THURSDAY, MARCH 22, 1917.

MATHEMATICAL ANALYSIS.

(1) *Functions of a Complex Variable.* Being part 1 of vol. ii. By Prof. E. Goursat. Translated by Prof. E. R. Hedrick and O. Dunkel. Pp. x+259. (Chicago and London: Ginn and Co., 1916.) Price 11*s.* 6*d.*

(2) *Intégrales de Lebesgue. Fonctions d'Ensemble. Classes de Baire.* By C. de la Vallée Poussin. Pp. viii+151. (Paris: Gauthier-Villars et Cie, 1916.) Price 7 fr.

(3) *Functions of a Complex Variable.* By T. M. MacRobert. Pp. xiv+298. (London: Macmillan and Co., Ltd., 1917.) Price 12*s.* net.

(1) THIS is a competent translation of the last, substantially revised, edition of the original. Prof. Goursat needs no introduction to the mathematical public, so we content ourselves with directing attention to some of the features of this admirable course. The definition of "analytic function" coincides with Cauchy's definition of "fonction monogène"; the properties of such functions are developed with great lucidity, and the student is easily led on to such ideas as power-series, circles of convergence, Weierstrass's theory of analytic continuation, conformal representation, and so on. Riemann's surfaces are alluded to, but not discussed; the main outline follows Cauchy, and in this we think the author is judicious, because, however useful Riemann's surfaces are by their appeal to intuition, they are not easily realised by a beginner, and they have to be constructed in every special case by analytical methods.

Specially noteworthy is the way in which Prof. Goursat expounds some of the more recent discoveries and theorems, such as Weierstrass's factorial formulæ, Mittag-Leffler's theorem, functions with natural boundaries (such as Schwarzian functions), and so on. He has not only mastered these subjects, but is able to discuss them in an original and illuminating manner. For example, the brief discussion of Abel's theorem (pp. 244–50) brings out the essential point that if $R(x, y)$ is a rational function of x, y, and (x_i, y_i) is an intersection of two curves $\phi=0$, $\psi=0$, then the sum $\sum_i R(x_i, y_i)$, taken over all the intersections, is a rational function of the coefficients of ϕ, ψ. This is the real basis of Abel's theorem; all the rest is detail, which may be troublesome enough in any particular case.

There is a comparatively long section on elliptic functions; another on the application of them to curves of deficiency 1; Hermite's important theory of "cuts" is explained; and the last chapter is on functions of several variables. Altogether we could not wish for a better handbook for students of function-theory; it is clear, compact, and consistent; the references are to first-rate authorities, and sufficient to introduce the reader to the original sources. We are very glad that the methods of Cauchy and Hermite are given such prominence, because they are of permanent value, and only require some modifications of minor importance to bring them up to the current standard of rigour.

(2) Every now and then an advance in function-theory compels us to revise our notion of a definite integral. When the nature of Fourier series had been properly understood, Riemann generalised the definition of an integral so as to apply to them, and Dirichlet followed on the same lines. One of the main topics of the present course is a new definition of an integral (the Lebesgue integral) reducing, as the case may be, to the Riemann or the ordinary integral when it exists, but applicable to cases where both the previous definitions are at fault. Although brief, the course is so far self-contained that it ought to be intelligible to a reader who knows little or nothing about the theory of sets or that of trans-finite numbers; the first section deals with measurable sets and their content, and the nature of Lebesgue integrals; the second with "additive functions of sets"; the third with Baire's classification of functions of sets. The last, so far as we can judge, is an important notion, more or less comparable with Hadamard's classification of whole functions (*mutatis mutandis*, of course), and adding one more to the family of "well-ordered classes" or sequences. Another point that cannot fail to strike the reader is the extraordinary difference between the properties of open and closed sets; this distinction is not a new one, but its importance is becoming more and more clear.

The author is sparing in his use of new symbols and technical terms; one, however, seems deserving of mention as being likely to be very convenient. If E is any set and E′ its complement in the whole field considered, ϕ, *the characteristic function* (or characteristic) of E, is defined as being 1 for any element of E, and 0 for any element of E′. Much use is made of the theory of lattices, more or less in the manner of Minkowski. It is scarcely necessary to add that the author's treatment is original, even when dealing with the discoveries of others, and that he contributes much of his own invention.

Although not quite analogous to the problems of this course, we may give an easy example to show the kind of difficulties with which it deals. Take a real positive variable x, and define $f(x)$ to be 1 when x is rational, and 2 when x is irrational; then $f(x)$ is perfectly definite over any closed interval (a, b), but the integral of $f(x)$ from a to b does not exist, either in the ordinary sense or in that of Riemann, because $f(x)$ has finite oscillation within any interval δx, however small, and the discontinuities are crowded together. We have, however, an upper limit integral $2(b-a)$, and a lower limit integral $(b-a)$.

(3) Mr. MacRobert has written a book that is likely to be very useful; it is not too big, the selection of theorems is judicious, and there is a large number of really instructive examples, both

worked and unworked. Beginning with the ordinary definitions of complex numbers, etc., the author goes on to holomorphic functions, contour integration, and power-series; then we have Weierstrass's theory of infinite products, and after this various applications to gamma-functions and elliptic functions (both first-stage and second-stage). Finally, there are four chapters on linear differential equations, with applications to Legendre and Bessel functions. Singular points are considered after the manner of Cauchy; Weierstrass's theory of analytical continuation is explained; there is a good introduction to the work of Fuchs, Frobenius, etc., on linear differential equations; and the last chapter shows how to find solutions of $aw''+bw'+cw=0$ by means of definite integrals, with illustrations comprising Bessel functions and the hypergeometric series.

It is a small matter, perhaps, but we regret to see on p. 2 the formula $\tan\theta=y/x$ put in such a context that a beginner is apt to take it as a definition of $\text{amp}(x+iy)$. The proper definition of the latter is that it is any angle satisfying the *two* relations $\cos\theta=x/r$, $\sin\theta=y/r$, where $r=|x+iy|=+\sqrt{(x^2+y^2)}$. No other definition meets the requirements of function-theory.

G. B. M.

PHYSICAL CHEMISTRY.

Theoretical Chemistry, from the Standpoint of Avogadro's Rule and Thermodynamics. By Prof. Walter Nernst. Revised in accordance with the seventh German edition by H. T. Tizard. Pp. xix+853. (London: Macmillan and Co., Ltd., 1916.) Price 15*s.* net.

THE fact that a fourth English edition of this treatise, based on the seventh German edition, has been called for is sufficient testimony, if any were still required, to the excellence of a work which has made for itself a high reputation for its individuality and lucidity. First published more than twenty years ago, the book was written from a definite point of view, emphasised in the title, owing to the belief of the author that "the theoretical treatment of chemical processes—the most important part of my task—depended, first, on the Rule of Avogadro, which seems to me an almost inexhaustible 'horn of plenty' for the molecular theory; and, secondly, on the Laws of Energy, which govern all natural processes." The position thus taken up by the author has become increasingly justified with time.

But although we give a glad welcome to this new edition of a valuable book, we cannot but feel some regret that certain sections should not have been made rather more modern, and that little or no attention should be given to some recent and valuable contributions to physico-chemical science. The translator frankly recognises that "the character of the work is slowly changing, since it is no longer possible in a book of this size to describe fully all modern developments of theoretical chemistry." This is quite true, but the reviewer cannot but feel that if the necessary trouble were taken, a certain amount of rearrangement of the matter would allow most of the important new developments to be at least indicated, if not fully treated. It must be regretted, for example, that in a book of this character no mention is made of the recent important work on X-ray spectra and the bearing of this on the atomic theory. Moreover, certain other sections, such as that on osmotic pressure, might with great advantage be rewritten (so far as the experimental work is concerned), in view of the investigations, in this particular field, of Morse and his collaborators, and of Lord Berkeley and E. G. J. Hartley. One table giving the results obtained by Morse and Frazer is reproduced, but it refers to some of the earlier work of these investigators carried out before their apparatus and technique had been perfected. In the case of this subject, moreover, the importance of which the author recognises, something more might be expected than the bare reference which is made to the work of Lord Berkeley and Mr. Hartley. (In passing, one may point out a misprint which seems to have gone through all editions of this work; namely, on p. 133, Flurin instead of Flusin. Likewise in the index.) Defects such as those indicated certainly diminish the value of the work for the general student, and the reviewer cannot regard as complete compensation the interesting treatment of Nernst's own researches, such as the sections dealing with the specific heat of solids and all that is based thereon, and the Nernst heat theorem.

Nevertheless, although there will always be a difference of opinion regarding the emphasis to be placed on the various sections of the subject, we cannot but recognise the success with which the author gives, in general, a survey of a very large and growing branch of knowledge; and this new edition of an inspiring and intellectually bracing book will doubtless receive the welcome it deserves. We ought also to express to the translator our appreciation of the general excellence of his work. Is, however, one may ask him, "depolarisators" (p. 778) an English word?

A. F.

OUR BOOKSHELF.

The Land and the Empire. By Christopher Turnor. Pp. 144. (London: John Murray, 1917.) Price 3*s.* 6*d.* net.

MR. TURNOR is well known as an enthusiastic landowner who firmly believes in the future of British agriculture if only it is properly taken in hand. He divides his book into three parts: the errors of the past; land settlement and education; and a sketch of an organised agricultural industry. The keynote to the whole is that a new outlook is wanted. On the rural side the Government, the landowners, and the farmers must all be brought to recognise that the holding of land implies the

duty of cultivating it in the best possible manner; on the urban side the people must realise that the country ought never again to be so dependent on sea-borne food as it has been during the past fifty years. Henceforth, Mr. Turnor urges, security of supply must be the motto, instead of a cheap supply at all hazards; and, lastly, the workers themselves must have a new outlook, and realise that salvation for our future economic troubles lies in unrestricted, and not in restricted, individual output.

Mr. Turnor argues his case extremely well, and drives home his arguments with numerous diagrams illustrative of his statistics.

One of the secondary effects of the war is that agriculture is fast becoming a controlled industry, and experiments in organisation are being tried now on a vastly larger scale than before. Already some of the suggestions of the reformers have been carried out. We have minimum prices; we shall soon have a minimum wage. The Game Laws have had a hole knocked through them, and in several directions the new conditions are advanced beyond the wildest dreams of 1914. We shall soon see how the new order is going to work, and in the meantime we can only welcome the fullest discussion of the agricultural problem as it is and as it seems likely to shape itself.

Morphology of Invertebrate Types. By Dr. A. Petrunkevitch. Pp. xiii+263. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1916.) Price 6*s.* net.

THIS volume is divided into twenty-eight chapters, each dealing with one type. Each chapter consists of a description of the systems of organs of a type and a series of instructions to be followed in the examination of the animal. Much importance is rightly attached to the drawings which the student is directed to make, and to do away with any tendency to copy the figures included in the book these are either diagrammatic or represent some related type. This latter device has here and there its disadvantages, *e.g.* the figures of Ankylostoma and Wilsonema are of relatively little use in aiding the student to understand the structure of Ascaris; there are too many differences between Ascaris and the types figured.

The descriptions are accurate, and on the whole well done, though some parts are too short, *e.g.* the accounts of the nephridia of the earthworm and of Nereis are inadequate. The types chosen are all found in America, except the Trematode *Dicrocoelium lanceatum* and the medicinal leech, but many of them occur also in Britain or are closely similar to British species, and the book will therefore be helpful to those "on this side" who desire an account of the general anatomy of such types as Pennaria, Sertularia, Tima, Aurelia, Dendrocœlum, Daphnia, a spider (Agelena), Asterias, Venus, Limax, Loligo, and Molgula. But in most laboratories in this country where similar types are studied, probably more attention is devoted to the finer structure of some of the organs, *e.g.* the nephridia cited above.

LETTERS TO THE EDITOR.

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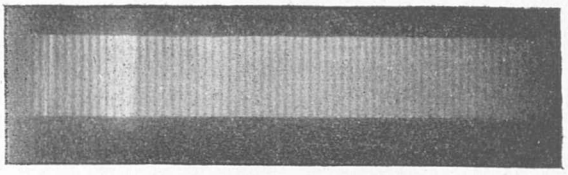
The Horizontal Temperature Gradient and the Increase of Wind with Height.

IF the horizontal layers of air were isothermal (the upper layers having the lower temperature), then the gradient winds at different heights would be proportional to the temperatures (absolute) at those heights. Consequently the wind would decrease with height, and although a higher temperature at a given altitude over the higher pressure is a necessary corollary of an increase of wind with height, the converse is not necessarily true. It is clear on reflection that with such a temperature distribution as that described above, the temperature at any point in BD of Mr. Dines's diagram in NATURE of March 8 (p. 24) would be below the temperature at the corresponding point in AC, so that BD would be less than AC, and consequently v less than V; but the actual relation runs some risk of being obscured by Mr. Dines's use of isobaric surfaces which in other respects gives an admirably simple exposition of a theorem in atmospheric dynamics, and shows also that if the isobaric and isothermal surfaces coincide there is no variation of wind with height. Incidentally, during the past winter months the mean isotherms have run from N.W. to S.E., and have given at 6000 ft. a N.W. "thermal" wind of about $1\frac{1}{2}$ metres per second superposed on the wind between 1000 and 1500 ft. E. GOLD.

Meteorological Section, R.E., March 16.

A Fixed System of Grating Interference Bands.

I WISH to direct attention to a very remarkable property possessed by one of the systems of interference bands which make their appearance when white light is reflected from a plane replica-film grating, backed by a parallel silvered surface separated by a film of air. The appearance of the fringes in question is shown in the accompanying photograph, when the grating has 14,508 lines to the inch and the air-space is 0·0740 cm.



This system of bands, when examined by a spectrometer with a fixed collimator, remained *absolutely fixed* in the field of view of the telescope as the grating was rotated. This rotation has the effect only of moving the spectrum to and fro across the field of view without, in the least, altering the position of the dark fringes. This important property, which is uniquely exhibited by these fringes, seems to have escaped the notice of Prof. C. Barus, who has dealt with grating interferences and with their application to the displacement interferometry in a series of papers which appear in a collected form in the monograph "On the Production of Elliptic Interferences in Relation to Interferometry" (Carnegie Publication No. 149, 1911).

The fringes appear to be due to the interference between two portions of light arising out of the single beam incident on the grating, one of them being reflected at the silvered surface and then diffracted out by the grating element which it meets, and the other being diffracted into the air space by the same grating element and then reflected out by the silvered surface. The path difference is equal to

$$2t\,(\cos X - \cos \phi)$$

where ø and X are the angles of incidence and emergence respectively, and t the thickness of the air film. Therefore the condition for interference is

$$2t\,(\cos X - \cos \phi) = \frac{2K+1}{2}\lambda \quad . \quad . \quad . \quad . \quad (1)$$

where K is an integer.

But since we are using the grating, ø and X are connected by the relation

$$d\,(\sin \phi - \sin X) = n\,\lambda \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where d is the grating interval and n the order of the spectrum.

Hence, dividing (1) by (2), we have

$$\tan \frac{\phi + X}{2} = \frac{(2K+1)\,d}{4tn}$$

In this equation (ø+X) is the angle which the direction of any particular dark fringe makes with the incident light, *i.e.* with the axis of the collimator. Since (ø+X) is determined once for all independent of the position of the grating, the absolute fixity of the fringes is accounted for. A detailed paper on this subject was laid before the session of the Indian Science Congress held at Bangalore in January, 1917.

C. K. VENKATA ROW.

6 Singarachari Street, Triplicane, Madras, S. India, February 10.

Mountain Sickness.

THE reference in the Notes columns of NATURE of January 25 (p. 415) to the physical failure experienced in mountain-climbing at high altitudes sent me to the very instructive (and suggestive) article by Dr. A. M. Kellas in the *Geographical Journal*. And the great interest now attached to one of the inevitable problems of the immediate future gave me to think that a few supplementary notes might be of sufficient interest for publication. The "mountain sickness" which forms the association that specially interests the physiologist and the physician was impressively brought under the notice of the latter in the "fall" of the fifteenth century; when the gold-thirst of the ruthless Spanish invader of the western Eldorado made him familiar with its symptoms directly after reaching the very elevated backbone of the southern section of the New World. The oldest special description that appeared in print would seem to have been that of Da Costa; and the very human appetite for novelty proceeded very soon to make the "*mal de montagnes*" a phrase-name as familiar to Western Europe as that of the *mal français*—so very unhappily—rapidly came to be. The syndrome was referred to in the various linguistic territories bordering the giant Cordilleras as: *Soroche, mareo des Cordilleras, asthma des montagnes*, etc. And the native prophylactic, on the colossal slopes and towering cliffs of the Cordilleras of Peru, was slow and continuous mastication of prepared pellets of the dried juices of *Erythroxylon coca*—the original version of American "gum-chewing." The phenomena came in time to receive definite scientific discussion, notably at the hands of Bouguier ("Voyage en Peru") in 1745, and Condamine (of Peruvian bark fame) in 1751.

As world-wide scientific mountaineering developed—along lines of modern evolution—a number of French and German observers came to depict in turn their personal experiences of the symptom-group: Saussure, Clissold, Barry, Rohrdoff, Zumstein, Lepileur, Martins, and Bravais—according to their several personal experiences on Mont Blanc; Humboldt, Boussingault, and Hall—on the upper reaches of Chimborazo. As might be readily anticipated, in a personal experience in which individual constitution and previous training count for so much, we are told by the illustrious Humboldt that: "Ces phénomènes sont très-dissemblables suivant l'âge, la constitution, la finesse de la peau, les efforts antérieurs, les forces musculaires," etc. It very obviously corresponds in great, though not exclusive, measure to the "incommodités" of the *balloon* ascent of Biot and Gay-Lussac, on "le 6 fructidor, an XII" (August 24, 1804)—greatly exaggerated, of course, and developing at a lower altitude, from the very laborious *muscular exertion* of mountain-climbing. The latter rivals, as a factor in physiological derangement, the *suddenness* of change of environment in a balloon ascent, which bars off all chance of the gradual adaptation which would be so very necessary for functional adjustment.

JOHN KNOTT.

Dublin, March 2.

BORNEO AND ITS INHABITANTS.[1]

AS explained in the author's unfinished introduction, this book is a somewhat disconnected account of the natural history of Borneo, compiled from notes while he was in charge of the Rajah of Sarawak's museum at Kuching.

The first chapter deals with the mammals, and, as might be expected, considerable space is devoted to the orang-outang, or, as the author prefers to call it, the "Maias," this being its correct Malay name. It is satisfactory to learn that this interesting representative of the human family is still abundant, though local, in Sarawak. Though the fauna of Borneo is lacking in many of the larger mammals that appeal to the sportsman, it has at least its full share of remarkable forms among the smaller species. Many interesting details are given of that extraordinary little lemur, the Tarsier, *Tarsius spectrum*, and of the so-called flying lemur, *Galeopithecus volans*, that puzzle for systematists which has now the distinction of an Order to itself. The remarkable colour relationships between the squirrels of the island and certain unpalatable tree-shrews of the genus Tupaia are discussed at length. The relations of palm civets with coffee are at first sight far from obvious, but those of our readers who obtain their coffee from Borneo and are curious as to the previous history of the best quality berries should consult p. 33! It is of peculiar interest to find the mouse-deer taking the place in the native folk-lore of "Brer Rabbit," the latter itself being a direct descendant of the hare which always figures as the cunning hero in equatorial Africa.

The second, third, and fourth chapters are de-

[1] "A Naturalist in Borneo." By the late Robert W. C. Shelford. Edited, with a Biographical Introduction, by Prof. E. B. Poulton. Pp. xxvii+331+xxxii plates. (London: T. Fisher Unwin, Ltd., 1916.) Price 15s. net.

voted to birds, snakes, and other reptiles, and contain some excellent illustrations. Some account is given of the so-called "flying snakes," which, by rendering the ventral surface concave, are enabled to effect a sort of parachute descent from a moderate height. The author assists in dissipating the popular idea in this country as to the ubiquitous character of poisonous snakes in the tropics, since these do not, as a matter of fact, constitute a very large proportion of the snake population, and are seldom actually aggressive. An amusing account is given on p. 77 of the use of a stuffed python as a scarecrow for rats, though this would perhaps be scarcely suitable for adoption in this country.

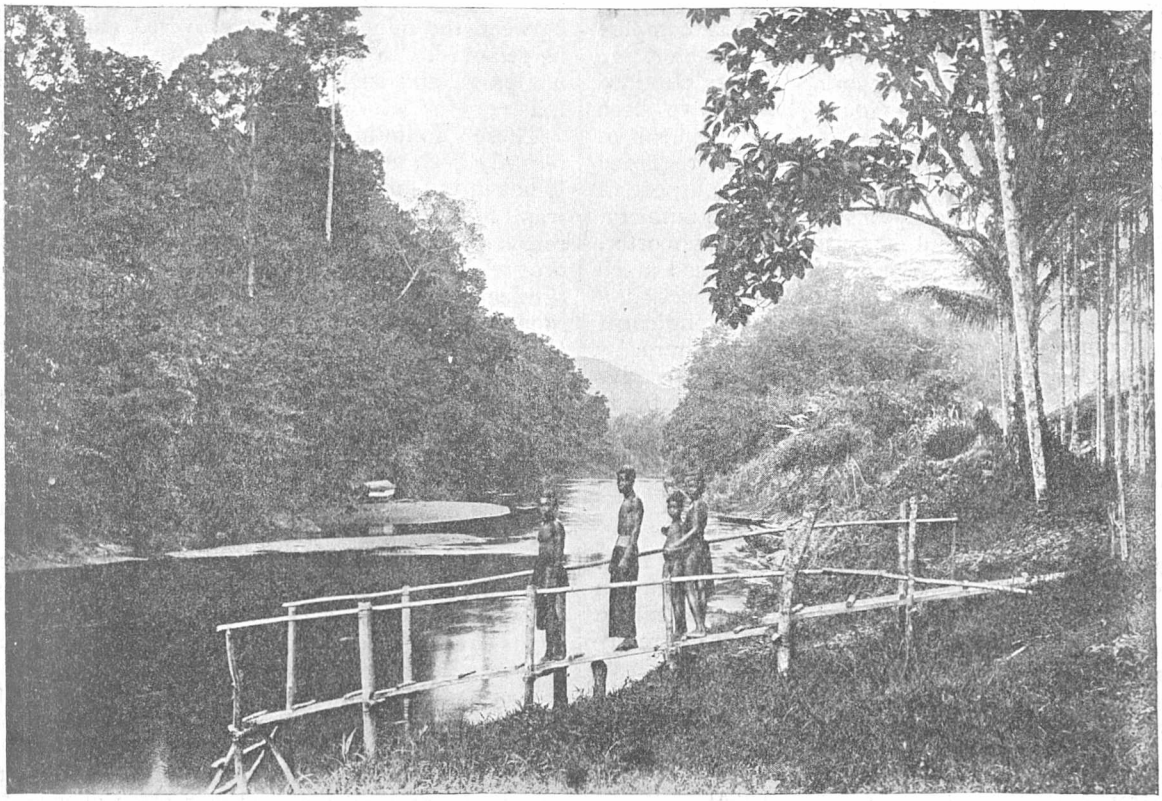


FIG. 1.—Upper Sadong River at Tabekang. From "A Naturalist in Borneo."

The author was primarily an entomologist, and it is not surprising that the chapters on insects occupy rather more than one-third of the book. Especial attention is directed to the Orthoptera, more particularly the cockroaches, on which he was a recognised authority. It is not generally known that the common cockroach, *Blatta orientalis*, had invariably been found associated with human habitations until it was recorded a few years ago in the Crimea under leaves, stones, etc., in woods in a truly wild state. Many details are given of the striking coloration of various Mantids, especially of those which are floral simulators and are thus a living trap for butterflies and other flower-frequenting insects. In the chapter on beetles some good figures are given of the remark-

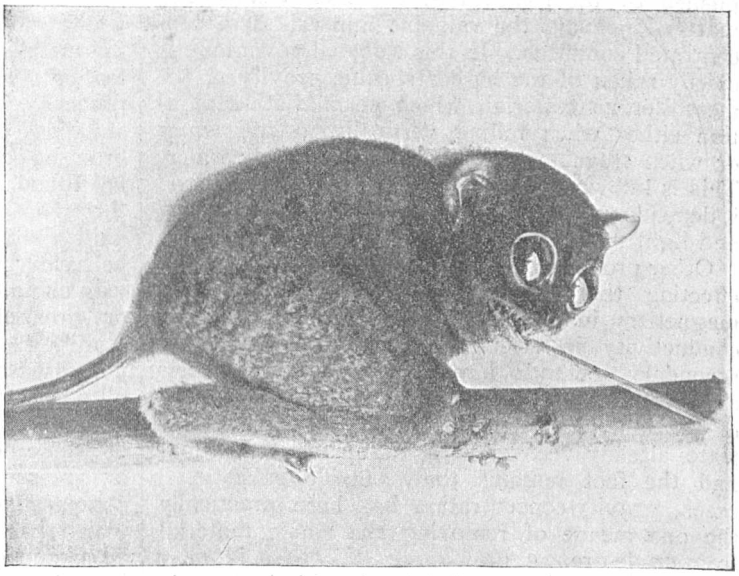


FIG. 2.—The Bornean Lemur, the Tarsier, *Tarsius spectrum*. From "A Naturalist in Borneo."

able "Trilobite" larvæ of what is presumed to be a very large, unidentified Malacoderm. The importance and overwhelming number of ants in the tropics, with a detailed account of their complex relations with plants, occupy another chapter. In the author's view the supposed benefits obtained by so-called myrmecophilous plants have been exaggerated, and the wonderful development of plant forms in this relation should be regarded more as protective devices than for the purpose of attraction. A whole chapter is devoted to mimicry, of which theory the author was a strong supporter, as indeed might be expected in one who had much experience of the tropics. In this connection a valuable list is given of the Bornean Longicorns mimicking Hymenoptera and other Coleoptera.

The later chapters are devoted to an attractive account of expeditions into the interior, the fauna of the seashore, and some notes on the manners and customs of the natives, while a number of explanatory notes by Prof. Poulton and others form an appendix.

The book is well printed and has a useful index, while the excellent illustrations are mainly from the author's own photographs. Though much has been done by its distinguished editor to combine it into a more or less connected whole, it is greatly to be regretted that its author's untimely death necessarily renders it less complete than we could have wished. It will, nevertheless, be found most fascinating reading by all lovers of Nature.

THE FLOTATION METHOD OF ORE CONCENTRATION.

THE recovery of metalliferous minerals from crude ores in the condition of cleanliness necessary for metallurgical operations is accomplished by the removal of the non-metalliferous material, leaving the valuable minerals in a concentrated condition. In this removal advantage is chiefly taken of the higher specific gravity of the metalliferous material, which permits its separation either when falling vertically in still water or when travelling horizontally in moving water. This is known as water- or gravity-concentration; it depends upon the differential movement of heavy and light minerals in water.

Other properties are also at times made use of in effecting this removal, such, for example, as magnetism in magnetic separation, and electric conductivity in electrostatic separation. These secondary methods have, however, found their application almost exclusively in the separation of the individual minerals of a complex concentrate already recovered by water concentration, and the fact remains that, outside exceptional cases, gravity-concentration has been practically the one means of removing the waste material from crude ore.

This means has well-defined and inexorable limitations. When the ore has to be crushed fine in order to release the individual grains, some of it unavoidably becomes rendered so impalpably fine that all advantage of gravity becomes lost in the greater factor of the water's resistance, and no differential movement is any longer possible. Gravity-concentration also demands for its success that there shall be a sufficient difference in gravity between the mineral to be recovered and that to be removed. In cases where that difference does not exist, and such are continually occurring, it fails.

These limitations have until comparatively recently been accepted as in the nature of things. If not in the mechanical preparation of ores, there was in the hydro-metallurgical processes of recovery the compensating factor of remarkable progress. The advent of cyanidation in 1889 had gradually effected a revolution in the recovery of gold and silver. In this process no removal of the worthless material was necessary, since the active solutions themselves made the necessary discrimination, attacking only the valuable mineral and leaving the mechanical preparation responsible simply for crushing the crude ore to the necessary fineness.

In the case of the base metals the position was not so satisfactory. The greatly increased consumption of these metals necessitated attention to the more complex and poorer deposits. Among them, opportunely, was the immense Broken Hill deposit containing argentiferous lead and zinc ores in a heavy matrix. By gravity-concentration it was possible to market only about 60 per cent. of the lead, and less of the silver, leaving the bulk of the zinc associated with the heavy waste as a middle product, while the finest and lightest portion of the crushed material was often allowed to flow away.

The quantities concerned were, however, so enormous that every process possessing any possible chance was tried, with in almost every case little success. Among them, however, was one which took advantage of the property possessed by metallic sulphides when in a fine condition to float, and therefore known as the flotation process. When, for instance, a mixture of such sulphides and waste in a fine condition is gently brought on to the surface of moving water, it will be found that the waste particles will break through that surface and sink, whereas the sulphides will float away. Further, this differential behaviour will be the more pronounced if in one way or another the sulphide particles can be oiled or greased. This, providentially enough, can readily be done because of a second property possessed by sulphide particles, that of adsorbing oil when agitated with a small proportion of oil in an aqueous mixture, a property which the particles of waste do not possess. This effect of an oiled or greased surface will be appreciated from the comparative ease with which a small needle which has been passed through the fingers can be made to float, whereas it would be very difficult indeed to get the same needle to float after it had been cleaned in the flame or by alcohol.

In this oiled condition the floating powers of sulphides are so reinforced that what otherwise might be an inadequate separation is then generally highly satisfactory. The air, and not the oil,

is, however, the prime factor, and the reason the sulphide particles float is because of the air-film attached to them and not because of oil buoyancy. Accordingly, though a small amount of oil is generally used, flotation may be, and in particular cases is, achieved without oil. Nor is it necessary to bring the mixture gently on to the water surface; the sulphide particles, if introduced below the surface, will attach themselves to air-bubbles introduced at the same time, and rise. This result is probably more readily completed if enough oil is present to cover the sulphides with the filmiest covering of oil, though an excess of oil would agglomerate such particles and cause them to sink. Be that as it may, it is considered that the particular function of the oil is to lower the surface tension of the water and so permit the mineral-laden bubbles to form a froth which is the stronger both because of the presence of the oil and because of the strengthening effect of the mineral particles themselves; in this latter connection the retention of the globular form by drops of water thrown on to a dusty floor is interesting. When thus assembled into a froth the collection of separated sulphides is easy.

Two main theories have been put forward to explain flotation. The first, and probably the most applicable, is that of interfacial tensions between the different phases, sulphide particle, air-bubble, water, and sometimes oil droplet. This was suggested by the difficulty of wetting sulphides. It is conceivable that the sulphide surface has a potentiality to oxidise or otherwise change its chemical state, and for that reason to stick to an air-bubble when brought in contact with one; whereas the oxides, carbonates, and silicates of the worthless material, having nothing to get from the air, are inert. Flotation may then for convenience be said to depend upon the surface energy of mineral particles, just as magnetic separation is dependent upon their magnetism.

The second theory, and one of great assistance as a working hypothesis, is based on the fact that mineral particles in water, by reason of the film around them, are electrically charged, the sulphide particles positively and the non-metalliferous particles and air-bubbles negatively. Under these conditions the attachment of the sulphide particles to the air-bubbles is readily understood; air being a non-conductor, discharge would not come with contact.

In addition to oil, sulphuric acid is also generally used. Its effect is to increase the wetting powers of the water, so that less of the waste is entrained with the sulphides and the concentrate consequently cleaner. Whether the view be taken that the acid achieves this effect simply by cleaning the surfaces, or by acting as an electrolyte, largely depends upon what theory is being applied. If carbonates be present in the ore, an additional effect of the acid is that the generation of carbonic acid gas may render the special introduction of air unnecessary, since experience has shown that bubbles of this gas may take the place of air.

Whatever the true theory, it is impossible to question the fact of the great importance of flotation concentration. Its success upon the zinc middling product at Broken Hill was immediate. At first, in 1900, used only for treating a sandy material, with the elimination of imperfections and the introduction of improvements it eventually became applied to the slime, the position now being that the whole range of zinc products on that field is treated by flotation, and zinc ore to the extent of about 500,000 tons per year is being recovered.

Such a success could not be without influence upon the recovery of fine material elsewhere, and at this time the large disseminated copper deposits of America were becoming big producers of copper. With these low-grade deposits ordinary gravity-concentration was yielding at most, even with an extensive plant, a 70 per cent. recovery of the contained copper, the larger part of the loss being in the very fine material. Upon this material flotation tests showed a much better recovery, and many plants have now been provided with a flotation equipment to treat this fine material, bringing the total recovery of the copper up to about 85 per cent. One large mine, having a capacity of several thousand tons a day, has indeed gone to the extent of making flotation the prime concentration process employed, in spite of the fact that a gravity-concentration plant had been designed and was about to be put into execution.

Lead ores in their turn have had this process applied to their finer material, to the much-improved recovery of the lead contents; while simple zinc ores have similarly benefited. Flotation has also in some cases been applied to the beneficiation of the fine sulphides of silver and the tellurides of gold, encroaching in these cases upon a field long the monopoly of the cyanide process; while among the ores of the minor metals, molybdenite, the sulphide of molybdenum, except for what can be done by hand-picking, is entirely recovered this way.

Finally, it may be said that though Australia led the way, there is scarcely a metalliferous district in the world where flotation has not become a factor of the greatest interest, while its advent has been to the base metals the same beneficent revolution that the cyanide process was to the precious metals.

It is a pleasure to know that this process, like the cyanide process, was largely the discovery of British experimentalists, and in connection with it the names of Elmore, Sulman, and others will become historical. The only regret is that it should have been the subject of so much litigation and the source of so much animosity.

MAJOR SYDNEY D. ROWLAND.

WE regret to announce the death on March 6, in France, from cerebro-spinal fever, of Major Sydney Donville Rowland, R.A.M.C., M.R.C.S.

Sydney Rowland was born in 1872 and educated at Berkhamsted School, whence he pro-

ceeded in 1889 to Cambridge with a science scholarship at Downing College. At Cambridge he took the Natural Science Tripos and was for a short time assistant demonstrator in the Physiological School. Whilst at Cambridge he was a prominent member of the Cambridge Natural History Society and some time its president. At this time he was keenly interested in almost every department of natural science and philosophy. As a friend who was his contemporary has expressed it, he was an amateur of science in the best sense of that word.

After leaving Cambridge Rowland came to London and completed his medical studies at St. Bartholomew's Hospital. At the end of 1898 he received an appointment which afforded him scope for his particular gifts, namely, that of assistant bacteriologist at the Lister Institute, and he remained a member of its staff until his death. Henceforth he was able to devote the whole of his time to scientific investigation.

Rowland was an extraordinarily good mechanic, and his ingenuity and skill were at all times at the service of his colleagues. The conquest of technical difficulties was a pure joy to him, and he was even sometimes in danger of letting it assume the importance of an end in itself. He early became an excellent microscopist, and ultimately acquired an unusually perfect command of all the applications of what he used to term "glass and brass."

His earlier researches were concerned with the structure of bacteria and the study of various enzymes which Hedin and he discovered in the expressed juices of animal cells. The next important piece of work upon which he was engaged was carried out in conjunction with the late Dr. MacFadyen. The latter having ascertained that bacteria survived the temperature of liquid air, it occurred to him and Rowland that grinding up bacteria at this low temperature would afford a cell-juice much more nearly resembling the composition of living bacteria than had hitherto been possible to attain, and they hoped that the injection of bacterial cell-juices, so obtained, into animals might afford curative sera for typhoid and other diseases. The research was a lengthy one, and the technical difficulties to be overcome very considerable. The latter were ultimately conquered by Rowland, but the result was disappointing, and the main object was not attained.

Rowland was a member of the Commission for the Investigation of Plague in India and worked at Bombay during 1905 and 1906. He took an active part in establishing the dependence of the human epidemic of plague upon the rat epizootic and the importance of the rat flea in the spread of the disease.

On his return to England he worked upon problems in plague immunity, principally with a view to the improvement of methods of prophylactic inoculation, and published a number of important papers on this subject. He was still occupied in this work when, in October, 1914, he obtained a commission in the R.A.M.C. and proceeded to France in charge of No. 1 Mobile Laboratory. He was recently engaged in discovering meningococcus "carriers" amongst troops and contracted the disease himself.

Rowland had an original and versatile mind and was interested in almost all departments of scientific activity. He was somewhat erratic, but a faithful friend, whose spontaneous gaiety and generous sympathy endeared him to all those who knew him intimately. C. J. M.

NOTES.

IT is officially announced that Mr. A. D. Hall has been appointed Permanent Secretary to the Board of Agriculture in succession to Sir Sydney Olivier, K.C.M.G., now resigned. Sir Sydney has made many friends at the various agricultural colleges and research institutions, and his term of office has been marked by a kindly and sympathetic consideration of all matters relating to the application of science to agriculture. He carries with him into a well-earned retirement the good wishes of all those with whom he was brought into contact. The agricultural teachers and advisers, and the workers at the agricultural institutions generally, greatly appreciated his sincerity and his obvious desire to help British agriculture in every way possible. During his term of office the Board of Agriculture has considerably expanded, and is now larger than ever before. Mr. Hall's appointment as Sir Sydney's successor will be welcomed everywhere, and will be taken as an earnest that still further developments are contemplated. Mr. Hall has recently put forward his ideas in his book, "Agriculture after the War," in which he sets out a coherent plan for the development of British agriculture on sound scientific lines. Several of the recommendations have since been adopted, and there can be little doubt that the war period will furnish experience of special measures which will be invaluable in the reconstruction after the war. Thus Mr. Hall starts in his new office at an opportune moment for further developments. At the same time it must be admitted that in many respects the situation is bad; some egregious blundering on the part of War Office officials in their dealings with agriculturists has recently come to light, and has caused serious misgivings among farmers. Mr. Hall has the hearty good wishes of everyone in the attempts he will doubtless make to straighten out the tangle.

WHEN the establishment of a separate Department of Scientific and Industrial Research was announced in December last, Lord Crewe stated that the Chancellor of the Exchequer was prepared to advise the Government to devote a sufficient sum to cover operations during the next five years on a scale which would provide four, or perhaps five, times as much for co-operative industrial research as had been spent for the whole purposes of research hitherto. The Civil Service Estimates just issued include the sum of 1,038,050*l.* to the Department of Scientific and Industrial Research, being a net increase of 998,050*l.* upon last year's amount. Grants for investigations carried out by learned and scientific societies, etc., are estimated at 24,000*l.*, and grants to students and other persons engaged in research at 6000*l.* These grants will be distributed by a committee of the Privy Council, on the recommendation of the Advisory Council, to promote the development of scientific and industrial research in the United Kingdom, and will be subject to such conditions as the committee may

think necessary. The 1,000,000*l.* grant in aid of industrial research will be paid to the account of the Imperial Trust for the encouragement of scientific and industrial research. The expenditure of the trust will be audited by the Comptroller and Auditor-General, but any balance remaining on the account will not be surrendered at the close of the financial year. Grants will be made by the directions of the Committee of the Privy Council over an agreed period to approved trade associations for research, to supplement the funds of the associations, and payments in respect of such grants will not be liable to surrender by the grantees at the end of the financial year. We understood from Lord Crewe's remarks on December 1 that for the next five years or so about 200,000*l.* a year would be available for scientific and industrial research, so that apparently the grant of 1,000,000*l.* is the sum which is to be drawn upon for this purpose. The amount estimated for salaries, wages, and allowances in the new department is 7250*l.*, which includes 1500*l.* for the secretary and 850*l.* for the assistant secretary. Travelling and incidental expenses are estimated to amount to 800*l.*

PROF. C. S. SHERRINGTON, Waynflete professor of physiology in the University of Oxford, has been elected a corresponding member of the R. Accademia delle Scienze of Bologna.

ON Thursday next, March 29, at 3 p.m., the president of the Royal Society will unveil the memorial to Sir William and Lady Huggins in St. Paul's Cathedral. Addresses will be given by the president, and by the president of the Royal Astronomical Society.

THE annual general meeting of the Chemical Society will be held at Burlington House on Thursday, March 29, at 4 p.m., when a ballot for the election of officers and council for 1917–18 will be held, and Dr. Alexander Scott, the retiring president, will deliver an address entitled "The Atomic Theory."

THE death is announced, in his sixty-eighth year, of Dr. E. D. Peters, professor of metallurgy at Harvard University and the Massachusetts Institute of Technology since 1904. He was the author of standard works on copper smelting, as well as of many technical monographs.

DR. W. C. ALPERS, dean of the School of Pharmacy at Western Reserve University, Cleveland, has died in that city at the age of sixty-six. He was a native of Hanover, and studied at Göttingen. In 1914 he was elected president of the American Pharmaceutical Association. He was a member of the revision committee of the U.S. Pharmacopœia, and the author of volumes on "The Medicinal Plants of Staten Island" and "The Pharmacist at Work."

ATTEMPTS have recently been made to work coal on the island of Bornholm, in the southern Baltic. No Carboniferous rocks are exposed, since apparently they have been cut out by the faults that have brought Rhætic, Lias, and later rocks against the older Palæozoics. Traces of coal have, however, been found by boring, but the attempts referred to have now shown that any workable layers lie at such a depth that their exploitation is not a paying proposition.

THE council of the Incorporated Municipal Electric Association, recognising the important part that electricity may be made to play in the better cultivation and greater production of the land and in the extension of rural industries, has formed the nucleus of what is ultimately intended to be a committee representative of all interests with the object of a thorough investigation into the technical and commercial problems underlying the application of electrical energy for such purposes. The chairman of the committee is Mr. S. E. Britton, City Electrical Engineer, of Chester, and among the objects are:—(1) To investigate and advise upon the problems underlying the supply and use of electrical energy in agricultural areas for power, lighting, heating, culture, and other purposes for farms, villages, and rural industries. (2) To collect and collate information, and publish literature bearing upon the above. (3) To co-operate with agricultural and other associations. (4) To investigate in co-operation with manufacturers the development, manufacture, and adaptation of agricultural machinery, and appliances for utilising electrical energy.

THE Royal Geographical Society announces that the King has approved of the award of the Royal Medals for the present year as follows:—Founder's Medal to Commander D. G. Hogarth, R.N.V.R., for his explorations and other geographical work in Asiatic Turkey, 1887–1911; Patron's Medal to Brig.-Gen. Rawling, C.M.G., for his explorations in western Tibet and Rudok, 1903, his journey from Gyantse to Simla *viâ* Gartok, 1904, and his explorations in New Guinea, 1908; Victoria Medal is awarded to Dr. J. Scott Keltie for his eminent services to geography during his secretaryship of the society. The other awards are:—Murchison Grant to Rai Bahadur Lal Singh for his devoted work as surveyor to the expedition of Sir Aurel Stein; Back Grant to the Rev. Walter Weston for his travels and explorations in the Japanese Alps—a district previously unknown to Europeans; Cuthbert Peak Grant to Dr. A. M. Kellas for his exploration and ascent of new peaks in Sikkim, and his investigation of the effects of high altitude; Gill Memorial to Mr. E. C. Wilton for his geographical work in south-western China.

THE Advisory Committee for Aeronautics has appointed a Light Alloys Sub-Committee. The members of the sub-committee are Mr. Henry Fowler, superintendent of the Royal Aircraft Factory (chairman), Lieut.-Commander C. F. Jenkin, R.N.V.R., and Prof. F. C. Lea, representing the Air Board; and Capt. H. P. Philpot, Mr. A. W. Johns, and Dr. W. Rosenhain, representing respectively the Aeronautical Inspection Department, the Director of Naval Construction, Admiralty, and the National Physical Laboratory; together with the chairman of the Advisory Committee for Aeronautics, *ex officio*. The functions of this sub-committee will be to advise Government Departments on questions relating to light alloys, to institute research for the development and improvement of such alloys and the methods of working them, and to assist in the removal of difficulties which may arise in their production and use. It will be in close touch with the experimental work on light alloys which is being carried out at the National Physical Laboratory, the Royal Aircraft Factory, the University of Birmingham, and elsewhere, and hopes to be able to give advice and assistance to manufacturers undertaking the production of light alloys and to founders engaged in the manufacture of engine parts, cylinders, pistons, crank cases, etc.

AT the first ordinary meeting of the Refractory Materials Section of the Ceramic Society, held at Leeds University, it was stated that the remarkable properties of zirconia make it an admirable refractory. Even the natural crude zirconia is well adapted for use in electrical furnaces and in other cases where exceptionally strong heat has to be resisted. In Germany it was

used for various purposes, and before the war was sold at prices ranging from about 31*l.* to about 50*l.* per ton, according to the degree of purity. Podszus proposes to make refractory ware of fused zirconia, burning at 2300°–2400° C. in a furnace made chiefly of fused zirconia, using coal-gas, petroleum, or acetylene, first with air-blast and finally with oxygen-blast. Ruff and Lauschke found the melting point of pure zirconia to be 2563° ± 10° C., and that addition of small proportions of alumina (1 per cent.), thoria (1 per cent.), or yttria (1 to 3 per cent.) was beneficial when burning zirconia up to 2000°, 2200°, or 2400° C. respectively. Dr. J. W. Mellor ascribed the spalling of magnesite bricks to two main causes: the shrinkage resulting from the change of calcined magnesite from a form having a lower specific gravity to a form with a higher specific gravity, and the shrinkage caused by the closing of the pores on heating. The feasibility of setting up a definite standard was asserted. Prof. J. W. Cobb, referring to methods of control for the temperature-time-atmosphere effects, said he had found it necessary to make Seger cones considerably larger, so that they might be easily visible in position and better able to withstand accidental heat-waves. He also found it advantageous to modify the shape, so as to give an edge instead of a point above. He hoped that now they are being made in England their disadvantages will not be perpetuated.

THE death of Mr. Baldwin Latham at the advanced age of eighty removes a notable link with the engineering profession in Victorian days. A generation ago Mr. Latham was in the forefront of practising civil engineers, and was widely known and respected as an authority on all matters connected with the science of sanitation. He was twice president of the Royal Meteorological Society and president of several other scientific societies, as well as twice Master of the Playing Card Makers' Company. His book on sanitary engineering, first published in 1873, speedily obtained recognition as a standard work, and was awarded a diploma of honour at the Health Exhibition of 1884. In the course of his practice, Mr. Latham was commissioned to prepare a great number of reports on schemes of water supply and sanitation for various localities. In Great Britain he actually carried into execution more than one hundred such works, in addition to advising on a great many more. Abroad, he designed and constructed water-supply and sewage-disposal works for Calcutta, Bombay, Ahmedabad, and other Indian cities, and he also prepared a scheme for Cairo. He was a great authority on underground water, and carried out extensive hydro-geological surveys. By the knowledge he acquired, he was enabled to forecast the outbreaks of the Croydon Bourne, which in some years flows down the Caterham Valley.

BY the death on March 3 of Mr. A. E. Gibbs, at fifty-eight years of age, St. Albans has lost one of its most esteemed citizens, and science an able and assiduous naturalist. Although engaged in business as a printer and part proprietor of the *Herts Advertiser* and the *Luton News*, Mr. Gibbs took an active part in all local educational matters, having been honorary secretary of the School of Science and Art, a member of the Education and Public Library Committees, and one of the founders of the new High School for Girls, and also of the Hertfordshire County Museum, of which he was a secretary and the curator of the natural history and numismatic collections, to each of which, and also to the archæological collection, he contributed largely. Commencing his scientific studies with geology, he early turned his attention to botany, especially cryptogamic, but lately he had chiefly devoted his energies to entomology, collecting Lepidoptera and other insects, not only in this country, but also on the continent of Europe and in northern Africa. He was a fellow of the Linnean, Zoological, Entomological, and Royal Horticultural Societies, and when he died was near the end of his two years' term of office as president of the Hertfordshire Natural History Society, his last publication, one of many papers he contributed to the society, being a presidential address on the "Satyrid Butterflies of Hertfordshire," illustrated by a coloured plate of *Pararge aegeria* and its varieties.

IT is with deep regret that we record the death, at the age of seventy-one, of Charles Achille Muntz, the distinguished French agricultural chemist, who was well known for his investigations on air, soil, and agricultural products generally. Muntz was of Alsatian birth, and began his scientific career as "préparateur" for Boussingault at the Conservatoire des Arts-et-Métiers, by whom he was attracted to agricultural chemistry. His first important work was done in connection with Schloessing in 1878, and formed a simple yet striking investigation, which at once attracted world-wide attention and has since led to remarkable developments. It had long been known that nitrates are formed in soil from nitrogenous organic compounds, and the reaction was proved to be of the highest agricultural importance. But the mechanism of the change was unknown; neither chemical nor physical causes seemed to account for it, and no other agent was suspected. Schloessing and Muntz began by measuring the amount of nitrification taking place when dilute sewage was allowed to trickle down a tube packed with chalk; they found that no action occurred for twenty-one days, but then it suddenly set in. Why, they asked, was this delay? If the process were chemical or physical, it should set in at once; the only explanation appeared to be that it was biological, the period of delay being the time needed for the multiplication of the organisms. This hypothesis was tested by adding a little chloroform; the process at once stopped; it was started again, however, when the chloroform was removed and some soil extract added. Although Muntz did not proceed further with the work, others took it up, and it led to the establishment of a new branch of science—soil bacteriology. Some years afterwards he showed how nitrification might be intensified so as to give a commercial source of nitrate if necessary; but subsequent electrical developments have probably displaced biological methods on the large scale. His other investigations, if they attracted less attention, were no less meritorious; he did good work on the chemistry of the atmosphere, determining its content of ammonia and nitric acid, and demonstrating also the presence of alcohol. His other chemical work dealt with mannite and other sugars, and with the nutrition of animals; finally, mention must be made of his admirable book on manures.

IN the March issue of *Man* Prof. C. G. Seligman discusses a series of canoe prow ornaments from Netherlands New Guinea. The occurrence of representations of birds in these carvings suggests that the natives of this region may have totem birds. It is remarkable that ornaments of this type do not seem to occur in British New Guinea west of Cape Nelson promontory. The suggestion is made that the Humboldt Bay ornaments represent the more archaic form which became modified in the Massim area by the influence of a foreign culture, Polynesian or Melanesian, of which there is abundant evidence in that district. "In other words, while the basic idea of the ornament remained unaltered, a people

who may almost be said to have 'seen' in curves (if not in spirals) succeeded in imposing their idea of representation upon the simpler animal forms of the folk with whom they mixed."

THE Journal of the Royal Society of Antiquarians of Ireland (vol. xlvi., part ii., for December, 1916) contains two important contributions on Irish antiquities. Mr. T. J. Westropp continues his survey of ancient forts and dolmens in western Ireland with an account of those in Inagh and Killeimer, County Clare, in which a number of hitherto unknown buildings are described. Mr. J. P. Condon has carried out a similar survey of rude stone monuments in the northern portion of Cork County, in which he extends and brings up to date the catalogue of these erections made by Borlase in his "Dolmens of Ireland" and by other writers. Much destruction has taken place since the holdings have fallen into the hands of the peasant proprietary, and it is well that these interesting antiquities should be carefully described before it is too late.

THE *Psychological Bulletin* (vol. xiv., No. 1) contains an article by C. S. Berry on the effect of smoking on the speed and accuracy of adding figures. Each evening, half-an-hour after dinner, the writer added one hundred figures arranged in ten columns of ten figures each, the length of time taken to perform the operation being noted and also the number of errors. On alternate evenings he had smoked one cigar immediately before performing the test, and he kept records for twenty days. The results of the experiment, according to the author, are at variance with those of other investigators, giving, contrary to his expectation, an improvement of 7·7 per cent. in the time taken on the "smoking" days; the differences in the number of errors made were so slight as to be negligible. The author, however, does not say whether, prior to beginning the investigation, he had had sufficient experience of the test to have overcome the effect of practice, nor does he give the daily variations for a similar length of time under normal conditions. It is necessary to have had an extended series of normal records preceding a drug investigation before it can be confidently affirmed that the differences, if any, are true drug effects. Ordinary normal variations are surprisingly great for many tests, and particularly so for intellectual operations. The present article may serve, however, to stimulate further inquiry.

A CURIOUS human abnormality—the "Hereditary Absence of Phalanges through Five Generations"—is described by Dr. E. Cragg and Dr. H. Drinkwater in the *Journal of Genetics* for December (vol. vi., No. 2). This condition is more extreme than that known as "brachydactyly," since each digit—excepting the thumb and great toe—has only one phalanx and no nail. The deformity of the fingers behaves in some respects as a Mendelian dominant, but more than half the offspring in marriages between affected and normal persons are affected. The thumbs of these abnormal individuals are often flattened, and perhaps show a tendency to bifurcation.

THE New Zealand Defence Department has issued a practical pamphlet on fly-control in military camps, written by Prof. H. B. Kirk, of University College, Wellington. He has found that the breeding of flies in latrine-trenches may be stopped by ramming the earth hard; while spraying latrine-pans with light oil, or with a dilute solution of arsenic and sugar, kills very many flies. Wires coated with "tangle-foot" are found efficient for catching flies in rooms; vertical wires from a foot to three feet long are best, "suspended from a horizontal wire or from any chance support." An ingenious plan for trapping flies that may gain access to garbage-bins is described. Many ways of treating horse-dung for the destruction of maggots are suggested, such as spraying with 1 per cent. arsenical sheep-dip in sweetened water, or pegging tarpaulin or sacking along the base of stacks to prevent the insects from escaping.

IN view of the considerable extension of our arable area which is foreshadowed, the problem of the production and dissemination of improved varieties of agricultural seeds acquires still greater importance than has yet been attached to it in this country. According to a writer in the *Journal of the Board of Agriculture* (February, p. 1081), the introduction of "Plumage" barley alone has probably added at least 250,000*l.* to the value of the barley crop in this country. The lines upon which improvement must be carried out have now been fairly well defined, and the time would appear ripe for the development of a national organisation for the production and control of improved seed supplies. The writer of the article suggests that the desired end can only be secured by means of a Seed Control Agency, to be administered in association with the research institutes concerned with plant-breeding, and supported, if necessary, by the State. The agency should serve as a centre of distribution, not only of new and improved varieties of seeds, but also of guaranteed "pure" stocks of the established varieties of proved merit. A brief account is given of the work done on these lines and the results achieved, at Svalöf, in Sweden.

A GOOD representation of the weather for London is obtained from the Greenwich meteorological observations, and these also show generally the weather conditions over England. The long series of observations affords a trustworthy comparison with past years. Observations for the past winter, December to February, are taken from the results published in the daily weather reports of the Meteorological Office. The mean temperature for each of the three months was below the average, the greatest deficiency being 4·6° Fahr. in February, and the mean for the whole winter was 3·4° below the normal. The mean winter temperature, 35·9°, was 7° colder than the preceding winter, 1915–16, and was the coldest winter since 1894–95, when the mean was 35·1°, and the lowest in the last seventy-five years was 34·3° in 1890–91. Frost occurred in the shade on fifty-two nights during the three months, the occurrences being respectively 18, 19, and 15. Frost also occurred during the latter half of November, and it is occurring occasionally during the present month. The aggregate rainfall was less than the normal; the total measurement was 4·49 in., which is 86 per cent. of the average fall for the last sixty years. December was the only month with an excess of rain, and in all there were forty-eight days with rain. The duration of bright sunshine was 63 per cent. of the average, and there were forty-eight sunless days in the three months, comprising in all ninety days.

THE Transactions of the Optical Society of London for the session 1915–16 extends to more than 300 pages, twelve of which are occupied by subject and name indexes to the sixteen volumes of Transactions which have now appeared. One of the most valuable papers in the volume is that of Dr. Boswell on the properties which sand must possess to be suitable for glass making, and especially for optical glass making. By an examination of the optical glass sands of Fontainebleau and of Lippe he finds that the ideal sand for the purpose should consist of 100 per cent. silica, be practically free from iron, organic and clayey matter, and be in angular grains of the same size,

unless the melting-pots are arranged for stirring. There are no sand beds at present known in this country from which sand for optical glass making can be obtained of such uniformity and at so low a cost as that from Fontainebleau. There are, however, large supplies of sand suitable for good flint glass, laboratory glass, table ware, plate glass, etc. Dr. Boswell points out that the whitest and best sand is almost invariably found associated with carbonaceous matter and often in the coal measures.

A USEFUL contribution to our knowledge of alternating stress is contained in a paper read at the Institution of Mechanical Engineers on February 16 by Dr. William Mason, of Liverpool University. The machine used in the experiments was designed by the author so as to be capable of applying repeated torsion, or bending, or repeated torsion and bending simultaneously. It is a slow-speed machine, and most of the work was carried out at frequencies either less than, or very little exceeding, 200 cycles per minute. This plan has several advantages to recommend it. Typical curves were obtained showing how the cyclical range of strain varies with the range of stress and with the number of cycles endured. The material used was a dead mild steel. The range of stress under which the elasticity became impaired was always fairly definite. It was also found that a large number of repetitions were endured at ranges of stress that induced considerable ranges of extra-elastic strain. It is probable that the range of stress that would cause fracture in, say, 100 million cycles will be nearer in amount to the range that actually produced fracture in 1 to 5 million cycles than to the range of stress that brought departure from the elastic condition. The calculated ranges of stress at which cracking occurred were found to be greater for solid than for hollow test-pieces. The effect of giving rest to a specimen in which an extra-elastic range of strain has developed is to reduce the range of the strain; the effect appears to be similar to that of hardening after strain, and not to be of the nature of recovery of elasticity. No real adjustment of elastic limits (with equal + and − stresses) was observed. There appears to be a marked variation, with frequency of repetition of cycle, of the physical state of mild steel subjected to repetition of a higher range of stress than that consistent with unimpaired elasticity, the mobility being greater with higher frequency. For the quality of mild steel used, the range of induced maximum shear stress, at which the elasticity becomes impaired, is sensibly the same in both alternating torsion and alternating bending, thus showing agreement with Guest's criterion of elastic failure.

MESSRS. JOHN WHELDON AND CO., 38 Great Queen Street, W.C.2, have just issued a catalogue (New Series, No. 78) of second-hand books dealing with chemistry which should be of service to many readers of NATURE. It comprises the library of the late Dr. Hugo Muller, and is particularly rich in German works. Complete sets of the *Chemical Gazette*, the *Chemist, Chemical News* (to 1916), Journal, Proceedings, and Annual Reports of the Chemical Society of London (to 1916), the *Technologist*, and the Journal of the Royal Society of Arts (to 1913) are offered for sale.

THE following volumes are in preparation for appearance in the "Cambridge Psychological Library" (*Cambridge University Press*):—Psychology, Prof. J. Ward; The Nervous System, Prof. C. S. Sherrington; The Structure of the Nervous System and the Sense Organs, Prof. G. Elliot Smith; Prolegomena to Psychology, Prof. G. Dawes Hicks; Psychology in Relation to Theory of Knowledge, Prof. G. F. Stout; Mental Measurement, Dr. W. Brown; The Psychology of Mental Differences, C. Burt; Collective Psychology, W. McDougall; The Psychology of Personality and Suggestion, Dr. T. W. Mitchell; and The Psychology of Dreams, T. H. Pear.

OUR ASTRONOMICAL COLUMN.

COMETS 1915*a* AND 1916*b*.—The following continued ephemeris of comet 1915*a* (Mellish), calculated for Greenwich mean midnight by Mlle. J. Vinter-Hansen, has been circulated by Prof. Strömgren:—

1917	R.A.	Decl.	Log r	Log Δ
	h. m. s.	° ′		
Mar. 22	4 59 26	+41 25·0	0·8502	0·8597
26	5 0 43	22·1		
30	2 10	19·5	0·8543	0·8710
Apr. 3	3 44	17·5		
7	5 5 26	+41 15·9	0·8584	0·8816

During the above period the path of the comet is in Auriga.

Prof. Strömgren also reports an observation of comet 1916*b* (Wolf), made at Copenhagen with the 14-in. equatorial on March 1. The comet is described as being very faint, and the corrections to the ephemeris were −56s., +3′.

The following continued ephemeris is given by Dr. Crommelin in the February number of the *Observatory*:—

1917	R.A.	Decl.	Log r	Log Δ	Brightness
	h. m. s.	° ′			
Mar. 22	18 56 26	+2 8	0·3063	0·2989	28
26	19 5 59	3 2			
30	15 36	3 59	0·2946	0·2751	33
Apr. 3	25 16	4 58			
7	35 1	6 0	0·2833	0·2517	39
11	44 50	7 3			
15	19 54 43	8 9	0·2725	0·2291	45
19	20 4 40	9 16			
23	14 41	10 24	0·2622	0·2074	53
27	20 24 46	+11 34			

The brightness on April 3, 1916, is taken as unity, and no allowance is made for physical causes of brightening. It is expected that the comet will become bright enough to be visible to the naked eye during June and July.

THE SUN-SPOT ZONES.—The results of an examination of the latitudes of sun-spots, as recorded in the Greenwich observations for the period 1879 to 1911, have been given by H. Arctowski (*Mem. Soc. Spett. Ital.*, February, 1917). As in the previous discussions by Mr. Maunder and Dr. Lockyer, he finds that the curve showing the variation of latitude during an 11-year cycle does not fall continuously from high to low latitude, but has several subsidiary maxima and minima. The phase of the cycle is shown to be different in different zones. Thus, in the period 1889–1903, the maximum frequency of spots in the zones 20° to 30° occurred in 1892; in the zones 20° to 10° it occurred in 1893; and in the zone +10° to −10° in 1894. Spots ceased to be visible in the first of these zones in 1896, in the second they remained until 1901, while in the third they did not appear until 1891 and persisted to 1903, two years after the new cycle had begun. The curves suggest that there is a superposition of a number of distinct variations, of which the principal corresponds to the simplified Spörer's curve and extends throughout the cycle, while some persist only a few years, and others may be of very short duration. The variation would thus appear to proceed by a succession of impulses.

A GROUP OF FOSSIL PLANTS.[1]

THE publication of Mr. Wieland's first volume in 1906 was an event of great importance which had a wide influence on botanical research. The author gave an account of the floral and vegetative morphology of several species of Cycadeoidea, a genus represented in Upper Jurassic and Lower Cretaceous strata in many parts of the world, but nowhere on so large a scale as in the United States, where hundreds of well-preserved trunks have been found. Though agreeing generally in habit and in most anatomical features with recent Cycads, Cycadeoidea is characterised by reproductive shoots of a type far removed from that of the existing members of the Cycadaceæ. The work accomplished by European investigators since Wieland's first volume was published is summarised in the present volume, which also contains many new facts and amplifies the earlier descriptions; it also includes some account of the author's Mexican expedition in 1909–10, which yielded a rich harvest of Liassic Cycadean fossils. Incidentally Mr. Wieland emphasises the importance of personal observation in the field, and gives salutary advice to many of us who have neglected this part of a palæobotanist's duties. He directs attention to the short-sighted policy of some museum authorities in refusing to allow their specimens to be disfigured by the lapidary's wheel.

The American Cycads are divided into groups in part geographical and in part morphological, and each set of forms is critically discussed from a taxonomic point of view. The Maryland stems agree closely with the English specimens described by Buckland from Portland, and British students are reminded that they have not fully investigated their own material. Two of the most interesting species described and beautifully illustrated are *Cycadeoidea colosallis* and *C. Dartoni*, the latter founded on a portion of a trunk bearing 500 to 600 strobili, most of which contain well-preserved seeds and embryos. A chapter on the seeds of Cycadeoidea is especially interesting; in it the author develops more fully his views on the evolutionary history of seeds as represented more particularly by those of the Bennettitales. The structure of the American seeds agrees in essentials with that of European types, the most complete account of which we owe to the late Prof. Lignier. Wieland institutes comparisons between the Mesozoic Cycadean seeds and several Palæozoic genera, such as Lagenostoma, Conostoma, and others, and in the course of the discussion he gives a summary of recent work on the older seeds. He suggests that the genus Codonotheca, usually regarded as the male flower of some Pteridosperm, may be a bisporangiate shoot, which originally contained a central seed, though there is no definite evidence of this, surrounded by a whorl of microsporophylls. His contention is that the complex seed-coats of Palæozoic and later types are the result of sterilisation and fusion of encircling leaves or sporophylls round a central spore; in other words, he interprets the elaborate seed-coats as reduced foliage-organs which have become intimately associated with a megaspore. It is, however, noteworthy that the bisporangiate flowers of such a type as *Cycadeoidea colosallis* are apparently more primitive than the much older Palæozoic seeds, which show no trace of any encircling whorl of leafy organs.

In a chapter on Cycad derivatives Wieland ranges over a wide field, but without committing himself definitely to any clearly defined view on the question of a relationship between the Angiosperms and the Cycadean stock. He holds that the columnar, and often unbranched, stems characteristic of the great majority of the Cycadeoideas are an unusual type derived from a much more slender and freely branched ancestral form. Comparisons are made between the Magnoliaceæ and the Bennettitales, and reference is made to opinions on the evolution of the Conifers, the position of the Gnetales, and other questions. His survey of the fossil Cycads leads to the conclusion that the true Cycads were probably never more abundantly represented than they are to-day: they were preceded by the Cycadeoidea type, a comparatively stereotyped form, and at an earlier stage the Williamsonia group occupied the dominant position, a group exhibiting a much greater range in the form of flower and stem. Some account is given of Cycadean foliage from Mesozoic strata, and of the rise and decline of the Cycad element in Mesozoic floras from the Rhætic to the early Cretaceous period, when the Angiosperms assumed the leading *rôle*.

Mr. Wieland's second volume is a contribution of considerable importance by an author who has well earned the right to speak with authority on a subject of exceptional interest; but after reading the long theoretical discussions, which are suggestive, though the conclusions are often open to question, one regrets that more attention was not paid to the elucidation of several morphological problems that are still unsolved, and on which the splendid American material can undoubtedly throw much light. The author is an enthusiast with a vivid imagination, and does not always fully appreciate the difficulties of the problems before him; his desire to solve the mysteries of the early stages in plant-evolution leads him into deep waters of speculation, and his points are not always easy to grasp owing to a diffuse style and the lack of concise summaries of conclusions. The photographic plates are probably the most striking illustrations of fossil plants ever published, and the student owes a debt of gratitude, not only to the author, but also to the officials of the Carnegie Institution.

A. C. SEWARD.

[1] "American Fossil Cycads." Vol. ii., "Taxonomy." By G. R. Wieland. Pp. 1–267+plates i–lviii. (Published by the Carnegie Institution of Washington, 1916.)

METEOROLOGY AND THE SOLAR CONSTANT.

THE Journal of the Scottish Meteorological Society (No. xxxiii.), recently issued, contains, as usual, some very interesting articles.

Lieut. Douglas, Royal Flying Corps, gives some details of his experience during his ascents amongst the clouds in northern France. He finds stratus cloud most frequently in anticyclones and round their eastern and northern borders. The top in such cases is very flat and even, and an inversion of temperature is met with at the upper surface. The lowest temperature is generally at the top of the cloud, but is occasionally met with a little lower. If cumuli attain sufficient height they develop into thunderstorms, but at least 6000 ft. from top to bottom is required for this to happen, and on all occasions in 1916 when thunder developed, the height was not less than 10,000 ft. Mr. Douglas states that cirrus and cirro-stratus almost certainly consist of thin snow.

Dr. Knott discusses the value of the solar constant and the associated problems, giving chiefly a summary of the work of Abbott and Fowle and Anders Ångström. He explains very lucidly the method devised by Langley, by which the error caused in determining the constant by the selective absorption and radiation of the air is overcome. The values obtained for the constant range from 1·97 at Washington to 1·92 at Mount Whitney (14,500 ft.), the mean of 573 observations at Mount Wilson (5670 ft.) gives 1·93, and Dr. Knott considers that we may take these results as correct, so that the solar constant is very nearly 2 gram-calories per cm.^{2} per minute. This is

equivalent to an average of 0·5 g.-c. per cm.^{2} per minute received at the outer surface of the atmosphere over the whole earth.

Out of the radiation received Abbott and Fowle consider that 37 per cent. is reflected, chiefly by the air and clouds, and to a small extent by the earth. The figures they give are that out of the whole radiation reaching the outer limit of the atmosphere 52 per cent. reaches the level of Mount Wilson and 24 per cent. the surface of the earth.

The experiments of Ångström were on what he calls the effective radiation of the earth—that is to say, the whole radiation from the surface less the back radiation from the air. The returned radiation from the air depends on the amount of water vapour present, and since this increases with increasing temperature, the effective radiation is found to increase slightly with decreasing temperature. Ångström also states that dry air will radiate with half the radiation of a black body.

The other articles are on the underground drainage of the upper part of the Dee Basin, by Dr. John Horn, and on the distribution of cloud and rain with reference to the centre of a cyclonic depression, by Sir Napier Shaw. The latter contains four very interesting illustrations showing the average distribution in four well-defined storms that passed over the British Isles at various dates The areas of rain and also of cloud lie on the whole in front of the centre, but have not any very definite shape. The author remarks that "even in well-marked depressions convection is a local phenomenon."

The usual meteorological tables for Scotland for 1915 complete the volume.

SCIENCE AND MODERN LANGUAGES IN CIVIL SERVICE EXAMINATIONS.

IT is a matter of common knowledge that the country is largely governed by men who enter the Civil Service as first-class clerks, since from these men the principal permanent officials are so frequently chosen. Attention has been directed to the fact that nearly all these positions are filled by persons whose main educational qualifications are a considerable knowledge of Latin and Greek.

In reply to this, the defenders of the system pointed out that in 1913 the first and third places in the examination were taken by students of science, and that in 1914 the second place was gained by a science man.

But these figures are most deceptive, as the following statistics will show. In 1913 sixteen vacancies were announced. Of the first sixteen candidates, twelve took Latin and Greek, and all of these Greek history and Roman history; only four took mathematics and science; only two took French—one evidently as a make-weight, since he did not get enough marks to enable him to count the subject; none took Italian or German. Of the two who took French, one secured 254 marks out of a total of 2320, and another no marks out of a total of 2344.

The men who gained the first sixteen places secured marks as follows:—

Greek	6,250
Latin	5,817
Greek history	3,580
Roman history	3,673
	19,320

Greek history and Roman history are counted in with Greek and Latin because, as can be seen by the papers, nearly all the questions can be answered by anyone who has made a careful study of Greek and Latin literature in which the history of the two nations is embedded.

The same sixteen candidates secured the following total marks for the subjects mentioned:—

Mathematics	6,707
Natural science	3,491
French	254
Italian	0
German	0
	10,452

In other words, mathematics and science and modern languages secured much less between them than classics.

In 1914 nine vacancies were announced; of the candidates who took the first nine places, seven took both Greek and Latin, and of those, six took both Greek and Roman history; only two took mathematics with some science, and only two took French; none took Italian or German. The two who took French scored for this language 417 marks out of a total of 3876 and 321 out of a total of 3094 respectively. The two who took science scored respectively 859 marks out of a total of 3528 and 561 out of a total of 3408.

The men who gained the first nine places secured marks as follows:—

Greek	3,453
Latin	4,528
Greek history	1,745
Roman history	1,834
	11,560

The same nine candidates secured the following total marks for the subjects mentioned:—

Mathematics	3,901
Natural science	1,401
French	738
Italian	0
German	0
	6,040

It will be seen that the candidate who studies anything but Latin or Greek has a comparatively small chance of success in the examination; the result is that the country is largely governed by persons who, for the most part, have little knowledge of, or sympathy with, scientific method, and who are frequently unwilling to accept scientific advice; many of the appalling mistakes made at the beginning of the war were due to this.

Another result of the present system of examination, which allots an altogether disproportionate number of marks to Latin and Greek as compared with science and modern languages, is that the higher posts in the Civil Service are practically closed to persons who have not been educated at either Oxford or Cambridge. In 1913 and 1914 forty first-class clerks were selected; of these, twenty-five came from Oxford; ten from Cambridge; one from the University of London; one from a Scotch university; two from Irish universities; *and none from all the provincial universities in England and Wales combined!*

Everyone would regret if the higher posts in the Civil Service were not recruited largely from Oxford and Cambridge; but it is ridiculous to suppose that all the provincial universities combined were incapable of producing, during the last two years before the war, a single person worthy thus to serve the State. Men from the modern universities have little chance of success, since the endowments for higher classical teaching are largely concentrated on the banks of the Isis and the Cam.

J. WERTHEIMER.

THE VALUE OF RESEARCH IN SCIENCE.[1]

SCIENCE of some sort is now being very widely taught at all stages of education, and so far from its progress being impeded as used to be the case by disadvantages of a public kind, most Governments are more or less alive to the importance of devoting public funds in furtherance of scientific work, and almost every honours list now contains the names of men distinguished in science. In India the various Governments have made a very fair beginning in the matter of funds.

It is impossible, and would be of little value for our purposes, to estimate the amount devoted to scientific teaching in schools and colleges by the various education departments. I have, however, endeavoured, with the kind assistance of the Hon. Mr. Davidson and the Financial Department of the Government of Madras, to form some idea of the amount being spent upon original research and other higher scientific work throughout India.

On the nature and essence of "research" I propose to offer a few observations later on, but it is not without interest to note at this point the connections in which the word occurs in the various Budget estimates. The Government of India supports a Forest Research Institute and College at Dehra Dun, and devotes about 4 lakhs a year to it; it contributes 5 lakhs a year to the Indian Research Fund, about 5½ lakhs to the Agricultural Research Institute at Pusa, and a lakh to the Central Research Institute at Kasauli.

Some of the local Governments have entertained, or propose to entertain, what they call in the Budget forest research officers. The Agricultural College in the Madras Presidency has for part of its title that of Research Institute. The Government of Bengal gives research scholarships. The Punjab Government enters a small portion of its contribution to Government colleges as research grant. In Burma a small sum is devoted to what are called leprosy researches.

The Budgets, however, provide for many other forms of scientific activity in connection with which the word "research" does not happen to have been used, such as: further experimental work in connection with agriculture, bacteriological work as affecting man and animals, other investigations of a medical nature, and work relating to fisheries and other industries.

Further, various Governments support museums, in some of which, at any rate, scientific work is carried on, and our institute here at Bangalore receives an annual grant of Rs.87,500 from the Government of India, which has promised, should any private individual be willing to subscribe, to provide a like amount so long as its total grant does not exceed Rs. 1,50,000.

There are also the various Imperial surveys; in some of these the expenditure must, of course, be mainly debited to administrative work, but in the majority of them the funds do something towards the progress of science.

Without taking the surveys into account, the annual expenditure from public funds on scientific work in British India is somewhere in the neighbourhood of Rs.70–80 lakhs—that is to say, 500,000*l*.—and to this must, of course, be added large capital sums invested in buildings. This expenditure is supplemented to some extent by the more progressive of the native States, including, I need scarcely say, the State in which we have the pleasure to be at present. Lastly, private sources have contributed, but to a lamentably small extent. In this last respect there have been a few striking exceptions, and perhaps the foremost of these was the projected gift of the late Mr. Tata, to the carrying out of which by his sons our institute owes its existence.

Now I propose to deal with the question of research. Research is often alluded to as a perfectly simple operation; one even hears of men being "taught to research"; newspapers speak of it in the lightest manner, whereas in even my student days it was spoken of with almost bated breath as indicating something to which only the best of us could look forward, something which few of us were ever likely to carry on with any hope of success.

It is probably impossible to find a classification of research work devoid of considerable overlapping, and in many cases the motives are undoubtedly mixed, but it seems possible to recognise three classes: that carried on with the single purpose of ascertaining the truth in regard to the causes of things; that which has for its immediate object a specific utilitarian purpose, but still without any expectation whatever of a pecuniarily remunerative result; and research with the avowed object of making money out of it sooner or later.

The first and second classes would come under the head of scientific research in the sense in which the term is used by the Privy Council Department of Scientific and Industrial Research, while the third class is industrial research; but what I want to emphasise is the fact that the first class alone is research in pure science, while the second and third classes are both research in applied science—that is, science put to practical use; practical as distinguished from abstract or theoretical.

Huxley said that what people call applied science is nothing but the application of pure science to particular problems. The Advisory Council says that this no doubt is so; there are not two different kinds of science; at the same time it realises that it has to deal with the practical business world, in the eyes of which a real distinction seems to exist between pure and applied science. There are, however, men in the business world who see more clearly. An American manufacturer pointed out only the other day that "there are no sharp lines to separate pure from applied, scientific from practical, useful from useless. If one attempts to divide past research in such a manner he finds that time entirely rubs out the lines of demarcation."

But whatever terms have been used, the application of scientific knowledge for the good of mankind is as old as that knowledge itself, and one may safely say that the majority of those who have attempted this application have not been swayed by any pecuniary motive. The scientific agriculturist is not in most cases the person into whose pockets comes the money secured by the use of better methods. Medical science in all its branches is applied science, and although the doctor may earn his living by means of fees, medical research is not undertaken from pecuniary motives. It has been for the most part the application to a particular problem of the scientific knowledge of the day, and there has, of course, been no such application with a more noble purpose. Still, it is not pure science, and there have often been medical men who have left further application to others, while they have reverted to purely scientific problems.

What utilitarian research would have discovered the fundamental facts in regard to electricity or have led to the framing of the atomic theory? Who can say how many profound truths await discovery because some utilitarian who happened upon a glimmering of them did not think it worth while to pause and investigate the apparently irrelevant?

[1] From the presidential address delivered before the Indian Science Congress, Bangalore, January, 1917, by Sir Alfred Gibbs Bourne, F.R.S., K.C.I.E.

How much research has been undertaken by the student of pure science which he would have frankly admitted to be apparently useless? How much patient work and loving care have been bestowed upon investigations seemingly impossible of application to any of the specific problems of the day? Upon research of this kind no utilitarian would have been at all likely to embark, yet sooner or later such research has either proved capable of direct application or—and this has more often been the case—has unexpectedly formed a corner-stone, or occupied a more humble but still useful position, in building up some far-reaching generalisation capable of being seized upon at once by the worker in applied science, thus in turn perhaps stimulating further scientific research.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The subject proposed for the Adams prize essay for the period 1917–18 is "The Diffraction of Sound Waves." The solution of a typical problem or problems, such as that of diffraction by a circular or rectilinear aperture in a plane screen or by a circular disc, is desired free from approximations or restriction to relatively long waves. Treatment of the corresponding problems in electric waves is also suggested.

The question of compulsory Greek in the Previous examination has been very prominent during the present term. The case for the abolition of compulsory Greek has advanced greatly since 1905, when it was put to the vote and defeated. A syndicate appointed in 1913 to consider the regulations for the Previous examination reported that it was unable to recommend that Greek should continue to be a compulsory subject, and a new scheme was drawn up for the examination in which Greek was made alternative to French or German. Had it not been for the outbreak of war, this reform would probably by this time have become an accomplished fact, but, as it was, the discussion of the report was delayed until last year, and afterwards the syndicate expressed the opinion that it was inexpedient to bring the scheme before the Senate while so many members of the Senate were absent on war service.

Early in the present term the council of the Senate issued a report on the subject. The council agreed that it was inadvisable to proceed at once with the whole question of the reform of the Previous examination, since this should be considered together with the considerable modification and reconstruction of the educational system of the University which was likely to take place after the war; but it held that the question of Greek was of practical urgency at the present time, and it was of opinion that, as a temporary provision, the papers at present set in French and German (which are easier than those proposed by the syndicate) should be alternative to Greek. However, the council had ascertained that if a discussion were held and a vote taken in the existing circumstances, it would be greatly resented by some members of the Senate absent on war service, and it had accordingly decided not to take action at the present time. This aroused widespread disappointment in the University, and a memorial bearing a long and influential list of signatures was presented to the council asking it to reconsider its decision. A counter-memorial was presented; strong protests were also issued by a small number of residents now engaged on war service in various Government offices. The result has been that the council adheres to its decision to take no action at present, but the constitution of the Previous examination is to be considered further, so that it may be possible to take action immediately upon the conclusion of the war.

THE third conference of the Committee for the Development of Regional Survey will be held at Newbury on April 7–17, and it is proposed to make a detailed study of the town and region. No formal classes will be held or lectures given, but there will be daily conferences for the purposes of study. The committee hopes that sufficient workers will be able to attend the conference to make all aspects of the regional survey possible, physical, historical, and social. Members are asked to communicate with the hon. local secretary, Kingsbridge Road, Newbury.

THE governors of the Imperial College of Science and Technology have recently considered the conditions to be fulfilled in the case of students of the Royal School of Mines whose associateship courses of study have been interrupted by their undertaking service with the Forces of the Crown or other approved war-work, precedent to the award to them of the diploma of associateship of the Royal School of Mines in Mining or in Metallurgy or in Oil Technology. Instead of insisting upon the full four-year course, the opportunity is offered for a student to complete in three years the tests ordinarily imposed, having regard to experience gained during the war, and, in that case, the reduction is contemplated of the requirement as regards practical work (shifts) by one-third, and the possibility of a man making good in certain arrears of subjects during vacations, but it is considered inadvisable to make any curtailment of the work of the first and second years.

AT a representative and largely attended conference of examining bodies in Great Britain held on March 15 at the Board of Education under the presidency of Mr. A. T. Davies, chairman of the British Prisoners of War Book Scheme (Educational), it was unanimously decided, on the motion of Sir Edward Busk (University of London), to approve certain proposals for the encouragement and recognition of the studies pursued by prisoners during their internment. Steps are being taken to give effect to these proposals, and various examining bodies (including most of the universities) have already intimated their willingness to recognise work done and examinations passed in the camps, and to extend to the men on their return facilities for sitting for examinations under conditions which will take account both of their special circumstances and their needs. A message was read from the President of the Board of Education in which Mr. Fisher expressed sympathy with the objects of the conference and his belief that the result of its efforts would prove a great encouragement to the men to use wisely and well the time of their captivity, and, further, would be of material assistance to them on their return to this country. It is intended that the decision arrived at shall be communicated, as soon as possible, as "a message of encouragement and hope" to the various internment camps in enemy and neutral countries. In the meantime it was suggested that friends and relatives of student prisoners might do them a service if, when writing to them, they will direct their attention to the steps in this connection which are being taken on their behalf.

THE issue of the Journal of the Royal Society of Arts for March 9 contains a paper on "German Methods" by Mr. J. H. Vickery, read before the society on March 7. In it Mr. Vickery deals, among other matters, with German education and science. He points out that it is the habit of the Germans to refer to the English as being a "practical" people. But he urges that, in point of fact, the German has

been much more practical in the matter of turning scientific knowledge to account. "With all his boasted idealism he has long since ceased to follow scientific research purely and solely for the love of the thing." He "has been taught that if science possesses any practical value it would be an unpardonable violation of an economic law to allow that value to go unexploited. As a result the university and Government laboratories are closely linked up with the factories and workshops of the nation." Scientific achievement both in theory and in practice receives higher recognition in Germany than in any other country. That commercial and industrial use is made of the achievements of science has not lowered the tone of the German man of science, but has raised the tone of German industries. In Germany, says Mr. Vickery, "not merely one man as a voice crying in the wilderness, but a thousand voices, from the Kaiser downwards, have been crying in chorus—*Think scientifically, act scientifically.*" There is no need, he thinks, for us to copy German methods, for if we once recognise the underlying truths of scientific development, both in theory and in practice, we shall be able to work out the methods of fruitfully applying the discoveries of science.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 8.—Sir J. J. Thomson, president, in the chair.—W. B. **Bottomley**: Some effects of growth-promoting substances (auximones) on the growth of *Lemna minor* in culture solutions. 1. Raw peat, when further decomposed by means of aerobic soil organisms—"bacterised peat"—is found to contain certain growth-promoting substances (auximones). 2. *Lemna minor* plants cannot maintain growth for any length of time in culture solutions containing only mineral nutrients. 3. The presence of soluble organic matter is essential for complete growth. 4. The addition to the mineral culture solution of 368 parts per million of organic matter from the water extract of bacterised peat resulted, after six weeks, in a multiplication of the number to 20 times, and an increase in weight to 62 times, that of the control plants. The water extract free from humic acid, representing an addition of 97 parts of organic matter per million, gave $9\frac{1}{2}$ times the number and 29 times the weight; 32 parts per million from the alcoholic extract gave $3\frac{1}{3}$ times the number and $7\frac{1}{3}$ times the weight; 13 parts per million from the phosphotungstic fraction gave $1\frac{1}{2}$ times the number and $2\frac{1}{2}$ times the weight. 5. The effect of the reduction in amount of auximones with successive fractionation of the bacterised peat was also manifest from the general appearance of the plants. Those in mineral nutrients only, decreased in size week by week, and became very unhealthy in appearance, whilst there was a progressive improvement in the appearance of the plants supplied with increasing amounts of auximones. Those receiving the larger amounts retained their normal healthy appearance throughout the experiment and increased in size. 6. The beneficial effect of the auximones was not due to a neutralisation of the toxic substances present in the ordinary distilled water, since comparable results were obtained with conductivity water. 7. An interchange of culture solutions, with and without auximones, showed that the plants are very sensitive to the presence or absence of these substances. —Florence A. **Mockeridge**: Some effects of growth-promoting substances (auximones) on the soil organisms concerned in the nitrogen cycle. This investigation deals with the effect of bacterised peat and the various auximone-fractions obtained from it upon the four chief groups of soil bacteria concerned in the nitrogen cycle, *in situ*, and in liquid culture. The addition of bacterised peat to soil increased the rate of nitrogen fixation quite independently of any bacteria contained in the material. This increase was not due to aeration, nor could it be brought about by chemically treated peat. Experiments in liquid culture showed that a water extract of this material greatly increased the nitrogen fixation of Azotobacter and of *Bacillus radicicola*. An alcoholic extract and the decomposed phosphotungstic acid and silver baryta fractions from it were also very effective. Similar results could not be obtained with chemically prepared soluble humus or with artificial humus. The accumulation of nitrate in soil containing bacterised peat was greater than that which could be accounted for by the soluble nitrogen which it contained, and took place more rapidly than in a similar soil provided with an equal amount of soluble nitrogen as ammonium sulphate. Since the water extract of the material was found to be directly nitrifiable, its effect upon the rate of nitrification was not tested, but the auximone-fractions, which were not nitrifiable, greatly increased the rate of nitrification of ammonium sulphate solutions. The auximone-fractions were without effect upon the rate of ammonification in soils and upon the ammoniacal fermentation of urea. The water extract had no effect upon the rate of denitrification, but the auximone-fractions directly inhibited the process. The work indicates that certain decomposition products of organic matter stimulate the activities of certain soil bacteria, and appear to play an important part in nitrogen metabolism.

Physical Society, February 9.—Prof. C. V. Boys, president, in the chair.—Dr. A. **Griffiths**: Note on the calculation of the coefficient of diffusion of a salt at a definite concentration. In the calculation of the coefficient of diffusion, by B. W. Clack, a simple relation is assumed between the density of a solution of a salt and the concentration. This simple relation is only approximately correct, and compromises are made which require justification. This note (1) suggests a method of calculating the coefficient of diffusion which, to a high degree of theoretical accuracy, gives values for the coefficient which are independent of a precise relationship between density and concentration; and (2) justifies the method of calculation adopted by B. W. Clack.—Dr. P. E. **Shaw** and C. **Hayes**: A special test on the gravitation temperature effect. In the Philosophical Transactions of the Royal Society, vol. ccxvi., pp. 349-92, there is a paper by one of the authors dealing with the possible existence of a temperature coefficient of the constant of gravitation. It was suggested in the discussion that the effect might be due to an inward displacement of the large lead spheres, at the higher temperatures, due to convection currents. In the present paper experiments are described in which this point is tested by micrometric measurements of the positions of the supporting wires. It is shown that, at the higher temperatures, there is a small *outward* displacement of the spheres, probably due to the expansion of the crosshead from which they are suspended. A slightly *higher* value has, therefore, to be given to the temperature coefficient of gravitation.

Geological Society, February 16.—Annual general meeting.—Dr. Alfred Harker, president, in the chair. —Dr. A. **Harker**: Anniversary address. Some aspects of igneous action in Britain, especially its relation to crustal stress and displacement. This relation appears not only in the distribution of igneous activity in time and space, in the succession of episodes, the habits of intrusions, etc., but also in the petrographi-

cal facies of the igneous rocks themselves. The cause of such relation was sought in the existence of extensive inter-crustal regions in a partially molten state: that is, with some interstitial fluid magma, which must normally be rich in alkaline silicates. There will be a continual displacement of the interstitial magma from places of greater stress to places of less stress, and certain broad differences in chemical composition are therefore to be expected between the igneous rocks of orogenic belts and those erupted in connection with gentle subsidence.

February 28.—Dr. Alfred Harker, president, in the chair.—Dr. A. **Smith Woodward**: Fourth note on the Piltdown gravel, with evidence of a second skull of *Eoanthropus dawsoni*. With an appendix on the form of the frontal pole of an endocranial cast of *Eoanthropus dawsoni* by Prof. G. **Elliot Smith**.—Excavations last summer round the margin of the gravel-pit at Piltdown (Sussex) supported the conclusion that the deposit is a varied shingle-bank, and that the three layers containing Palæolithic remains and derived Pliocene fossils are approximately of the same age. Many elongated flints and pieces of Wealden sandstone were observed in the bottom sandy clay with their long axis more or less nearly vertical. No teeth or bones were found, but one nodular flint obtained from the same layer as Eoanthropus seems to have been used by man as a hammer-stone. This is not purposely shaped, but merely battered along faces that happened to be useful when the stone was conveniently held in the hand. In the winter of 1915 the late Mr. Charles Dawson discovered in a ploughed field, about a mile distant from the original spot, the inner supraorbital part of a frontal bone, the middle of an occipital bone, and a left lower first molar tooth, all evidently human. These are rolled fragments, and the first and third may be referred with certainty to *Eoanthropus dawsoni;* but it is doubtful whether they represent more than one individual. In mineralised condition they agree with the remains of the type-specimen. The piece of frontal bone exhibits the characteristic texture and thickness, with only a very slight supraciliary ridge, and a small development of air-sinuses. The occipital bone is somewhat less thickened than that of the original specimen of Eoanthropus, and bears the impression of a less unsymmetrical brain. In an appendix Prof. G. Elliot Smith expresses the opinion that the endocranial cast of the fragment of frontal bone presents features more primitive and more ape-like than those of any other known member of the human family.

Zoological Society, February 20.—Dr. A. Smith Woodward, vice-president, in the chair.—C. J. C. **Pool**: Insects reared in the insect house during 1916. Experiments showed that melanic variations of the magpie moth (*Abraxas grossulariata*) were not connected with melanic variations in the larva. In the case of dragonflies, although the larvæ of several British species had been reared to maturity, it was found impossible under the conditions to feed the full-grown insects, which survived only a few days after emergence from the water. Similarly, it was found impossible to feed various species of Longicorn Coleoptera, although other beetles, differing as widely in diet as Carabidæ and Lamellicorns, fed readily on banana. Experimental feeding with beetles of the genus Necrophorus showed that while these insects were refused by meerkats (Suricata) they were eaten by a mongoose and Capuchin monkeys.—A. de C. **Sowerby**: Heude's types of artiodactyle ungulates in the Sikawei Museum, China. In the case of the species of Sus, Cervus, Capricornis, and Nemorhædus it was shown that Heude had disregarded variations due to age, season, and other causes, and that in each of these genera the number of species must be greatly reduced.—G. A. **Boulenger**: The lizards of the genus Philochortus. Matschie.

March 6.—Dr. S. F. Harmer, vice-president, in the chair.—Dr. F. E. **Beddard**: The scolex in the Cestode genus Duthiersia, and the species of that genus.—Capt. S. R. **Douglas**: Results of an experimental investigation of the migration of woodcock breeding in the West of Ireland. The paper, among other interesting points, showed an increase in the number of woodcock breeding in the West of Ireland.

Linnean Society, March 1.—Sir David Prain, president, in the chair.—J. C. **Mottram**: Observations upon the feeding-habits of fish, more especially of *Salmo fario*, and of riverside birds. These observations, extending over a period of eight years and supplemented by from between 500 and 600 autopsies, show that the liability to attack of any species depends upon many factors, such as the general and special hunger of the preyer, the total and relative abundance of the food-supply, the abundance and ease of capture of the preyed upon, and its relative palatability. It follows that in order to estimate the palatability value of a species, it is necessary to take into account all these factors. The observations indicate that species cannot be sharply divided into palatable and unpalatable. Observations are also recorded which show that both fish and birds are deluded by rough resemblances to insects on which they may be feeding, and that therefore a rough mimicry may be of some value in the struggle to exist.—Dr. J. C. **McWalter**: A note on botany in Malta. The note began with remarks on the prevalence of *Oxalis cernua*, Thunb., in Malta, still as universal as it was more than twenty-five years ago, when Prof. George Henslow wrote about it (Proc. Linn. Soc., 1890–92, pp. 31–36), which is still quoted as the most recent contribution to its study. Seasons at Malta are numerous, uncertain, and erratic, but the Cape sorrel seems most prevalent in March and April; it is now called "The English Weed." Dr. McWalter next suggested the cultivation of certain medicinal plants, of which the present supply is short, but well adapted in his view for growth in Malta. "Labour is, as a rule, cheap, and though an era of prosperity now prevails on account of the war, it is thought that great distress will prevail afterwards unless useful work be provided for the people."

CAMBRIDGE.

Philosophical Society, February 5.—Dr. Marr, president, in the chair.—Dr. **Marr**: Submergence and Glacial climates during the accumulation of the Cambridgeshire Pleistocene deposits. Near Narborough, at March and elsewhere in the fens marine deposits occurred from below fen-level to a height of at least fifty feet above present sea-level, indicating a submergence followed by re-emergence. Evidence was given to show that the later Pleistocene deposits of the neighbourhood of Cambridge indicated the same two movements, and that the encroachment of the sea took place in Lower Palæolithic times, and the recession in Upper Palæolithic times. The climate in Lower Palæolithic times was apparently warm, and there is some evidence of a cold period at the end of these times. Warmer conditions probably followed, and towards the end of Upper Palæolithic times a second period of cold is marked by the presence of the reindeer and an arctic flora in the pit near Barnwell Station. Prior to the Lower Palæolithic times the chalky Boulder Clay was accumulated; we therefore seem to have evidence of three cold Pleistocene

periods. This accords with the views of Continental geologists.—P. **Lake**: Glacial phenomena near Bangor, North Wales. During the Glacial period the valley of the Ffryddlas was blocked at its mouth by the Ogwen glacier and converted into a lake. The valley shows three terraces, and three corresponding overflow channels are cut in the ridge which bounds the valley on the north. One of these overflow channels debouches high up on the seaward slope of this ridge, and it is concluded that there was water up to this level. Other evidence on the seaward slopes of the neighbouring hills points to a similar conclusion; but there is nothing to show whether this water was the actual sea- or fresh-water dammed up by ice in the Irish Sea.—H. **Woods**: The Cretaceous faunas of New Zealand. The Cretaceous deposits of New Zealand rest unconformably on older deposits, and in the South Island are usually succeeded by the Amuri Limestone of Tertiary age. Two faunas have been recognised; one of approximately Gault age, the other of Upper Senonian age. Both faunas are of the Indo-Pacific type.—R. I. **Lynch**: Exhibition of the fruit of Chocho *Sechium edule*: remarkable in the nat. order Cucurbitaceæ, native of the West Indies, and cultivated also in Madeira as a vegetable.—G. N. **Watson**: The limits of applicability of the principle of stationary phase.—H. C. **Pocklington**: The direct solution of the quadratic and cubic binomial congruences with prime moduli.—C. E. **Weatherburn**: The hydrodynamics of relativity.—R. **Hargreaves**: The character of the kinetic potential in electromagnetics.—Dr. M. J. M. **Hill**: The fifth book of Euclid's elements. (Fourth paper.)—G. H. **Hardy**: A theorem of Mr. G. Pólya.

DUBLIN.

Royal Dublin Society, February 27.—Mr. R. Lloyd Praeger in the chair.—G. H. **Pethybridge** and H. A. **Lafferty**: Further observations on the cause of the common dry-rot of the potato in the British Isles. In all the cases (thirteen) of dry-rot of the potato tuber examined during the last few years from Ireland, Scotland, and England, *Fusarium caeruleum* (Lib.), Sacc., has been found to be the causative parasite. It attacks the tubers only and does not cause a "wilt" disease of the growing plant. Susceptibility to infection increases with increasing maturity of the tubers. Infection usually occurs through wounds, but can also occur in the absence of them. The fungus also causes a rot in tomato fruits. *F. arthrosporioides*, Sherb., is to be added to the list of species of Fusarium pathogenic to the potato tuber.

MANCHESTER.

Literary and Philosophical Society, January 23.—Prof. S. J. Hickson, president, in the chair.—Prof. G. **Elliot Smith**: The endocranial cast of the Boskop skull. Dr. Péringuey, director of the South African Museum, has submitted for examination and report an endocranial cast obtained from the fossil human skull found near Boskop, in the Transvaal, in 1913. Apart from the right temporal bone, the base of the skull is missing; but sufficient of the calvaria has been recovered to show that the capacity of the cranial cavity must have been well above 1800 c.c., perhaps even as much as 1900 c.c.—greater than that of the philosopher Kant's skull, and almost as large as Bismarck's. The flatness of the cast and certain of its features suggest affinities of the Boskop man with the Neanderthal race. But the larger size, and especially the form, of the prefrontal bulging indicates an even closer kinship with the peoples found in Europe in Aurignacian and later times. The conclusion that seems to emerge from a comparison of the cranial casts of extinct varieties of mankind is that the chief factor which above all others determines brain superiority is not so much mere bulk as the size of the prefrontal area.—Dr. G. **Hickling**: The skull of a Permian shark. A preliminary statement was made concerning the results of a re-examination of certain remains of the skull of *Diacranodus texensis*, Cope, sp., now in the Manchester Museum. The material is sufficient for a practically complete restoration of the cranium and jaws, while there is some indication of the character of the branchial apparatus, not hitherto described.

PARIS.

Academy of Sciences, January 29.—M. A. d'Arsonval in the chair.—H. Le **Chatelier**: Some scientific problems to be solved. Problems awaiting solution are suggested in connection with glass, metallurgy, pyrometry, heating, and agriculture.—Ch. **Lallemand**: A French economic mission in Spain.—Remarks by M. E. **Perrier** on the earlier mission to Spain organised by the Institut de France.—G. **Bigourdan**: The first scientific societies of Paris in the seventeenth century. The Academies of Montmor, Sourdis, etc.—J. **Renaud**: The time on ships. At sea, it is customary to reset the ship's clocks every twenty-four hours to the local noon. Certain inconveniences of this plan are set out, and an alternative method is suggested.—V. **Commont**: The deposits of the historic period superposed on the Neolithic tufa of the valley of the Somme. The marine shells found in these deposits are débris of Gallo-Roman origin and have been carried to their present position by man.—Mlle. Yvonne **Dehorne**: A new species of Stromatopore from the Hippurite chalk: *Actinostroma kiliani*.—H. **Arctowski**: A correlation between magnetic storms and rainfall.—A. **Angot**: Value of the magnetic elements of the Val-Joyeux Observatory on January 1, 1917. The variation of the declination is the greatest that has been observed since the commencement of regular observations (1883).—P. **Sée**: Moulds causing alteration of paper. The moulds, or their spores, are present in new paper, and probably arise from the material used. In spite of the diversity of the material and the experimental conditions, the fungi isolated are always the same and their number is limited. A list of the species is given.—A. **Guilliermond**: Researches on the origin of the chromoplasts and the mode of formation of pigments of the xanthophyll group, and of the carotines.—L. **Bordas**: The *rôle* of the Ichneumonides in the contest against the parasites of forest trees. *Pimpla rufata* renders great service to agriculture by laying its eggs in the bodies of a number of caterpillars. It can be used to prevent or mitigate the ravages of *Tortrix viridana* on oak trees.—J. **Pavillard**: *Pelagorhynchus marinus*.—J. **Amar**: Observations on the prothesis of the lower limb. It is concluded that the prothesis of the lower limb is irrational, and out of harmony with the laws of physiology, of locomotion, and of economy of energy.—G. **Bourguignon**: Normal chronaxy of the brachial triceps in man.—M. **Busquet**: The vaso-constrictive action of nucleinate of soda on the kidney.—A. **Bach**: The non-specificity of the animal- and plant-reducing ferment.—A. **Policard** and B. **Desplas**: Tolerance of the tissue of war wounds in course of cicatrisation for foreign bodies of microscopic dimensions. The mechanism of latent microbism of certain cutaneous scars.

February 5.—M. Paul Appell in the chair.—G. **Bigourdan**: Some ancient observatories of the Provençal region in the seventeenth century. The observatory of Avignon. Sketches of the astronomical work of Bonet de Lates, Tondut de Saint-Legier, Payen, Gallet, Bonfa and Morand.—L. **Lecornu**: The

determination of the legal time. As an alternative to summer time produced by the sudden change of one hour, a gradual method is suggested, reducing the interval between each two consecutive midnights during the spring months by 30 seconds.—E. **Ariès**: The law observed by the four Massieu functions for bodies taken in corresponding states.—R. **Garnier**: The irregular singularities of linear differential equations.—W. H. **Young**: The theory of the convergence of Fourier's series.—Et. **Delassus**: The general notion of movement for holonomial and non-holonomial systems.—E. **Jouguet**: Secular stability.—H. **Villat**: A calculation of resistance in a limited fluid current.—L. **Fabry** and H. **Blondel**: The provisional elements of the planet discovered by M. Sy at Algiers, October 2, 1916. From the calculation of the provisional elements the planet would appear to be new.—F. **Grandjean**: The application of the theory of magnetism to anisotropic liquids.—S. **Meunier**: Complement of observations on the part played by micro-organisms in fossilisation.—A. **Robin**: Comparative analyses of the heart and muscles in healthy and phthisical individuals, with some therapeutic applications.—J. **Cluzet**: New electrical syndromes observed in the wounded.—M. **Ranjard**: Contribution to the study of the diagnosis of war deafness.

BOOKS RECEIVED.

Bengal, Bihar and Orissa, Sikkim. By L. S. S. O'Malley. Pp. xii+317. (Cambridge: At the University Press.) 6*s*. net.

Science and Education: Lectures delivered at the Royal Institution of Great Britain. Edited, with an Introduction, by Sir E. Ray Lankester. Pp. 200. (London: W. Heinemann.) 1*s*. net.

Plants Poisonous to Live Stock. By H. C. Long. Pp. vi+119. (Cambridge: At the University Press.) 6*s*. net.

Cours de Physique. By Prof. E. Rothé. Deux. Partie. Thermodynamique. Pp. xv+328. (Paris: Gauthier-Villars et Cie.) 13 francs.

Peaceful Penetration. By A. D. McLaren. Pp. 224. (London: Constable and Co., Ltd.) 3*s*. 6*d*. net.

Germanism from Within. By A. D. McLaren. Pp. x+363. (London: Constable and Co., Ltd.) 7*s*. 6*d*. net.

Field Crops for the Cotton-Belt. By Prof. J. O. Morgan. Pp. xxvi+456. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

DIARY OF SOCIETIES.

THURSDAY, MARCH 22.

ROYAL SOCIETY, at 4.30.—Observations and Experiments on the Susceptibility and Immunity of Rats towards Jensen's Rat Sarcoma: J. C. Mottram and Dr. S. Russ.—Problems Bearing on Residual Affinity: Spencer Pickering.—Residual Magnetism in Relation to Magnetic Shielding: Prof. E. Wilson and Prof. J. W. Nicholson.—The Solar and Lunar Diurnal Variations of Terrestrial Magnetism: Dr. S. Chapman.

ROYAL INSTITUTION, at 3.—Modern Improvements in Telegraphy and Telephony: Prof. J. A. Fleming.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Modern Methods of Finding the Latitude with a Theodolite: Dr. J. Bell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Machine Switching Telephone Gear: F. R. McBerty.

ILLUMINATING ENGINEERING SOCIETY, at 5.—*Discussion*: Fluorescence and Phosphorescence and their Use to Produce Luminous Effects: Opener, F. H. Glew.

FRIDAY, MARCH 23.

ROYAL INSTITUTION, at 5.30.—Magic in Names: E. Clodd.

PHYSICAL SOCIETY, at 5.—Third Guthrie Lecture: Molecular Orientation: Prof. P. Langevin.

SATURDAY, MARCH 24.

ROYAL INSTITUTION, at 3.—Russian Idealism: S. Graham.

TUESDAY, MARCH 27.

ROYAL INSTITUTION, at 3.—Geological War Problems: Prof. J. W. Gregory.

ROYAL SOCIETY OF ARTS, at 4.30.—Land Settlement in South Australia: The Hon. F. W. Young.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 5.—South Slav Customs and Beliefs as Illustrated in Old Ballads and in Tales by Serb Authors: Miss M. E. Durham.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—The Decimal System of Coinage, Weights, and Measures: H. Allcock.

WEDNESDAY, MARCH 28.

GEOLOGICAL SOCIETY, at 5.30.

INSTITUTION OF NAVAL ARCHITECTS, at 11 a.m.—President's Address: The Earl of Durham, K.G.—Standardisation as Applied to the Machinery for Cargo Boats: D. B. Morison.—A Method of Obtaining for Ship Design the Spacing of Bulkheads according to the Rules of the International Convention: W. J. Lovett. At 3 p.m.—Stress Determination in a Flat Plate: J. Montgomerie.—The Closing of All Ship Side Apertures from the Bridge: Signor E. Benvenuti.—Description of an Apparatus for Interpreting Stability for the Use of Shipmasters: T. Graham. At 7.30 p.m.—The Strength and Inner Structure of Mild Steel: Prof. W. E. Dalby.—Design of Pin Joints based on Ultimate Strength: Lieut. W. A. Scoble.

THURSDAY, MARCH 29.

ROYAL INSTITUTION, at 3.—Telephony: Prof. J. A. Fleming.

AERONAUTICAL INSTITUTE, at 8.—The Necessity for New and Special Treatment of Metals Employed in Aircraft Construction: J. de Kozlowski.

INSTITUTION OF NAVAL ARCHITECTS, at 11 a.m.—Further Experiments upon Wake and Thrust Deduction Problems: W. J. Luke.—Some Experiments on the Influence of Running Balance of Propellers on the Vibration of Ships: J. J. King-Salter.—Theory of Wave Motion on Water: Sir George Greenhill. At 3 p.m.—Marine Application of Reduction Gears of Floating Frame Type: J. H. Macalpine.—Launching: P. A. Hillhouse and W. H. Riddlesworth.—Buoyancy and Stability of Submarines: Prof. W. Hovgaard.

LINNEAN SOCIETY, at 5.—Prof. T. H. Morgan's Work on the Mechanism of Heredity: W. Bateson.

FRIDAY, MARCH 30.

ROYAL INSTITUTION, at 5.30.—Recent Developments of Molecular Physics: Prof. J. H. Jeans.

GEOLOGISTS' ASSOCIATION, at 7.30.—Cephalopoda, and their Value in Geological Study: W. F. Gwinnell.

SATURDAY, MARCH 31.

ROYAL INSTITUTION, at 3.—Russian Idealism: S. Graham.

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