Huxley, and Coventry. Dr. Jenkinson will lecture on the embryology of Chordata and on regeneration. Prof. Gotch, F.R.S., will continue his general course of physiology, and will give advanced lectures on the excitable phenomena of nerve. Dr. Haldane, F.R.S., and Dr. Ramsden will lecture on subjects of the Final Honour examination in physiology; and practical instruction, elementary and advanced, will be given by Dr. Scott, Dr. Vernon, Dr. Ramsden, and Dr. Douglas, together with the professor; the subjects specially dealt with being histology, muscle and nerve, and physiological chemistry.

Prof. Sollas, F.R.S., will give a general course on geology, and will lecture specially on the geology of Europe. Mr. Vaughan will lecture on palæontology and evolution. Prof. Vines, F.R.S., will give courses on botany for students of forestry and agriculture respectively, and a preliminary course for elementary students. Practical instruction at the Botanic Garden will be given by Dr. Church and Mr. Hiley. Prof. Somerville, F.R.S., will lecture on the principles of agriculture and on forest botany, Mr. Curtler on the history and economics of agriculture, and Mr. Morison on agricultural chemistry. Prof. Odling, F.R.S., will lecture on organic chemistry: uric acid and products; Dr. Watts on organic chemistry: terpenes and camphors. Mr. Marsh will continue his course on the history of chemical theory, and Mr. Fisher will lecture on the subjects of the Preliminary examination in chemistry. Dr. Baker, F.R.S., will lecture at Christ Church on the chemistry of the metals. Prof. Bowman and Mr. Barker will lecture and give practical instruction on elementary crystallography and mineralogy.

Lectures will be given and practical work conducted in geography by Prof. Herbertson, Mr. Beckit, Miss MacMunn, and Mr. Crawford. Dr. Grundy will lecture on the historical geography of Greece, and Mr. Munro on that of Canada. Mr. Mackenzie will give advanced instruction in surveying. Mr. Knowles will superintend instruction in physical anthropology, Dr. Schüster will lecture on statistical methods in anthropometry, Mr. H. Balfour on comparative technology, and Mr. Marett on social anthropology. Sir W. Schlich, F.R.S., will lecture on forest valuation and forest management, Mr. Caccia on sylviculture and forest protection, and Mr. Grosvenor on forest zoology.

DR. A. D. IMMS, professor of biology, University of Allahabad, has been appointed forest zoologist to the Government of India, Forest Research Institute, Dehra Dun, United Provinces.

PROF. HENRI BERGSON, professor of philosophy of the Collège de France, has accepted the invitation of the Senatus Academicus of the University of Edinburgh to be Gifford lecturer from October, 1913, to October, 1915.

IT is announced in *Science* that formal distribution has been made of the California property of the late Mr. D. O. Mills. Among other bequests we notice the following:—the American Museum of Natural History, 20,000*l.*; the New York Botanical Garden, 10,000*l.*; and the American Geographical Society, 5000*l.*

A NOTE in *Science* states that the registration of students in several of the larger universities is reported to be as follows:—Columbia, 7429; Chicago, 6466; Minnesota, 5965; Wisconsin, 5538; Pennsylvania, 5389; Michigan, 5381; Cornell, 5104; Illinois, 5118; Harvard, 5028; Nebraska, 4624; California, 3450; and Missouri, 3141.

THE council of Bedford College for Women (University of London) has received donations and promises to the building fund amounting to 8285*l.* This leaves only 1715*l.* to be collected to enable the college to claim the additional grant of 10,000*l.* promised by the London County Council when the fund reaches 60,000*l.*

The council urgently appeals for this balance of 1715*l.* on the further ground that if it is obtained before January 1, 1912, Sir Francis Trippel has undertaken to raise the remaining 30,000*l.*, which will complete the building and endowment scheme.

WE learn from the annual report and statement of accounts for the year 1910–11 of the Livingstone College that it has been decided to inaugurate a Livingstone Centenary Fund in connection with the centenary of the birth of Dr. Livingstone, to take place in 1913. It is proposed to devote the fund to the paying off of the mortgage on the property, the carrying out of certain important improvements in the college premises, and the raising of an endowment. Livingstone College, it will be remembered, was instituted with the object of preparing missionaries and providing them with an elementary medical training.

The fourth annual dinner of old students was held on December 13 in the new Imperial College Union in Prince Consort Road, this being the first occasion on which the new club has been used for such a purpose. Sir Alexander Pedler, president of the Old Students Association, presided, and Mr. J. A. Pease, the President of the Board of Education, was the guest of the evening. In proposing the toast of "The College," Mr. Pease referred to the large number of students who have passed through the college, many of whom are occupying positions as chemists, geologists, engineers, and Government officials, and are doing excellent work. Prof. W. W. Watts, in responding, referred to the relationship between the Royal College of Science, the Royal School of Mines, and the City and Guilds College under the new organisation, and expressed the hope that each will retain its individuality. Prof. Dalby, Dean of the City and Guilds College, proposed the toast of "The Old Students Association," to which the chairman replied. The guests included the Rt. Hon. A. H. D. Acland, Sir Alfred Keogh, Sir Arthur Church, and Prof. Cox.

IN his annual report for the year ending on June 30 last, President Butler, of Columbia University, in New York, summarises the benefactions received during the year by the University over which he presides. The gifts, legacies, and other receipts for designated purposes received during the year amounted to 507,000*l.* Of this great sum, 195,000*l.* was in partial payment of the legacy of the late Mr. J. S. Kennedy, and 138,700*l.* in partial payment of the legacy of the late Mr. G. Crocker. Toward the erection of the philosophy building 33,000*l.* was received from an anonymous donor. Other anonymous gifts of 20,000*l.* and 11,000*l.* were received. Including the gifts to Barnard College and to Teachers College, both of which are associated with the University, the sum total of benefactions for the year very nearly reached 600,000*l.* The grand total of gifts in money alone made to the several corporations included in the University during the last ten years reaches 3,310,000*l.* As indicative of the growth of the University during these ten years, it is interesting to note that while in 1901 the number of professors was 81, in 1911 it has reached 177. In 1901 there were 396 teachers of all grades, but during the present year the number has been 721.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, December 6.—Prof. W. W. Watts, F.R.S., president, in the chair.—Dr. T. F. **Sibly**: The faulted inlier of Carboniferous Limestone at Upper Vobster (Somerset). The Upper Vobster inlier lies rather less than a mile to the north of the main outcrop of the Carboniferous Limestone of the Mendips. This inlier has been dissected by quarrying operations. The northern and eastern portions are concealed by a covering of Lias, but its width from north to south is little, if at all, greater than 400 yards, while the east-and-west extent of the Carboniferous Limestone is about 1100 yards. The author has arrived at the following conclusions:—The inlier is a lenticular mass of Carboniferous Limestone, grits, and shales, superimposed upon the overfolded strata of the Coal Measures by thrust-movements. It comprises a northern limestone mass and a southern limestone mass, separated by a grit-and-shale mass. The beds of the grit-and-shale mass are in faulted relation to the Carboniferous Limestone. On the northern side, the adjacent beds of limestone represent part of the Seminula zone; on the southern side, the adjacent beds belong to the lower Dibunophyllum zone. In the northern limestone mass, Vobster Quarry exposes more than 500 feet of Seminula beds, overfolded towards the north-west. In the southern limestone mass the strata are locally overfolded northwards. The beds of the grit-and-shale mass comprise quartzites assigned to the Millstone Grit. They also include shales, with intercalated fine-grained sandstones. Possibly this mass includes the lowest beds of the Coal Measures, in addition to a portion of the Millstone Grit. In sections of Carboniferous Limestone, signs of the stresses to which the strata have been subjected are evident. The beds are often distorted, while slickensides and calcite-veins are developed. The occurrence of a lamellibranch fauna at the top of the Seminula zone is recorded.—J. **Romanes**: Geology of a part of Costa Rica. The part of Costa Rica to the west of San José as far as the Pacific coast is dealt with. San José is situated in a valley sloping westwards, and drained by the Rio Grande and its tributaries. The northern boundary of this valley is the chain of recent volcanoes which rise from its floor, while on the south the ground rises abruptly to form the Cerro Candelaria. In this range of mountains are exposures of limestone, marl, &c., together with igneous rocks. An examination of exposures has failed to produce any Cretaceous fossils, while the occurrence of numbers of Balani points to a Tertiary age for the beds. As this limestone stretches across the Atlantic-Pacific watershed, it yields evidence of an interoceanic connection in this area in Tertiary times. Of the igneous rocks, the most interesting feature is the presence of many boulders of monzonite, indicating a plutonic mass in these mountains. The surface of the valley is composed of a thick series of andesitic lavas. On the Pacific coast at Barranca and Manzanilla fossiliferous Tertiary beds are described. These are all marine ashes, and in the Manzanilla district appear to rest unconformably on an older limestone formation. The boulder-clays of Costa Rica are normal river deposits, though, locally, landslides and spheroidal weathering have played an important part.

Linnean Society, December 7.—Dr. D. H. Scott, F.R.S., president, in the chair.—H. N. **Dixon**: Some mosses of New Zealand. Several collectors had contributed to this account, and specially referred to the mosses sent by Mr. W. Gray from Mauriceville, Wairapa, North Island, which were of the highest interest. A new genus was named Tetraphidopsis, Broth. and Dixon.

Royal Astronomical Society, December 8.—Dr. F. W. Dyson, F.R.S., president, in the chair.—Miss Winifred **Gibson**: The errors of measurements on photographic plates. Measures were made with various orientations of the plate, and the results compared. It was concluded that unless a preliminary series of measurements were made, measures with four different orientations would be required, as maintained by M. Lœwy, in order to obtain trustworthy results.—F. Hope **Jones**: The synchronome astronomical regulator. The arrangement was exhibited and described. It consists of a free pendulum with detached gravity escapement, the impulse being given by a lever falling upon a wheel pivoted at the bottom of the pendulum, and reset by the "synchronome" remontoire action. The arc is maintained constant by an inertia device of Mr. Shortt.—H. H. **Turner**: The determination of differential star places by photographic methods. The selection was suggested of many consecutive regions of the same declination and hour-angle on the same plate, with considerable overlap. The present paper was restricted to the consideration of systematic errors, the main discussion of final places being reserved for a future communication.—Prof. **Fowler** showed photographs of the spectrum of comet Brooks, taken by Mr. Slipher at the Lowell Observatory, and of the spectrum of Morehouse's comet.—A fine series of photographs were also shown of comets Brooks and Beljawsky, taken at the Khedivial Observatory, Egypt, by Mr. Knox Shaw.—G. D. C. **Stokes**: A

critical comparison of the overlapping section of the Oxford and Potsdam Astrographic Catalogue. A number of plates covering the richest region of the zone were selected for examination, and forty stars distributed all over the overlapping area, but not too near the edges, were chosen. These stars were between 8·5 mag. and 10 mag., so as to be neither too bright nor too faint to give good images. Two systems for obtaining the required solutions were adopted and investigated, and the results compared, proper motions being taken into account. The author concluded that the astrographic errors must be ascribed as much to erroneous photographic places as to errors of meridian catalogues. The errors in right ascension were smaller than those in declination.

Royal Anthropological Institute, December 12.—**John Gray**: A new perigraph. In recent years anthropologists have come to the conclusion that one of the best methods of determining the racial affinities and differences of two skeletons is to compare the outlines of their skulls and other bones. It is necessary that these outlines should be exact orthographic projections, and for this reason photographs, taken by the ordinary camera, are unsuitable. Various special instruments, known as "perigraphs," have been devised, chiefly by Continental anthropologists, for drawing these outlines, among the best known of which are those of Martin, of Zurich, and Klaatsch, of Breslau. Most of these instruments suffer from certain defects. A new design has been introduced in the two forms of the perigraph, exhibited and described by Mr. Gray, in which advantage is taken of the well-known principle in mechanism that every point in a plate moving parallel to itself describes exactly similar curves. The application of this principle enables the outline to be drawn at one side instead of under or over the skull, and the delicate adjustments of tracer and pencil in the older instruments are rendered unnecessary. By an ingenious application of the stereoscopic principle, Mr. Gray is able in one form of his instrument to draw contour lines, at any height, without touching the skull.

Mathematical Society, December 14.—Dr. H. F. Baker, president, in the chair.—J. W. **Nicholson**: The pressure of radiation on a cylindrical obstacle.—H. **Hilton**: Hermitian invariants of a canonical substitution.—E. W. **Hobson**: The fundamental lemma of the calculus of variations and some related theorems.—W. **Burnside**: The outer isomorphisms of a group.—E. B. **Stouffer**: Invariants of linear differential equations.—J. C. **Fields**: A method of proving certain theorems relating to adjointness.

CAMBRIDGE.

Philosophical Society, November 27.—F. A. **Potts**: A new type of parasitism in the Polychæta. A new genus of the polychæt worms, here named Parasitosyllis, was found by Mr. Cyril Crossland at Zanzibar in 1902 as an ectoparasite on other polychæts and nemertines. Attachment is effected by the permanently protracted pharynx, lined by very thick chitinous layers which penetrate widely into the host, becoming quite inseparable from its tissues. The lumen of the pharynx is very restricted, probably only allowing the passage of fluids, absorbed by the pumping action of the proventriculus.—C. **Shearer**, H. M. **Fuchs**, L. **Doncaster**, and J. **Gray**: The experimental hybridisation of echinoids. (1) General account of the experiments (C. **Shearer**). (2) The chemical control of inheritance in echinoid hybrids (H. M. **Fuchs**). The authors described the results of experiments on the hybridisation of echinoids conducted at Plymouth. From a study of the characters of the late larva, which are much more definite than the early characters used by previous investigators, they showed that the inheritance of the parental characters in the hybrids was strictly maternal. (3) Cytological observations of hybrid echinoid eggs (L. **Doncaster** and J. **Gray**). Cross-fertilised eggs, *Echinus acutus*×*E. esculentus*, *E. esculentus*×*E. acutus*, and *E. acutus*×*E. miliaris*, were examined in the early segmentation stages to discover whether omission of chromosomes such as has been described by Baltzer occurs in these crosses. In *E. esculentus*×*E. acutus* the mitotic figures were quite normal. In the converse cross a varying number of chromosomes swell up and develop vesicles in the late prophase stages. These vesicles may be thrown off or remain attached to the chromosome; when thrown off they are frequently left on the outside of the spindle, and not included in the daughter nuclei. Some at least of the chromosomes which have produced vesicles may subsequently divide and behave normally. In *E. acutus* eggs fertilised by *E. miliaris* a similar but less regular and conspicuous formation of vesicles takes place.—Miss A. **Homer**: Note on the condensation of tryptophane with certain aldehydes. Crystalline derivatives of tryptophane have been prepared by the interaction of its aqueous solution with (*a*) formaldehyde, (*b*) glyoxylic acid, and (*c*) glyoxal. Another derivative has been isolated as the result of (*d*) the local heating of a layer of ether resting on the surface of an aqueous solution of tryptophane. There is an interesting relationship between the substances formed in the reactions (*a*), (*b*), and (*d*). Hydrolysis of the formaldehyde derivative and the action of heat on the glyoxylic derivative result, in each case, in the formation of the compound isolated in the reaction (*d*). The investigation of the properties of these substances has shown that in the Adamkiewicz, or glyoxylic, reaction the substance essential to the production of the violet colour is formaldehyde.

PARIS.

Academy of Sciences, December 4.—M. Armand Gautier in the chair.—H. **Poincaré**: The theory of the *quanta*. A study of the hypothesis deduced by Planck from his study of the law of radiation of black bodies. According to this theory, the elements to which the radiation of incandescent solid bodies would be due could only acquire or lose their energy by abrupt steps. This theory could not be expressed by differential equations; and the author has attempted to obtain the Planck law by other hypotheses with this limitation removed, but with negative results.—L. **Lecornu**: The balancing of motors. The problem of balancing motors arranged as in aëroplanes is more difficult than balancing a motor with parallel cylinders. It is shown that the desired result can be theoretically obtained by the addition of two or three auxiliary masses, fixed to suitable points.—A. **Laveran**: Concerning *Trypanosoma rhodesiense*. A study of the trypanosome discovered in Rhodesia by Stephens and Fantham. From the facts described, particularly the observations which demonstrate that an animal having acquired immunity for *T. gambiense* is infected like a new animal by *T. rhodesiense*, that the last trypanosome cannot be identified with *T. gambiense*. Experiments are in progress having for their object a similar comparison of *T. rhodesiense* with *T. brucei*.—A. **Müntz** and E. **Lainé**: The proportion of carbon dioxide in the air of the Antarctic regions. Samples collected between latitudes 64° and 70° show a mean content of 2·05 parts of carbon dioxide per 10,000, the lowest proportions occurring in the highest latitudes. These researches, and those obtained some time ago in latitude 55°, in the neighbourhood of Cape Horn, afford a striking confirmation of the views of Th. Schlœsing on the exchanges of carbon dioxide between sea water and air.—M. **Lannelongue**: Excavations at the hamlet of Séviac, near Montréal (Gers). Discovery of a big toe in bronze. The excavations have disclosed some mosaics in a good state of preservation. Details are given of a bronze toe which was found on the soil, and is remarkable for its vigour and anatomical exactness. It is surmised that it may be an *ex-voto* annexed to a statue in stone or marble, or it may be a fragment of an important bronze statue.—M. Moureu was elected a member of the section of chemistry in the place of the late M. Troost.—MM. **Schaumasse** and **Javelle**: A new comet discovered by M. Schaumasse at the Observatory of Nice, and observed by MM. Schaumasse and Javelle. This comet was found on November 30 with the bent 40-cm. equatorial, and appears as a circular nebulosity 3′ to 3·5′ diameter, with a badly defined nucleus of about the twelfth magnitude. The apparent positions are given for November 30 and December 1.—E. M. **Antoniadi**: Observations of the planet Jupiter in 1911 with the 83-cm. equatorial of the Observatory of Meudon. A detailed description of the planet is accompanied with five illustrations of points of interest.—H. **Deslandres**: Remarks on the preceding communication and on the utility of the observation of the

planets. The similarity between the disturbances in the atmosphere of Jupiter and the sun is pointed out, and also the importance of extending these observations to other planets.—M. **Tzitzéica**: The R networks.—Maurice **Potron**: Some properties of the linear substitutions with coefficients ≥ 0, and their application to the problems of production and wages.—Louis **Roy**: Viscosity in the movement of flexible membranes.—M. **Girousse**: The protection of installations with weak currents against disturbances due to alternating currents. Supplementary to an earlier note on the same subject. The limits between which the electromotive force and frequency of the disturbing current may be varied have been worked out.—A. **Guillet**: The measurements of small displacements by electrical means. The electrical method proposed is based on the mutual induction of two circuits, and is of the same order of delicacy as the micrometer screw or the optical interference method.—H. **Pécheux**: The resistance and thermoelectricity of tantalum. From the examination of three wires of different purity, the conclusion is drawn that the specific resistance and thermoelectric power of the tantalum increased with the purity.—P. **Vaillant**: The variations in the conductivity of a phosphorescent body under the action of light.—J. **Carvallo**: The conductivity of pure ether. By careful purification of the ether and the glass apparatus, the electrical conductivity was reduced to less than one-tenth that found by Schröder. Even this figure is regarded by the author as too high, and he considers that it is impossible to study completely the conductivity of pure ether in glass vessels.—Georges **Meslin**: The use of doubly refracting prisms for obtaining interference fringes.—A. **Lafay**: The phenomenon of Magnus. A study of the effect produced by a current of air directed normally against a cylinder rotating with a very high velocity.—André **Brochet**: Plotting the lines of equal potential in an electrolyser.—Eugène **Fouard**: The mechanism of osmosis. The experiments described are not in accord with the usual interpretation of the isotonic coefficients of de Vries, nor with the views of Girard and Henri.—G. **Urbain** and F. **Bourion**: Europous chloride. Europic chloride, $EuCl_3$, was first prepared in a pure state; this, reduced in a current of hydrogen at a temperature between 400° C. and 450° C., gives the lower chloride $EuCl_2$, the properties of which are described.—P. **Gaubert**: The indices of refraction of mixed liquid crystals.—J. **Tournois**: The formation of embryos in the hop by the action of the pollen of hemp. It has been found that the oosphere of the hop commences to segment under the action of hemp pollen. This development only appears under favourable conditions of nutrition, and even under the best conditions the development is always limited.—Ch. **Gravier**: Sexual dimorphism in the Capitellians.—A. **Vaissière**: The Opisthobranchs and the marseniads of the Gulf of Tadjoutah.—Ed. **Chevreux**: The amphipods of the French Antarctic expeditions.—Mieczyslaw **Oxner**: The biological analysis of a series of experiments concerning the attainment of sexual maturity, regeneration, and inanition in *Lineus ruber* and *L. lacteus*.—R. **Goupil**: Researches on *Amylomyces Rouxii*.—Mlle. **Robert**: The influence of calcium on the development and mineral composition of *Aspergillus niger*. Within the limits of accuracy employed (0·05 mg. calcium) calcium does not appear to have any influence on the development of this mould.—M. **Javillier** and B. **Sauton**: Is iron indispensable to the formation of the conidia of *Aspergillus niger*?—Raphael **Dubois**: Atmolysis.—Léon **Pervinquière**: The geology of the extreme south of Tunis, especially in the neighbourhood of Ghadamès.—Emile **Haug**: The geology of Meounes and Garéoult (Var).—L. **Cayeux**: A comparison between the Huronian iron minerals of the United States and the oolitic iron minerals of France.—J. **Thoulet**: A bathylithological map of the coast of the Gulf of Lyons between Saintes-Maries and Palavas and Cape Creus.—E. **Rothé**: The earthquake of November 16.

December 11.—M. Armand Gautier in the chair.—Ph. **van Tieghem**: Lepidariaceæ, a new family of Inovuleæ.—P. **Villard** and H. **Abraham**: The measurement of explosive potentials between 20,000 and 300,000 volts. Between electrodes formed of planes of very large area, above 30,000 volts, the explosive potential is a linear function of the distance of the electrodes. A similar relation has also been shown to hold for the case of spherical electrodes carried to symmetrical potentials.—Paul **Sabatier** and A. **Mailhe**: The preparation of the alcoholic amines by catalysis. An extension of the general method described in an earlier paper, the catalytic action of thoria upon a mixture of the vapours of the alcohol and ammonia. Isopropyl alcohol gives isopropylamine, with a little di-isopropylamine, and diphenylcarbinol gives aminodiphenylmethane. Numerous amines have been prepared, starting with cyclohexanol and its homologues. A modification of the catalytic process is described in which the ammonia is replaced by a primary amine; good yields of mixed secondary amines are obtained.—F. **Quénisset**: Photographs of the planet Venus obtained at the Observatory of Juvisy. The photographs demonstrate for the first time the existence of spots on the surface of this planet.—Kyrille **Popoff**: A cause which may have an influence on the estimation of the magnitude of stars. It is suggested that the luminosity of that part of the sky in which a star is situated may be a cause of the discrepancy between the visual and photographic determination of magnitude.—Henri **Renan**: Results of the discussion of observations made by MM. Lancelin and Tsatsopoulos for determining by wireless telegraphy the difference of longitude between Paris and Bizerta. The usual method has been modified by the introduction of an automatic recording instrument for the method of passages. The personal equation is greatly reduced, as is shown in a set of observations given.—A. **Soret**: A bilateral magnetic audiphone.—G. **Reboul**: Photographic impressions on copper. A plate of polished copper, after coating with a very thin layer of chloride or bromide by exposure to the vapours of chlorine or bromine, will give a positive after exposure to sunlight under a negative. The image is not permanent, even in the dark.—Jacques **Duclaux**: The absorption of gases by porous bodies.—Daniel **Berthelot** and Henry **Gaudechon**: The stability of various types of smokeless powder towards the ultra-violet rays. It is shown that the ultra-violet rays from a quartz mercury vapour lamp accelerates the spontaneous decomposition of smokeless powders. This promises to be a valuable method of investigating the stability of smokeless powders, supplementing the tests at present in use.—A. **Recoura**: A combination of ferric sulphate and alcohol. Contribution to the constitution of ferric sulphate.—Marcel **Guichard**: The formation and decomposition of anhydrous bodies: the case of iodic anhydride.—A. **Béhal** and A. **Detœuf**: The action of monochlorurea upon ketones. Monochlorurea in aqueous solution gives with ketones good yields of the monochlorketones. The preparation of several of these is described, and also of the corresponding semicarbazones.—P. L. **Viguier**: Some derivatives of tetrolic aldehyde and its acetal.—G. **André**: The soluble substances occurring in the plasma of tubercles of the potato. The pieces of potato were immersed in ether, and the aqueous solution thus expelled collected and analysed for nitrogen, phosphoric acid, and potash.—Leclerc **du Sablon**: The transpiration of cactus plants: the influence of light.—MM. **Desgrez**, P. **Regnier**, and R. **Moog**: The influence of trimethylamine chlorohydrate on the nutritive exchanges. In experiments on guinea-pigs and rabbits trimethylamine chlorohydrate caused a reduction in the nitrogenous secretions and an increase in the destruction of ternary compounds.—C. **Gessard**: The action of salts on the coagulation of the blood. A study of the relations between the diastase and calcium salts.—Lucien **Vallery**: Study of the coagulation of albumin by heat. Consequences from the point of view of the estimation of albumin in the urine. The whole of the albumin is not precipitated by heating either in presence of acids or electrolytes. Higher results are obtained by using Tanret's reagent, and reasons are given for the view that these higher figures are correct.—A. **Marie** and A. **Thooris**: Variations of the xipho-costal angle according to attitudes and human types.—Etienne **Rabaud**: Paracephalian and acephalian monsters.—R. **Anthony** and A. S. **de Santa-Maria**: The evolution of the *gyrus reuniens* in the Primates.—A. **Rochaix** and G. **Colin**: The action of the rays emitted by the quartz mercury vapour lamp upon the colorability of the acid-resisting bacilli. Under the action of these rays the acid-

resisting bacilli in the dry state lose their power of taking stains by the processes of Gram, Much, and Ziehl, but the process is not the same for all, since coloration by Much's method persists after the bacilli cease to stain by the other two methods.—V. **Commont**: Chronology of the protohistoric, Neolithic, and Palæolithic industries, and the stratigraphy of the Holocene and Pleistocene deposits in the north of France.—Attale **Riche**: The lacunæ affecting the lower part of the secondary layers at Crussol (Ardèche) and at the eastern edge of the Central Plateau.

BOOKS RECEIVED.

Modern Microscopy: a Handbook for Beginners and Students. By M. I. Cross and M. J. Cole. Fourth edition. Pp. xvii+325. (London: Baillière, Tindall and Cox.) 6*s.* net.

Quelques heures dans le Ciel. By Abbé Th. Moreux. Pp. 127. (Paris: A. Fayard.) 1 franc net.

Les Merveilles des Mondes. By Abbé Th. Moreux. Pp. 127. (Paris: A. Fayard.) 1 franc net.

L'Océan aérien. By Abbé Th. Moreux. Pp. 127. (Paris: A. Fayard.) 1 franc net.

Live Stock Journal Almanac, 1912. Pp. 343. (London: Vinton and Co., Ltd.) 1*s.*

The American Annual of Photography, 1912. Vol. xxvi. Pp. 328. (London: G. Routledge and Sons, Ltd.) 3*s.* 6*d.*

The Scientists' Reference Book and Pocket Diary for 1912. Pp. 24+calendar+100. (Manchester: J. Woolley, Sons and Co., Ltd.) 1*s.* 6*d.*

Lehrbuch der Experimentalphysik in Elementarer Darstellung. By Dr. A. Berliner. Zweite Auflage. Pp. xvi+720. (Jena: G. Fischer.) 18 marks.

The Classics of International Law:—Iuris et Iudicii Fecialis, sive, Iuris Inter Gentes, et Quæstionum de Eodem Explicatio, &c. By Prof. R. Zouche. Edited by Prof. T. H. Holland. Vol. i. A Reproduction of the First Edition. Pp. xvi+204. Vol. ii. A Translation of the Text. By J. L. Brierly. Pp. xvii+186. (Washington: Carnegie Institution.)

Handbuch der vergleichenden Physiologie. Edited by H. Winterstein. Siebzehnte Lieferung. Band I., erste Hälfte. Pp. 161–320. (Jena: G. Fischer.) 5 marks.

University of St. Andrews. Five Hundredth Anniversary. Memorial Volume of Scientific Papers contributed by Members of the University. Edited by Profs. W. C. M'Intosh, J. E. A. Steggall, and J. C. Irvine. Pp. xi+354. (Published by the University.)

More Animal Romances. By G. Renshaw. Pp. viii+252. (London and Manchester: Sherratt and Hughes.) 7*s.* 6*d.* net.

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DIARY OF SOCIETIES.

THURSDAY, DECEMBER 21.

LINNEAN SOCIETY, at 8.—Some Annelids of the Thames Valley: Rev. Hilderic Friend.—The Seedling Structure of Leguminosæ: R. C. Compton.—The Internodes of Calamites: Prof. Percy Groom.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Whim Well Copper Mine, West Pilbara, North-West Australia: H. R. Sleeman.—Emeralds: their Mode of Occurrence and Methods of Mining and Extraction in Colombia: C. Olden.—The "Glen" Bismuth Mines, North Queensland: W. C. Walworth Pearce.—Notes on a Simple Method of Separating Rock from Stiff Clays: F. A. Killik.

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