THURSDAY, MAY 27, 1909.

TWO STANDARD WORKS ON ZOOLOGY.

(1) *A Student's Text-book of Zoology.* By Prof. Adam Sedgwick, F.R.S. Vol. iii. The Introduction to Arthropoda, the Crustacea, and Xiphosura. By J. J. Lister, F.R.S. The Insecta and Arachnida. By Dr. A. E. Shipley, F.R.S. Pp. xii+906. (London: Swan Sonnenschein and Co., Ltd., 1909.) Price 24*s*.

(2) *A Treatise on Zoology.* Edited by Sir Ray Lankester, K.C.B., F.R.S. Part vii. Appendiculata. Third Fascicle, Crustacea. By Dr. W. T. Calman. Pp. viii+346. (London: A. and C. Black, 1909.) Price 15*s*. net.

THESE two ample volumes suggest that a comprehensive text-book on the whole animal kingdom can no more be written by a single zoologist. The advanced student needs an encyclopædic work in which several naturalists with wide general and deep special knowledge have united their labours. The great "Treatise" which is slowly taking shape under the editorship of Sir Ray Lankester has been planned from the outset on these lines, and Dr. Calman's volume is worthy of the best of its predecessors. Prof. Sedgwick now issues the third volume of his text-book, eleven years after the appearance of the first, and he tells us in his preface that, but for the help of his colleagues, Messrs. Lister and Shipley, this present volume would still be far from completion.

(1) When Prof. Sedgwick's second volume was reviewed in NATURE (November, 1905), the arrangement by which the Chordata were placed in the middle of the series, and the Arthropoda widely separated from the Annelida, was naturally criticised. The author, in his preface, now briefly replies to this criticism, pointing out that he followed "the clue given by the cœlom," and postponed the section on the Arthropoda until after that on the "enterocœlic" phyla. In defending this separation of the Arthropoda from the Annelida Prof. Sedgwick differs from Sir Ray Lankester, who adopts a single phylum—the "Appendiculata"—to include Arthropoda, Annelida, and Rotifera. Prof. Sedgwick is fully justified in regarding the Arthropoda as an independent phylum, as they "differ so fundamentally from the Annelida in their cœlomic arrangements," but in separating the two groups so widely in his system he surely puts too great a strain on the fascinating cœlomic theory.

To the volume before us Prof. Sedgwick himself contributes the chapters on the Tunicata, Enteropneusta, Echinodermata, Onychophora, and Myriapoda. His account of the Tunicata, which occupies sixty-five pages, is a masterly summary of the complex details of structure and life-history which characterise that interesting and puzzling class. The author's scepticism as to many current morphological ideas is shown by his remark that the ascidian subneural gland is "in its origin actually a part of the embryonic brain which the pituitary body never is." Nearly fifty pages are devoted to the Enteropneusta, a testimony to the great advances lately made in our knowledge of the group and to its zoological importance.

While upholding the vertebrate affinities of the Enteropneusta, Prof. Sedgwick insists that several fundamental features clearly indicate relationship to the Echinodermata, and his account of that great phylum, occupying nearly 200 pages, comes next in the volume. His discussion on the relationship between echinoderms and chordates is especially valuable and suggestive. Besides the well-known correspondences in the cœlomic spaces, the central nervous system, and the mesodermal limy skeleton, and the likeness of the tornaria to the echinoderm type of larva, attention is directed to the left-hand position of the mouth, both in the developing echinoderm and in the larval Amphioxus. This character is considered of the greater importance because no adaptational explanation of it, at least in the latter instance, is forthcoming. Incidentally, the author discusses the Dipleurula theory as elaborated by Bather, and gives reasons for doubting the existence of bilateral symmetry among the ancestors of echinoderms, though he has no other explanation of the free-swimming larvæ to offer. He further differs from most special students of the Echinodermata in his rejection of the association of the Crinoidea with the Palæozoic Blastoidea and Cystidea in a sub-phylum Pelmatozoa, holding our knowledge of the structure of the two latter classes to be too incomplete for any certain estimation of their affinities, while "Holothurians stand further from Asteroids and Echinoids than do the Crinoids." The value of the chapter on echinoderms is much enhanced by a remarkably well-chosen series of illustrations, including some hitherto unpublished drawings by Prof. E. W. MacBride.

The remainder of the volume (about 550 pages) is devoted to the Arthropoda. Mr. J. J. Lister contributes a short but admirable introduction on the phylum as a whole. On the disputed question of the segmentation of the crustacean and insectan head, Mr. Lister follows in the main the views of Hansen and Folsom, accepting the maxillulæ of the Apterygota as true appendages; but he ranges the arachnidan chelicerae with the insectan feelers, and thus makes the whole cephalothorax of a scorpion equivalent to the head of a cockroach. There is a remarkably good account of arthropodan eyes and vision.

(2) Mr. Lister has also written the chapter on the Crustacea, which occupies some 200 pages, and this section can be appropriately compared with Dr. Calman's volume of Lankester's "Treatise." In the former work the Trilobita are included among the Crustacea, while in the latter they are relegated to the Arachnida. Both writers agree that this ancient group of arthropods has affinities with the Arachnida and with the typical Crustacea, but, in view of their feelers and biramous limbs, their actual inclusion among the Arachnida can hardly be defended. In the classification of the Crustacea Mr. Lister is conservative, preserving the Entomostraca as a subclass, and holding to the long-recognised and familiar orders. Dr. Calman, on the other hand, rejects the Entomostraca as a natural group, and raises the Copepoda, Ostracoda, Cirripedia, &c., to the rank of "subclasses," dividing each into two or more "orders."

In this matter Mr. Lister's caution may, perhaps, be commended. In his arrangement of the Malacostraca, Dr. Calman adheres to his published views, in agreement with Boas and Hansen, splitting up the old order Schizopoda, so that the Mysidacea, with their reduced carapace, developed brood-pouches, and elongate tubular heart, are grouped with the Cumacea, Isopoda, Amphipoda, &c., in a division Peracarida, while the Euphausiacea are associated with the Decapoda to form the division Eucarida, characterised by an extensive carapace, a condensed heart, and the absence of brood-pouches. Mr. Lister, on the other hand, retains the order Schizopoda in its familiar signification. Here he clings to a position that must ultimately be abandoned, and he has little, except the opinion of Claus, to offer in its defence.

As might have been expected by those who have followed his excellent work, Dr. Calman's volume is especially strong in the morphological and systematic aspects of carcinology, while Mr. Lister deals more fully with development and bionomics. For example, we find in the latter author's chapter a summary of Keeble and Gamble's recent important work on colour-changes in the Decapoda, which has no place in Dr. Calman's volume. In both accounts of the Crustacea due regard is given to palæontology, and Mr. Lister appreciates no less than Dr. Calman the great importance of the Tasmanian Anaspides and its Palæozoic allies. By a judicious use of the two works, no student can fail to gain an admirable introduction to the study of the Crustacea.

Prof. Sedgwick has himself written the chapters on the Onychophora and the Myriapoda included in his volume. His epoch-making work on the structure and development of the Cape species of the former class might have prepared us for the excellence of his descriptions. In spite of Goodrich and Lankester's recent teaching on cœlomoducts, he still calls the peripatid excretory tubes "nephridia," a piece of conservatism in which he may find support from some zoologists; but it is hard to understand his rejection of the generic distinctions in the group, introduced by Pocock, and supported and extended by Bouvier, Dendy, and other recent workers. Except for Evans's Eoperipatus, he refuses to use the terms of these authors even in a subgeneric sense, needlessly coining a series of uncouth zoogeographical compounds such as "Chilio-peripatus," "Congo-peripatus," and "Capo-peripatus."

The unattractive yet interesting groups of Arthropoda known as "Myriapods" are dismissed in thirty pages. It is a matter for regret that the unnatural "Class Myriapoda" is retained, and in the discussion wherein the author defends this arrangement he does not even mention the natural solution of the difficulty—to treat the Chilopoda, Symphyla, and Diplopoda as independent classes—though he rightly insists on the insectan affinities of the Symphyla.

Mr. A. E. Shipley contributes a good chapter on the Insecta to Prof. Sedgwick's volume, giving a trustworthy account of the main structural features, and a clear, if brief, introduction to insect embryology, though the general discussion of metamorphosis is disappointingly curtailed. The denial of evidence for pre-Carboniferous insects ignores the ephemeroid and other remains described by Scudder from the American Devonian. Mr. Shipley's classification of insects is modified from Sharp's recent scheme; its only serious fault is the presence of the unnatural group "Anapterygota," including the Mallophaga, Anoplura, and Siphonaptera. In the account of the Apterygota, the two very remarkable genera, Anajapyx and Acerentomon (the latter regarded as the type of a new order), recently described by Silvestri, and the systematic work of Börner on the Collembola, should not have been neglected. In the description of the Lepidoptera, attention should have been directed to the importance of larval and pupal stages in the classification of the order, as pointed out by Chapman and others; from the statement on p. 710 it might be inferred that no lepidopterous pupa emerges partially from its cocoon.

The last chapter of the volume, occupying 90 pages, is devoted to the Arachnida. For this also, except a section on the Xiphosura by Mr. Lister, we are indebted to Mr. Shipley. The Pycnogonida, which appear as a subclass of the Arachnida, are too briefly dismissed; no reference is given to the works of Sars, Meinert, and Cole, nor is there any allusion to the puzzling ten-legged Antarctic genera; but the account of the Xiphosura and Eurypterida is especially good. The scorpions, spiders, and mites are excellently described, while the fairly full accounts of the Phalangidea and Palpigradi are welcome. The Tardigrada and Pentastomida appear as "appendices" to the Arachnida.

It is easy in reviewing such volumes to point out omissions, if not errors, and to suggest how this or that feature might be better otherwise. But the leading thought with which one lays them down is of gratitude to the authors for the labour expended on them and on the other volumes of the series to which they belong. With the yearly increasing output of research, the trustworthy text-book becomes more than ever necessary, and the modern English student is fortunate with sets of "Lankester" and "Sedgwick" on his shelves. G. H. CARPENTER.

THE FLORA OF THE PRESIDENCY OF BOMBAY.

The Flora of the Presidency of Bombay. By Dr. Theodore Cooke. Vol. ii., parts ii. to v. (London: Taylor and Francis, 1907–8.)

THE appearance of the last part of the second volume of the above completes the first instalment of the series of local floras projected to carry on the task of which "The Flora of British India," by Sir Joseph Hooker, aided by other eminent botanists, forms the foundation. The object of these "local" (or, as they might well be styled, provincial) floras is to amplify and, where necessary, to revise for a particular area the taxonomic information set out in the more general publication, and the present volume, judged in this light, must be held to have attained a high standard both in fulness and precision.

The descriptions, although answering the severest

technical requirements, are sufficient to guide even a beginner, and this is attained, among other means, by the inclusion of the whole account in a single paragraph, in place of the old plan of subjoining to an often curt diagnosis, sometimes barely intelligible without special study of the family or genus, a more or less loosely constructed note, usually in small print, on sundry features of the species, which might or might not, as things fall out, fulfil the end of a detailed description.

Another commendable feature of the work is presented in the analytical keys that are prefixed to the larger or more difficult genera. There is nothing easier, in a way, for a systematic writer than to make such a key on paper, and the more easily it has been made the more likely is it to be found in practice unworkable, or worse than useless; but the keys in this instance have been manifestly framed with some regard to the natural groupings of the species, and are clearly the result of personal and accurate examination of the material. As illustrations we may mention the synopsis at pp. 98–9 of the Bombay species of Diospyros, of Cordia (p. 199), Strobilanthes (pp. 365–6), and of the often almost hopeless genera of grasses (in the stricter sense). For the last-named very important family—the despair almost of taxonomists—Dr. Cooke has followed rather closely the arrangement made by Dr. Otto Stapf in the "Flora Capensis," which is that most generally now adopted, and, whatever may be thought of this as a comprehensive scheme for this difficult family, it must be admitted that Dr. Cooke's treatment of such genera as Panicum and Eragrostis, to say nought of Andropogon, has been fitted to it in a very workmanlike and skilful manner, without sacrificing detailed observations of the actual structure of the species, that are palpably the fruit of indefatigable work with the lens, by the author.

A like scrupulous accuracy pervades the nomenclature throughout the volume, though in some cases whole-hearted disciples of the Vienna Congress will miss sundry emendations that have doubtless been avoided purposely, for reasons analogous to those that have dictated, in the preparation of these Indian and colonial floras, adherence to the "Genera Plantarum" of Bentham and Hooker, as against the more recent work of Engler and Prantl. In the case of compendia founded, as the present is expressly, on the "Flora of British India," this is practically unavoidable, but in the analysis of families, and in some minuter matters, Dr. Cooke has shown, if anything, a shade too much deference to those monumental authorities. Take, for example, the arrangement of the tribes and subtribes in Compositæ (pp. 1–6). Assuming that Astereæ can be kept up as a tribe apart from Inuleæ, and that both should continue, even in a linear arrangement, to stand far apart from Senecionideæ through the intercalation of Helianthoideæ, Helenoideæ, and Anthemideæ, surely it is time to revise the subtribes of Astereæ. No doubt the solitary representative of the genus Erigeron found in Dr. Cooke's area, if it should be kept as an Erigeron at all, conforms to the definition of the subtribe "Heterochromeæ" by G. Bentham; but discoveries by the Abbé Delavay, by Wilson, and others in the Indo-Chinese region have shown that there are true Asters, and perhaps members of the allied genus Erigeron, that have the disk florets of the same bluish tint as the ligules, though of deeper intensity. In the "Genera Plantarum" it was admitted that in several genera all the florets are yellow, but now that the converse exception is known to affect the type-genus of the tribe, the division into Heterochromeæ and Homochromeæ seems to call for reconsideration.

A minor case suggests itself at pp. 1030–31, where the careful work of Jaubert and Spach on the actual forms of Melanocenchris has been swamped for the sake of resuscitating Koenig's practically barren title for the genus (Gracilea). This, of course, is a debatable example, but the same can hardly be said for the citation of Linnæus at p. 479 for the genus Boerhaavia, which Linné himself was most careful to attribute to its real author, Vaillant. In restoring *B. diffusa*, Linn., to the rank of a variety, Sir Joseph Hooker had, in fact, given the clue, because one or other of the two forms put under *B. repens* in the "Species Plantarum" was the type of Vaillant's genus. Whether either of those be identical with the *B. diffusa* of Linné can be decided only by inspection of the authentic types collected in Abyssinia by Lippi.

Dr. Cooke's "Flora" was commenced in 1900, and the first part appeared in July, 1901. On May 1, 1902, the Bombay herbarium at the Poona College of Science was destroyed by fire, and he has since had to depend largely on his own collections and those of Woodrow to supplement the classical material at Kew. He has examined and described 2502 indigenous species, and dealt with more than 500 introduced or cultivated plants known to the Presidency, distributed among 1029 genera and 148 families, embracing types of widely divergent affinities, and belonging to such diverse phytogeographical regions as the Oriental, East African, and Indo-Malayan. It is no mean achievement in itself to have completed such a task successfully. The final part is accompanied by a carefully prepared index to the book as a whole, and this is in two parts, the vernacular names being indexed by themselves, which, for most purposes, is the most convenient arrangement.

THE TEACHING OF PHYSICAL CHEMISTRY.

(1) *The Elements of Physical Chemistry.* By Prof. J. Livingston R. Morgan. Fourth edition, revised and enlarged. Pp. xiv+539. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 12*s.* 6*d.* net.

(2) *Outlines of Physical Chemistry.* By Dr. George Senter. Pp. xvii+369. (London: Methuen and Co., n.d.) Price 3*s.* 6*d.*

(1) THE fact that the former of the above-mentioned text-books has, in the space of a single decade, passed into its fourth edition, is sufficient evidence that the work has met with a large share of approval, and has shown it to be adapted to the requirements

of a large number of students of physical chemistry. Within the limits which the author has allowed himself, a very large amount of experimental work has been collected and discussed, and in this connection even the most recent work has received attention. In the initial chapters, however, dealing with the physical properties of substances, the author has been somewhat niggardly, and one is struck by a want of balance. Thus, whereas twenty pages have been allotted to the discussion of surface tension and the molecular weight in the liquid state, together with an excellent account of the author's drop method, barely a page has been devoted to refraction of light, and no mention at all is made of the rotation of the plane of polarised light. It must be confessed, also, that at times the condensation of language makes the reading of the book somewhat of a strain, and is productive of want of lucidity; so that the book, in parts, assumes the character of lecture notes rather than that of a self-explanatory text-book. In many cases, however, the author has been successful in minimising this evil by the insertion of tables of experimental results, and by the working out of numerical examples. This last feature of the book is indeed one to be greatly commended. No one can obtain a useful grip of physical chemistry without the study and actual working out of numerical problems. The collection of such problems inserted at the end of the book will therefore be of great value, both to the teacher and to the student.

The author has not been afraid to employ the methods of the calculus or to introduce the student at an early point to the study of thermodynamics. We can only wish that such a method might be adopted with some prospect of success in this country.

During the period which has elapsed since the appearance of the first edition, change has taken place in the attitude of mind of the author. Before the appearance of the third edition, the author states that he had come under the influence of Ostwald's "Naturphilosophie," and as a result he sets before himself the aim "to distinguish sharply between hypothesis and fact, avoiding the former as far as is possible."

Now, it cannot be denied that among students of science too little attention is usually paid to the philosophical side of the subject, so that the true meaning of a law, an hypothesis, and a theory is insufficiently appreciated, leading as a result to the confusion of hypotheses and theory with fact. Still, it cannot be said that the cure for this is to discard hypotheses altogether. Hypotheses are most valuable for the development of a science, so long as they are recognised as such, and are kept in their place. But the author himself is apparently none too sure of his ground here. It is, of course, perfectly competent for him, if he thinks it good, to eliminate hypotheses and theories, and to confine himself to what is experimentally determinable, and to generalisations of such observed facts, but when he states (p. 187): "By the word theory, then, we do not mean a hypothesis in which something not observed is added to the facts to 'explain' them, but only a generalisation of observed facts," surely he is taking undue liberties with language which can be productive only of confusion. Such a standpoint is to be regretted, for it greatly reduces the value of a book which has otherwise very much to recommend it.

(2) The second of the two books mentioned above can be heartily welcomed. It is put forward by the author as "an elementary introduction to physical chemistry," and as such the reviewer believes that it will, on the whole, be found very satisfactory. It cannot, and does not pretend to, treat in detail the whole subject of physical chemistry, but it does attempt, and this successfully, to introduce the student to the more important parts of the subject, special stress being laid on the modern theory of solutions, the principles of chemical equilibrium, electrical conductivity, and electromotive force.

The order in which the author treats his subject is as follows:—Fundamental principles of chemistry; the atomic theory; gases; liquid solutions; dilute solutions; thermochemistry; equilibrium in homogeneous systems; law of mass action; heterogeneous equilibrium; the phase rule; velocity of reaction; catalysis; electrical conductivity; equilibrium in electrolytes; strength of acids and bases; hydrolysis; theories of solution; electromotive force.

In the above treatment the author intentionally devotes comparatively little space to the discussion of physical properties and their relation to chemical constitution. In this, doubtless, he was wise; and yet one cannot help feeling that the addition of twenty, or even of ten, pages devoted to experimental results would not have greatly added to the bulk of the volume, and would certainly have been of great value in giving the student some idea of the utility of physical methods for the elucidation of chemical constitution.

In connection with the subject of dilute solutions, the treatment is not altogether satisfactory, insufficient emphasis being laid on the probability that solutions are essentially different from gases. Some indication might have been given that there is not only an experimental, but also a theoretical reason for substituting the mass of the solvent for the volume of the solution in the general osmotic equation; also the unsatisfactory character of the kinetic explanation of the mechanism of osmotic pressure should have been pointed out. Further, rather more definite guidance might have been given to the student than merely to say, "other views are that it (*i.e.* osmotic pressure) is connected with attraction between solvent and solute, or perhaps with surface tension effects," especially as the reviewer has pointed out that the surface-tension theory is untenable. It is true that the author inserts, as a saving clause, the sentence "It may be pointed out that the equivalence of osmotic pressure and gas pressure in great dilution is no evidence that they arise from the same cause," but the student will still probably continue to believe that the kinetic explanation is the best one.

The discussion of electrical conductivity and of electromotive force, two very important subjects, is very well done.

The book is wonderfully free from misprints, at least of a serious character, and on the whole the book is one which can be highly recommended to all students who wish to obtain a first acquaintance with the subject of physical chemistry. In language it is clear and well-expressed, and the practical illustrations which are appended to most of the chapters will be found very useful for laboratory work. The cost of the book, also, is extraordinarily low. A grave omission on the part of the publishers is the date of publication on the title-page. A. F.

ELECTRICAL ENGINEERING.

(1) *Transformers, for Single and Multiphase Currents. A Treatise on their Theory, Construction, and Use.* By Prof. Gisbert Kapp. Second, revised and enlarged edition. Pp. ix+363. (London: Whittaker and Co., 1908.) Price 10*s.* 6*d.* net.

(2) *Electrical Engineer's Pocket Book. A Handbook of Useful Data for Electricians and Electrical Engineers.* By Horatio A. Foster, with the Collaboration of Eminent Specialists. Fifth edition, completely revised and enlarged. Pp. xxxvi+1599. (London: A. Constable and Co., Ltd., 1908.) Price 21*s.* net.

(1) A NEW edition of Prof. Kapp's well-known book on transformers is bound to be interesting to all electrical engineers. Moreover, when the new edition is so much enlarged as to become practically a new book, the publication is of still greater importance.

The first two chapters are introductory in character, and deal respectively with general principles and with the losses in transformers. We cannot but feel some regret that the constants for hysteresis loss are not given in the form $K \times B^{1.5}$. This form gives practically the same result as the $B^{1.6}$ formula if a suitable value of K is chosen (as Prof. Kapp states on p. 17), and the calculation of the loss if the index is 1·5 can be much more readily made. The second chapter includes some valuable results of tests on the newer alloyed irons.

One of the best of the new chapters is chapter iii., where the subject of heating of transformers is dealt with very completely. The method of estimating temperature rise graphically for intermittent loads by combining the heating and cooling curves is very clearly given. Chapter v. is a very interesting one, dealing with the much neglected subject of the design of choking coils; the method of determining the necessary volume of the air-gap to give a certain amount of wattless current is both novel and useful.

In chapter vi. the design of the core of a transformer is considered, and a good deal of space is devoted to the discussion of the distribution of losses in a transformer. Some exception must be taken to the statement on p. 123:—

"The law of equal losses gives the maximum efficiency of a transformer which is the right size for the load. Arnold's law[1] gives it for a transformer which is slightly too large for the load."

[1] Copper loss = 0·8 hysteresis loss + eddy current loss.

Arnold's law and the law of equal loss are obtained on totally different premises, and both laws are correct for the given premises. It is true also that for a transformer designed on Arnold's law a higher efficiency can be obtained by increasing the load until the copper loss is equal to the iron loss, but this load may be more than the transformer can stand, and it is no more accurate to say that Arnold's law gives maximum efficiency for a transformer that is slightly too large for its load than it would be to say that the law of equal losses gives the maximum efficiency for a transformer that is slightly too small for its load.

In chapter vii. the design of a shell transformer is worked out in detail. One must enter a protest against the introduction of "Fill Factor." This is a literal translation of the German "Füllfaktor," but the English "Space Factor," introduced by Thompson, is now so well recognised that it seems a pity to use another term.

In chapter viii. the transformer theory is worked out in the same clear way as is done in the earlier edition. Prof. Kapp's well-known diagrams are described in detail, as well as the simplified drop diagram now so largely used. In the next chapter the calculation of magnetic leakage is considered, and some useful formulæ are given for calculating it in specific cases.

Chapter x. deals with the measurement of power; the usual methods of measuring power are described, including the three amperemeter and three voltmeter methods. Students might perhaps have been warned of the great accuracy of measurement in voltage and current which is necessary to obtain good results with these two methods. Chapter xi. deals with the testing of transformers, and includes also a description of most of the modern iron-testers, including the Epstein tester for total loss, the Grassot fluxometer, and Prof. Kapp's device for measuring magnetic quality.

The next chapter deals with a number of subjects, including safety appliances for transformers, three-wire transformers, auto-transformers, series working, and Scott's system of transformation from two-phase to three-phase working. It is similar to the corresponding one in the earlier edition, though the matter is greatly increased and brought up to date.

The last chapter gives some examples of modern single-phase and three-phase transformers, and is one of the most valuable in the book, both for the student and the designer. Not only are many plates and drawings included, but the details of the designs are worked out in many cases.

This book is likely to remain a standard treatise on the subject in English for some time.

(2) The "Electrical Engineer's Pocket Book" is similar to many other pocket books of the same class already on the market. It aims, however, at giving more complete and comprehensive information than most of these compilations, and deals with such subjects as electrochemistry, illuminating engineering, electrolytic action, firing mechanism for guns, electrometallurgy and X-rays, while more than 250 pages

are devoted to electric railways. The method of giving two tables for the same constant in two separate parts of the book is open to much criticism, and there are one or two obvious mistakes. In the description of the Weston cadmium cell, for example, the elements are stated to be cadmium and mercury instead of cadmium amalgam and mercury, while in the table of specific inductive capacities on p. 227 the specific inductive capacity of gutta-percha is given as 2·5, whereas on p. 36 we have the proper value of from 3·3–4·9. The whole of the table on p. 227 might well be omitted. Apart from a few minor defects, which it is very difficult to avoid in a compilation of this kind, the tables appear to be trustworthy, and are readily referred to by the aid of an excellent and complete index. E. W. M.

FOOD AND NUTRITION.

Human Foods and their Nutritive Value. By H. Snyder. Pp. xvi+362. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 5*s.* net.

OUR author remarks that the study of foods is "the oldest, most important, most neglected, and least understood of any that have a direct bearing upon the welfare of man."

No doubt there has been, and still is, neglect of systematic and coordinated scientific investigation into the many problems which arise in connection with the task of nourishing the human body. Yet a vast amount of work has been done on the subject. The list of books referred to in the present volume reaches the respectable total of one hundred. True, many of them—as, for example, the "Bulletins" of the United States Department of Agriculture—are only short studies of isolated points, but, on the other hand, the list is chiefly confined to American works, and is not intended to be a complete bibliography. Perhaps the indications point not so much to general neglect as to the present stage being one of accumulating evidence. By and by, it may be, some dietetic Kepler will discover laws of nutrition which will coordinate the facts better than can yet be done. Meanwhile, distinct progress is being made.

The opening chapter of the volume is devoted to expounding the general composition of foods. It describes how they are made up of water, inorganic salts, and organic compounds, and how the latter may consist of proteids and fats, starches, sugars, pectose, cellulose, and so on. After explaining the changes which foods undergo during cooking, the author passes to a consideration of the various classes of foods—*e.g.* vegetables, fruits and flavourings, milk and other dairy products, meat-foods, cereals, condiments, and beverages. In each case a short description of the article is given, indicating its composition as regards nutrient substances and, generally, its value as a food. Tables are appended which show, for ordinary American foodstuffs, the proportion of non-edible refuse, water, protein, fat, carbohydrates, and ash, together with the heat-equivalents of the foods.

Naturally in so small a book the information is often meagre, but it appears to be generally trustworthy. The treatment, though elementary, should serve to make the work a good introduction to the study of dietetics.

Probably the sections dealing with the digestibility of foods and with dietary studies will be found the most interesting. The author distinguishes between the completeness and the ease of digestion, and summarises the factors which influence the two as (1) combination of foods, (2) amount, (3) method of preparation, (4) mechanical condition of the food, (5) its palatability, (6) its physiological properties, such as astringency and laxativeness, (7) the individuality of the consumer, and (8) psychological influences—*e.g.* preconceived ideas as to the wholesomeness or otherwise of the food. On such questions as vegetarianism, the use of "whole-meal" bread, and heavy meat diets, Mr. Snyder takes a moderate and reasoned attitude. As regards the last, he maintains that at present the available results are too meagre to justify the formulation of other than tentative standards. "In the matter of diet," he says, quoting Hutchison's "Food and Dietetics," "every man must, in the last resort, be a law unto himself . . . . giving due heed to the warnings which nature is sure to address to him should he at any time transgress."

C. SIMMONDS.

THE BODY AT WORK.

The Body at Work. A Treatise on the Principles of Physiology. By Dr. Alex. Hill. Pp. xi+448. (London: Edward Arnold, 1908.) Price 16*s.* net.

DR. HILL has given us a book at once instructive and attractive. He writes for the amateur in science, but men deeply versed in physiology will find much to interest and to learn in his work. There is not a sentence in the book that could be spared, yet, although the reading commands close attention, it never fails to attract and to please. After a preliminary review of the subject of physiology, the second chapter, on the basis of life, reminds one of the great man whose name appears in the first line of the chapter, for "The Body at Work" is quite in the style of Huxley at his best.

The subject is approached from the unit of structure—the cell—through its groupings and specialising of structure and function to form the higher tissues and organs. The importance of the leucocytes, their manner of travelling, of multiplying, and of grouping, is graphically told, and the sections devoted to the blood and circulation in chapters iv. and ix. are simply but most explicitly handled. Amateurs in science can peruse with understanding the abstruse subjects of the functions of the thyroid gland, the suprarenal capsules, and the pituitary body. Digestion and dietetics, respiration in all its bearings, absorption and excretion are given in language that reads almost like a fairy-tale, yet with a scientific accuracy and bearing wholly trustworthy.

Throughout the book the meaning of vital processes is brought out in a fashion which leaves its impress.

The relationship of "vital action" to "physical phenomena" is carefully discussed, for the expressions "physical" and "vital" point a contrast constantly present to the physiologist's mind, and lead to much confusion. He is apt to regard as physical whatever he can test and measure in his laboratory, but cannot, however, make a model of a living cell or isolate it from the "vital" process which surrounds its existence in the living body. The technicalities of the nervous system are relieved by applied side-issues, often in the form of conversations, which enliven what are apt to be mere dry details.

The chapters on the special senses which close the book are fraught with information useful to physiologists, to musicians, and to teachers of singing and voice production. There is a message in the book to men and women of almost every calling, and everyone will find the text to be a model of writing and of how to convey information in a manner which commends itself to a teacher.

Scientific writings are, as a rule, mere catalogues of facts, put together in a manner more or less irrelevant. There is no reason for this except the absence of literary ability, a factor which obtains all too widely in medical and scientific writings generally. Huxley's works on scientific subjects, Sir Thomas Watson's on medicine, and Druitt's on surgery are exceptions to the rule, but they belong to a past generation, and seem to have left behind them no writers of their literary capacities. Dr. Hill, however, appears to have caught something of their inspiration, and we can only hope that he will deal with other subjects within his ken in a manner similar to that which he has given us in "The Body at Work."

OUR BOOK SHELF.

British and American Customary and Metric Legal Measures for Commercial and Technical Purposes. (Forming the Measure Section of Part i. of "The Mechanical Engineer's Reference Book.") By N. Foley. Pp. 25. (London: Crosby Lockwood and Son.) Price 7*s.* 6*d.* net.

THE necessity for these tables reminds us what an immense amount of time is wasted by the retention of the barbarous and cumbersome English system of measures. In two nations with more than 100 million people, not a small proportion of the school-time of every child is wasted in learning, and those engaged in industry and commerce in using, a system of measures which could not be less adapted to rapid and easy calculation. Yet we seem little nearer the time when our measures will be decimal and efficient, even though most of the opposition to the decimal system merits no respect.

The tables before us are for commercial and industrial use. All ordinary lengths, areas, volumes, weights, &c., in English measure can be converted, with their aid, at a minimum of calculation, to the metric equivalent. The range and arrangement of the equivalents have been thoughtfully chosen, and the printing is excellent, so the book lends itself to rapid use, and fits its purpose admirably.

We have only noted two serious misprints ("Tonne 2 = 1 ton, 1 qr., 9 lb.," and the equivalent of 3 tonnes); there is also an unimportant slip in the equivalent of 15 c.c. in cubic inches on p. 10; in many other places where we have tested the tables they are correct. Page 6 is reprinted on p. 7, and p. 10 on p. 11 with only the decimal point moved, which seems a waste of space.

In defining the ohm, volt, and ampere, the last is confused with 1/10 of the electromagnetic C.G.S. unit of current, while each of the former is "defined" in terms of the other and the ampere. The correct definitions, however, are mentioned by the author, but not as such. It would prevent confusion if the larger unit of heat were called in these tables a "kg.-calorie" instead of merely a "calorie."

It increases considerably the simplicity of the metric system if C.G.S. units are uniformly used in it. It is hoped that the author will help, as he well can, to attain this end by giving wherever possible in future editions of these conversion factors, the C.G.S. equivalent as the metric equivalent.

The units of pressure used in these tables are the engineer's lb. per square inch or kg. per square cm. Though they are thoroughly bad units, as they vary in magnitude from place to place and lead to confusion, they have, however, the advantage of conciseness over the physicist's "760 mm. of mercury at 0° C. in latitude 45° C. and at sea-level." The megadyne per sq. cm., which is nearly the average barometric pressure, deserves to be more generally used.

T. H. L.

(1) *Leitfaden der Tierkunde für höhere Lehranstalten.* By K. Smalian. Erster Teil, pp. iv+40, price 1.20 marks; Zweiter Teil, pp. iii+41–100, price 1.50 marks; Dritter Teil, pp. 101–208, price 2 marks. (Leipzig: G. Freytag; Vienna: F. Tempsky, 1908.)

(2) *Bau und Geschichte der Erde.* By O. Abel. Pp. viii+220. (Same publishers, 1909.) Price 4·50 marks.

(1) IN response, we are told, to a widely expressed wish, the author of the first of these works decided to condense and simplify his "Grundzuge der Tierkunde" (reviewed on a previous occasion in NATURE) so as to make a text-book. The result is the "Leitfaden," which is issued in three separate fasciculi, respectively suited (beginning with the last) to the requirements of the fourth, fifth, and six forms. The general plan of the work is to take a series of typical animals, and to make them texts for dissertations on the groups they represent. Despite the fact that some of the text-figures are of a somewhat ancient and obselete type, the work seems well adapted for its purpose.

We cannot, however, congratulate the author on the coloured plates. In the first part, for instance, we see a fox crawling over a slab of blue limestone or slate on which its red coat stands out so conspicuously that the presence of the marauder would be at once detected. In the third part the plate of African animals wherein Grant's bonte-quagga (*Equus burchelli granti*) does duty for the zebra (*E. zebra*) reappears in spite of attention having been directed to the error in our notice of the "Grundzuge."

(2) The appearance of the second of the two works is due to a reform which has been made in science-teaching in the middle schools of Austria. To put such reform in action, a suitable and up-to-date text-book was, of course, a *sine quâ non*; and Dr. Abel was accordingly entrusted with the compilation of such a work. No better man could have been chosen, as is demonstrated by the volume before us, which is practically all that such a text-book should be. It is not overladen with detail, each of the different sections of the subject receives its proper amount of space, and the illustrations, if not in the highest style, are at all events numerous. The volume commences

with a short account of the universe generally; this is followed by a short *précis* of dynamical geology, and the rest is devoted to stratigraphy and palæontology. A map of the geology of the Vienna basin directs the attention of the scholar to the importance of studying the strata of his own neighbourhood.

Goethe und Pestalozzi. By Karl Muthesius. Pp. vii +275. (Leipzig: Durr'schen Buchhandlung, 1908.) Price 4.50 marks.

WHEN all Europe was keenly excited by the social and educational work of a schoolmaster in a Swiss country town, Goethe held aloof. Pestalozzi's biographers have not hesitated to ascribe this to want of sympathy with the common people. Goethe, Minister of State and intellectual aristocrat, despised the poor and ignorant, and the *Schwärmerei* of early-nineteenth-century philanthropy seemed to him exaggerated, if not foolish. Such, at least, is a commonly received account of the matter, and the author of this interesting little book has shown what a libel upon the great man's memory it is. There can be little doubt, however, that Goethe made no effort to cultivate Pestalozzi, and still less that he distrusted Pestalozzian educational doctrine as it came under his notice. It was his misfortune to be acquainted with its weakest points. Goethe had no patience with an educational system which left out of its purview literature and history—everything, in fact, which could not be reduced to an A B C. In his view, geometry and geography, nature-study and language could never be made to fill up this gap, no matter how carefully they were systematised and ordered for school use.

Even the religious instruction of the traditional primary school was dropped by many of the new schoolmasters who had brought their inspiration from the shores of Lake Neuchatel. The tendency was to give up everything that would not fall into the Pestalozzian plan of beginning with concrete examples and ending with a definition. This was poison to Goethe. It had all the vices of current naturalism. Everything great that men had done and thought might remain unknown. The school youth was not brought into touch with types of human greatness—moral, poetic, or artistic. He was taken out of his historical connections and set afresh in an environment of things that could be defined! Small wonder the poet was distrustful. We have learned to know Pestalozzi better than Goethe did.

La France et ses Colonies au Début du XX^e Siècle. By M. Fallex and A. Mairey. Pp. vi+660. (Paris: Ch. Delagrave, n.d.) Price 5 francs.

THIS is one volume of an excellent series of regional studies "at the beginning of the twentieth century," throughout which M. M. Fallex's has been the principal hand. We find here a proper conception of geographical study thoroughly well applied. In the first part of the work a general survey of France is provided—its position, area, configuration, structure, climate, hydrography, and population. In the second and most important part the country is divided into natural regions, each one of which is considered in succession on the same lines as those of the general survey. The division itself is worthy of commendation and notice—(i.) the Central *Massif*, subdivided between the east and centre and the west and south, (ii.) the Pyrenean region, (iii.) the basin of Aquitaine, (iv.) the Alps of Savoy, (v.) the Alps of Dauphiné and Haute-Provence, (vi.) the Jura, (vii.) the Saône-Rhone valley, (viii.) the Midi, (ix.) the north-east, (x.) the north, (xi.) the basin of Paris in three subdivisions, (xii.) Brittany. Next follows political and economic geography, worked out no less satisfactorily than the regional. France itself occupies nearly five-sixths of the volume; the colonies, therefore, come in for what is perhaps disproportionately scanty treatment.

It is of no little interest to gather the French point of view as to the prospects of some of the colonies, for the authors are not content merely to make statements of fact and leave their readers to make inferences; here the inferences are found ready drawn, even if they are unflattering. Of the French establishments in Oceania we read " . . . ils ont toujours végété. C'est qu'ils sont trop loin de la France; en France on les connaît à peine." If this is so, the French student has an excellent opportunity of repairing his ignorance from this book and of extending the knowledge he gets from it, for excellent bibliographies are provided. There is also a full topographical index, a feature worthy of remark in a French work of this type. The illustrations are numerous and good.

The Interpretation of Radium. Being the Substance of Six Free Popular Lectures delivered at the University of Glasgow. By Frederick Soddy. Pp. xviii+256. (London: John Murray, 1909.) Price 6*s* net.

THIS book is based on popular experimental lectures delivered by Mr. Soddy at the University of Glasgow last year. The lecture form of address is retained, most of the experiments described being illustrated by photographs and diagrams. The book is intended chiefly for the lay reader, the author's object being rather to show the bearing of the new discoveries on our general outlook on nature than to give a detailed treatment of the subject.

The author gives a very clear and interesting account (in non-technical language) of radio-active phenomena and the light which the disintegration theory throws on them. The important work which Mr. Soddy has done in helping to establish this theory is a guarantee of the accuracy of his treatment. He confines his account mainly to the uranium-radium disintegration series.

The book will be found quite up-to-date, containing as it does reference to such recent work as Rutherford's proof that the α particle is an atom of helium, the experiments by Rutherford and Geiger in counting the number of α particles expelled by radium, and the author's own experiments on the production of helium from uranium and thorium. Many members of the general public, and workers in various departments of science, will find the book rich in interest.

Flower and Grass Calendars for Children. By Agnes Fry. Pp. 31. (Clifton: J. Baker and Son; London: Simpkin, Marshall and Co., Ltd., n.d.) Price 3*d*. net.

THE idea of making use of children's ability for committing verse to memory to introduce a few facts regarding the time of flowering and habits of plants, and thereby to stimulate their interest in botany, is commendable. The stanzas are short, and each is prefaced by a heading. There are four objects to be sought in such a calendar—the first to get true measure and cadence, the second to give good rhyme, the third to choose the correct month of flowering, and the fourth to introduce any striking facts regarding the character or habitats of the plants. The weakness of Miss Fry's verses lies chiefly in the measure, which is apt to be halt or forced; in this respect the grass calendar is more pleasing. As pointed out, the stanzas may and should be altered to suit the flowers in different localities.

LETTERS TO THE EDITOR.

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

Baskets used in Repelling Demons.

UNTIL about the end of the Japanese *ancien régime*, *i.e.* 1867, it was an invariable annual usage with the people of Yedo (now Tokyo), on the eighth of the second moon, to erect high before every house a bamboo pole with a basket on its top (Kawakita, "Morisada Mankô," ed. 1908, vol. ii., p. 251). However, from Tanehiko's "Yôshabako" (Yedo, 1841, bk. i., ch. ix.), it appears that about the seventeenth century a basket or a sieve was displayed on a tall pole or above the main doorway, not only on this so-called Work-start Day (*Koto-hajime*), but also on the eighth of the twelfth moon, named *Koto-osame*, or Work-finish Day—both these appellations primarily of agricultural concern, indicating to us a bygone age, when the New Year holidays of the Japanese husbandmen, with their preliminaries and after-games, covered some thirty days besides the whole first moon.

Citing many an old authority, and, among others, a stranger's statement, that in his native island nobody would stir out of doors on certain dark nights without carrying a basket to ward off the roving spirits, Tanehiko clearly shows the usage we are describing to have originally been meant for repelling demons. He argues, also, that this Work-start Day usage in Yedo had been first introduced—though with a manifest deviation as to the day of its performance—from certain provinces, whence the founders of its governing families had mostly sprung, and where, even so late as in Tanehiko's time, the inhabitants customarily displayed baskets, neither on the Work-start nor on the Work-finish, but only on the *Setsubun*, or Last Winter Day. Indeed, the Last Winter Day seems to have proved the fittest occasion for repelling or expelling malevolent souls, for, in its evening, apparently from time out of memory, it has been a universal custom in Japan to eject demons with baked beans forcibly thrown just before shutting all the doors and windows, and to stick upon the door-case a branch of the tree *Osmanthus aquifolium* and a half-roasted sardine, the strongly spined leaves of the former, with the unpleasant odour of the latter, sufficing to put to flight the spirits that try to intrude into any human dwellings.[1]

Whether or not Tanehiko's view is correct in tracing the Work-start Day usage of the past Yedo folks into an earlier provincial practice on the Last Winter Day, it is very significant in this connection that a Jesuit missionary of the seventeenth century observed every native of Tonquin to plant before his house a pole topped with a basket on the Final Night of the year, in order to scare away the intrusive demons. He relates it thus:—

"Gionti all'ultimo giorno dell'anno nel farsi sera, ciascuno dinanzi sua casa vi pianta 'un albero secco, o una longa pertica, nella cui cima, in vece di bandiera legano una cesterella, con attorno appesovi carte dorate, a modo di oro stridente, persuasi, che come ne'seminati, e negli horti sì mettono i spauracchi, per tenerne lontani gli uccelli, così quella cesta con quell'oro insù la pertica vaglia a fugare i Demonij, e non farli accostare alle loro case: che se in quell'ultima sera dell'anno, non ritrovassero quel riparo dinanzi l'uscio, senz'altro entrerebbero loro in casa a fargli sfortunati tutto l'anno. E se avviene, che alcuno tralasci di far questa cerimonia, e non curi di esporre la detta insegna, ne è mostrato à dito, e si dice: Ecco la casa del Demonio" (Filippo de Marini, "Historia et Relatione del Tunchino e del Giappone," Roma, 1665, p. 133).

I fully know that I am exposing my great ignorance in asking the following questions upon the subject. Are there any other people than the Japanese and the Tonquinese who used, or still use, baskets in frightening the demons? How has the origin of the custom been scientifically described? Also I have a note, taken from Waitz, "Anthropologie der Naturvölker," i., s. 347, Leipzig, 1872, to the effect that some Polynesians often apply, to mark a tabooed place, a basket-work moulded into shark or lizard. Why has basket-work been particularly chosen for this purpose?

The reason Tanehiko (*loc. cit.*) adduces to account for the Japanese use of baskets in repelling demons is that the basket originally employed in the rite had some of its openings shaped in star pentagon—the figure formerly held as specifically efficacious in averting evil influences, and termed Seimei's signature, after the greatest soothsayer Japan has ever produced (921–1005 A.D.). Someone opines that the star pentagon terrifies demons extremely, because it much resembles the eye of Fang-Shang, the principal demon-hunter in the Chinese ceremony of *Na* (see footnote), whom the "Ritual of the Chau Dynasty" (written *c.* 1100 B.C.) prescribes for this occasion to wear red trousers and black coat, a headdress of bearskin, and a mask with four golden eyes. Yet another opinion has been advanced which states that some wicker-works, *e.g.* the sieves, are so fabricated as forcibly to put the spirits in mind of the Taoist, and thence Buddhist, emblem named *Kuji* (lit., Nine Letters), formed lattice-like by intercrossing five vertical and four horizontal lines, and said to represent the nine Chinese characters, that make up a charm most powerful against all manner of demons. In this exposition I see the order of cause and effect quite inverted, it being obvious that the very *raison d'être* of the symbol *Kuji* is the assumed efficacy of the wicker- or lattice-work in keeping all within it in complete safety and well-being. This will be well understood should one inspect an old-fashioned Shinto shrine with its front strongly defended by a lattice, or should he peruse this subjoined passage:—

"The generality of the huts used as dwelling-houses [in Kordofan] are furnished with a flat-roofed shed of some twelve feet square immediately in front of them, which, in the dry season, forms the usual sitting-room. . . . It has a spacious doorway in front, through which light is admitted in sufficient abundance to dispense with windows, and is never closed when any of the family are at home. When they are absent, a piece of wicker-work, placed against it and sustained in its position by a piece of wood, serves to keep out dogs, fowls, and cattle; and being a sufficient indication that the inmates are absent, no one will approach it. Locks are dispensed with, and, as housebreaking is unknown, they are not required" (John Petherick, "Egypt, the Soudan and Central Africa," Edinburgh and London, 1861, pp. 213–4.

KUMAGUSU MINAKATA.

Tanabe, Kii, Japan, April 4.

[1] This Last Winter Eve rite of the Japanese reminds us of the Australians annually driving from their midst the accumulated ghosts of the last year's dead; of the modern Bohemians at Pentecost, and the Tyrolese on Walpurgisnacht, hunting the witches, invisible and imaginary, out of house and stall (Tylor, "Primitive Culture," New York, 1888, vol. ii., p. 199); and of the archaic Chinese ceremony of *Na*, which was to force the demons away from the imperial palace on the Final Night of the lunar year (*Chû-yr*), and which, since its adoption into the Japanese court ritual, 706 A.D., has become gradually confused in vulgar minds with the native observance of the Last Winter Eve, in spite of the but very rare coincidence of these two nights (Yashiro, "Kokon Yôran Kô," ed. 1905, vol. i., p. 931). *Cf.* the Tonquinese custom given in the text.

Vapour-density and Smell.

IN NATURE of May 13 (p. 308) Dr. Hill states that "no volatile body, the density of which is not greater than that of air, is a stimulant of our olfactory membrane." I venture to suggest some important exceptions to this rule, if, indeed, it is a rule, viz. ammonia, density 8·5; hydrocyanic acid, 13·5; and hydrofluoric acid, 10. Although the last-named consists mostly of molecules H_2F_2 at the ordinary temperature of the air, it contains a considerable proportion of HF molecules at 40° C. I have never heard of any of these (or, indeed, of formaldehyde) being prepared in such a way as to have no smell, and it does not seem probable that it could be done. I have myself prepared ammonia with the greatest possible care, and in several different ways; the product obtained has certainly a different smell from the commercial article, but it is still very pungent. It seems to me that the reason for this rule of smells is simply that the atomic weights of the large majority of the elements have a much greater numerical value than the density of air, putting hydrogen

equal 1 in both cases; and to this may be added that the vast array of organic compounds are mostly of complicated constitution, and must necessarily have high vapour densities. E. P. PERMAN.

University College, Cardiff, May 15.

"Blowing" Wells.

MR. S. H. LONG, the writer of the letter on "blowing" wells in NATURE of May 20, should refer to an article on "The Movement of Air in Fissures and the Barometer" (NATURE, vol. xxvii., 1883, p. 375), in which phenomena similar to those observed by him are described in the case of several wells in different parts of England.

12 Marloes Road, W., May 21. A. STRAHAN.

NATURAL HISTORY IN INDIA.

THE annual report of the natural history section of the Indian Museum for 1907–8 repeats the usual complaint that "lack of trained officers has again retarded progress," and the complaint is justified by the information that the trained staff—for a section that includes zoology, archæology, and numismatics—consisted of one permanent officer and one assistant engaged for a term, with a few casual assistants and humbly remunerated clerks, and a couple of Bengali students to help them. In plain language, this big assemblance of a staff, when measured by European standards, comes to but one man with life-interest at stake.

From this statement of the case it might be thought that a museum of natural history situated in the capital of the Indian Empire must be one of the many blessings of western civilisation that the oriental mind regards with pious indifference. But no; when we turn to an interesting appendix we learn that the "number of visitors to the museum during the 237 days on which the institution was open to the public was 580,161, or a daily average of 2447."

Or it might be supposed that zoology is a subject of little or no consequence to the welfare of our Indian Empire. Again, no. If it be called to mind that the majority of our fellow-subjects in India are *directly* dependent for their very lives upon crops that are ravaged by every sort of insect-pest, and that diseases carried by animals of many kinds, and diseases caused by divers parasitic animals and animalcules—not to speak of death by snake and beast of prey—account for about 75 per cent. of the mortality of the population, and for no one knows what percentage of the mortality of stock, it can hardly be said that the study of zoology is a matter with which India has no concern. No; the only possible conclusion is that the Indian Government, humane, just, and intelligent as it undoubtedly is, resembles all other administrations of the British pattern in its stolid indifference, not merely to natural science in the abstract, but even—and that is, indeed, hard to comprehend—to the pocket value of natural science.

But what it lacks in official thews and sinews the museum—thanks to the moving energy, the trained ability, and the wonderful versatility of its superintendent, Dr. Annandale—makes up in spirit, and nowhere is this more clearly shown than in its published output of research.

Publications now before us include parts ii. to iv. of the second volume of the "Records" and the third part of the "Memoirs," these containing papers by twenty-six authors, many of whom are European specialists.

One of the most striking and original features of these museum records is that, besides paying the attention justly due to such orthodox museum topics as vertebrates, mollusca, insects, crustacea, &c., they take thought of many small things that in many museums are regarded as somewhat off the beaten track—such as fresh-water polyps and polyzoa and plankton.

The series of reports on the fauna of brackish ponds is of great interest, for we are here on that plastic ground whence the fresh water receives its recruits from the stragglers of the sea. Solutions of several little problems depend upon careful observations, continued through the whole round of seasons, of the fauna of a definite delta station, such as are now being carried on and recorded by Dr. Annandale. An interesting item in this latest series of reports is Mr. T. R. R. Stebbing's account of an amphipod, a species of Grandidierella, the only congener of which inhabits a closed lagoon six miles from the west coast of Madagascar; here we get a peep at one of the pitfalls which this kind of study fences off.

Equally interesting are Dr. Annandale's reports upon the fresh-water fauna of the Indian continent—a subject which, outside vertebrate limits, has hitherto hardly been touched.

A paper upon the fresh-water fauna of a district of Tibet has also the charm of novelty, and Captain F. H. Stewart, who, in the course of other (official) duties, collected the material for it, deserves much credit for making such good use of an exceptional opportunity. The collection includes *Hydra fusca* from an altitude of 15,000 feet, and much lake-plankton which, as would be expected, is practically identical with that of northern Europe, except in the case of the ostracods.

Among other papers, that of Captain W. S. Patton, upon the differential diagnosis of *Cimex lectularius* and *Cimex rotundatus*, must be mentioned, by reason of the part played by the latter species in the dissemination of the microparasite of the insidious disease, *kála azár*.

The part of the memoirs in review is devoted to the earthworms of India, and consists of a systematic monograph by Dr. W. Michaelsen, and anatomical descriptions of certain aquatic forms by Major Stephenson. The value of Dr. Michaelsen's monograph is somewhat difficult to estimate. The systematic part of it, which includes a concise index of all the Indian species of oligochætes known, is undoubtedly a most useful piece of work, although in some places it is marred by an unfortunate controversial tone. But that part of it which deals with geographical distribution can scarcely be meant to be taken seriously, especially as it completely ignores the comprehensive and critical work accomplished in this field by that eminently judicial and preeminently qualified naturalist, the late Dr. W. T. Blanford.

To say that well-established facts relating to the present geographical distribution of animals must be taken into consideration in reconstructing the configuration of the land in former geological epochs is to state a proposition to which no reasonable geologist will object. But to make the unqualified assertions, as Dr. Michaelsen does, that the "endemic terrestrial oligochætes give us one of the best documents for the geological history of a country," and that "the recent geographical distribution and the relations between the different groups" (of land oligochætes) "enable us to determine the different paths of the former migrations, and thence the configuration of land and sea in former periods" is to put oneself out of court. It is unprofitable to criticise conclusions deduced from such a sweeping major premise.

A PERSIAN TREATISE ON FALCONRY.[1]

ALTHOUGH the ancient sport of falconry is still upheld to a limited extent in western Europe, it is to the East that we must turn at the present day if we would see "the pride and pomp and circumstance" that continues to attend a diversion practised from the remotest ages. The Arabs probably learnt the art from the Persians; for not only do many Arabic MSS. state that the first falconer was a Persian, but many of their technical terms relating to the sport are borrowed from the Persian language. In India, too, where hawking has always been popular with the native princes, the text-books (MS. or lithographed) are not in Hindustani, as might be supposed, but in Persian, although very corrupt, and disfigured by Punjabi and Sindhi idioms and technical terms. It is probably for this reason that these MSS. have remained so long untranslated; for it is certain that no one but a Persian scholar, who is likewise a proficient falconer, could attempt the task of translation with any chance of making himself understood.

Col. Phillott, in his preface to another work, the "Qawānīnu 's-Sayyād," published last year in the "Bibliotheca Indica," says, "Had I not been a practical falconer of more than twenty years' experience of falconry in the East, I would not have ventured to edit the present text." This admission applies with even greater force to the "Bāz-Nāma-yi-Nāsirī," of which his translation is now before us; for treating, as it does, of the art of hawking, it is full of technical terms inseparable from the sport, with descriptions of the Persian method of capturing and training hawks, and treating their ailments, which no one but a falconer would properly understand. Thus it would be difficult to find a more competent translator and editor for such a work than Col. Phillott.

We learn from his introduction that the present work is of no antiquity, having been composed in 1868, when the author was sixty-four. It was originally lithographed in Teheran, and a second (and perhaps a third) edition was lithographed in Bombay. The present translation has been made from the Teheran text.

FIG. 1.—From an Old Persian Painting, probably of the Mughal Period. From "The Bāz-Nāma-yi-Nāsirī: a Persian Treatise on Falconry."

The author was Taymūr Mirzā, a Persian prince of some celebrity, who, in 1836, accompanied by two of his brothers, paid a visit to the court of William the Fourth on a political mission, in which they succeeded, through the good offices of Lord Palmerston, eventually returning to Baghdad. Devoted from his youth to field sports, the author was well received by the Shāh (Nāsir 'd Dīn Shāh), and became a constant companion in his sporting expeditions. In Persia and around Baghdad the name of Taymūr Mirzā is still "a household word." It was not until quite late in life that he began to think of writing down his experiences as a falconer, to leave "as a memento for all lovers of the sport, whether tyros or experts." "Sixty-four years of my life," he writes, "have now passed, all spent in hunting and shooting. I have had no hobby but sport, no recreation but it." He died in 1874 at the age of seventy.

His work, relating as it does to a special branch of sport, naturally appeals most strongly to those for whom it was designedly written; but, putting aside technicalities, the general reader cannot fail to be amused with the anecdotes which are told of sport in Persia, as well as with the quaintness of oriental diction. Thus, speaking of a worthless hawk that defied his best efforts as a trainer, the author says (p. 39), "What could be the cause of her extraordinary behaviour? Puzzled and perplexed, I buried my head in the collar of reflection determined to unravel the tangled skein of the difficulty," &c.

To criticise any of the methods or devices of Persian falconers would here be out of place, though there are many passages which suggest comment. The

[1] "The Bāz-Nāma-yi-Nāsirī, a Persian Treatise on Falconry." Translated by Lieut.-Col. D. C. Phillott. Pp. xxiv+195. (London: Bernard Quaritch, 1908.) Price 21s. net.

Persian fowlers, like their Indian confrères, are adepts in the art of snaring, and it is curious to note that one of their devices for capturing a wild hawk at night by means of a lantern (p. 75) is, with slight variation, to be found in the "Book of St. Albans, 1486." Similarly a recipe for a slow-moulting hawk (p. 151) is also prescribed in that famous work of Julyana Berners. To explain such unexpected coincidences would take us now too far afield.

A valuable feature in the present translation is the number of footnotes which Col. Phillott has supplied, to explain and illustrate the Persian writer's meaning, to reconcile apparent discrepancies, or to confirm his statements from his own experience. To English readers interested in the literature of falconry, these footnotes will prove very instructive. The illustrations which accompany the text are of two kinds—reproductions of Persian drawings of hawking scenes, and

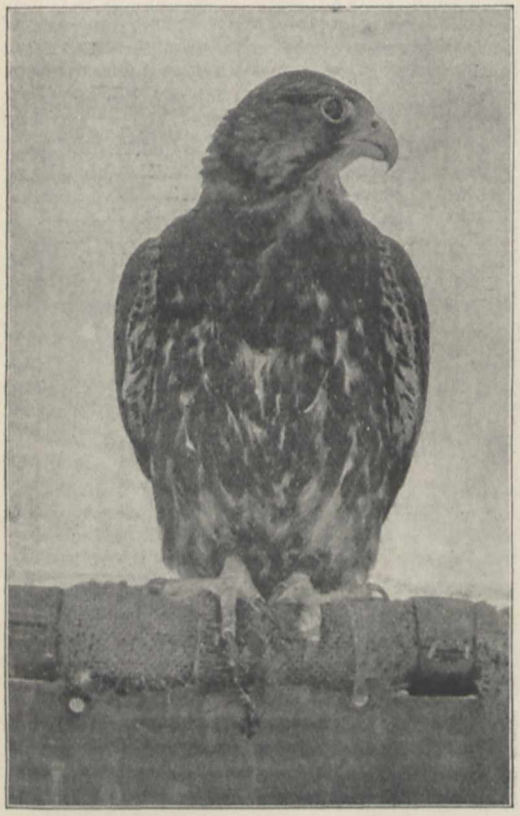


FIG. 2.—Young Passage Saker (Dark Variety). From "The Bāz-Nāma-yi-Nāsirī: a Persian Treatise on Falconry."

photographs from life of hawks employed by Persian falconers. The reader is here presented with a sample of each. J. E. H.

DR. SVEN HEDIN ON CENTRAL ASIA.

THE April number of the *Geographical Journal* contains two papers by Dr. Sven Hedin descriptive of his journeys through Tibet in 1906–8. The first of these is a narrative of his travels, which is necessarily so much abridged that it barely does more than give an idea of the extent and difficulties of his exploration; the other is a summary of the most important, or, rather, what Dr. Hedin regards as the most important, of his discoveries. The two are not necessarily identical, and it may be that when we have the full account of his travels the discoveries to which he now attaches greatest importance may prove of minor interest. For the present, however, we have only this summary, in which he enumerates the four most important results of his journey as the discovery of (1) the true source of the Brahmaputra, (2) the source of the Indus, (3) the "genetic" source of the Sutlej, and (4) the discovery of a continuous mountain chain, to which he applies the name Trans-Himalaya.

Of these the two first are of interest, especially the fact that no part of the drainage of the Kailas mountain finds its way into the Indus river; the third is a doubtful discovery, for though Dr. Hedin has discovered and visited the source of the largest of the feeders of the Manasarowar lake, it cannot in any proper sense of the word be regarded as belonging any longer to the drainage area of the Sutlej river. At one time there was continuous flow from Manasarowar to Rakas Tul, and again from that to the Sutlej, but this latter has been dry for at least half a century, while the former seems to have become intermittent and likely to cease in the near future; except for a possible escape by underground percolation, no part of the water of these lakes now finds its way into the river, and even this supposititious communication would not justify us any longer in describing a tributary of either of the lakes as the source of the Sutlej, nor does the matter seem much bettered by the addition of the adjective genetic.

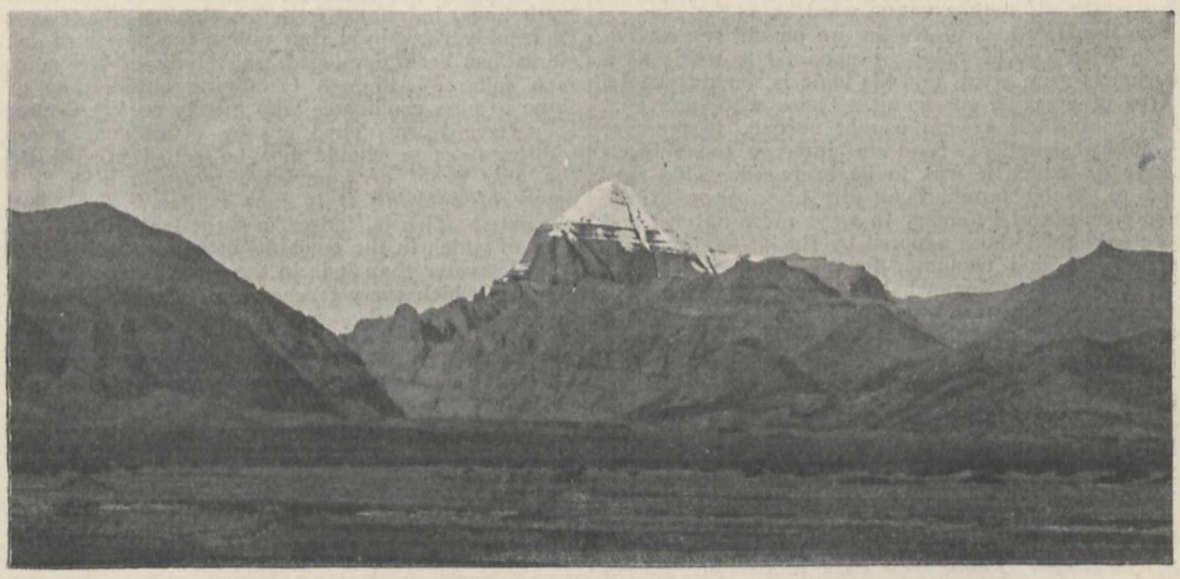
The most important, in his own view, of Dr. Hedin's discoveries, and the one around which controversy has settled, is that of a great continuous mountain range, coextensive with and parallel to the Himalayas, to which he has given the name Trans-Himalaya, a name to which exception has been taken, and which seems to require greater justification than Dr. Hedin has given. We may ignore the objection that the term was applied by Cunningham to the mountains lying between the Sutlej and the Indus, but we cannot accept the quotations from other authors cited as justification for the use of the term. A writer from the Indian side may use, with perfect correctness, the expression Trans-Himalayan, as applied to the country, or to explorations carried out, on the further side of the Himalayas, but it is a different matter when we are asked to accept the words as a definite geographical term, and once this proposal is brought forward the two questions arise as to whether the word is either justifiable in itself, or necessary. Of these two questions the first is a literary one, and it must be confessed that some real objections may be urged against the word adopted by Dr. Hedin, and accepted by Lord Curzon of Kedleston; but the second is the important one, for, unless the supposed range of mountains to which it is applied has a real individuality and independent existence, no special term is required or can be justified.

From earliest times it has been recognised that the great system of mountains which rises to the north of the Indo-Gangetic plain has an individuality of its own which deserves and requires a name, and the word Himalaya, originally applied to a part, has been extended to the whole chain of snowy peaks together with their dependent mountains of lower elevation. It has not, however, been so generally recognised that this unity belongs less to the mountains than to the plain at their foot, and some modern geographers, not content with merely recognising the individuality of the great chain, have attempted to trace the individual ranges of which it is composed along the whole length of the system, and thereby have retarded a proper appreciation of the true nature of this system of mountains. A simile proves nothing,

but is often useful as an illustration, and, without pressing the resemblance too far, the organisation of the Himalayan mountains may be compared to that of a great army, composed of many thousands of individual soldiers, grouped in regiments, these, again, in brigades and divisions, each having a separate individuality; but the individuality of the soldier differs from that of the regiment to which he belongs; this, again, merges in the individuality of the brigade, and the whole in that of the army. So with mountains, the peaks may be grouped into *massifs*, these into ranges, a series of which may form a great chain or system like that of the Himalayas or the Andes; but just as the brigades of an army are not each extended along the whole front, so the ranges do not extend along the whole length of the system. Each in turn comes to an end, and the chain is taken up by another, not as a direct continuation, but overlapping the end, so that the direction of the individual ranges is oblique to that of the system as a whole. Any other arrangement would probably be as physically impossible, with material such as that of which the earth's crust is composed, as the marshalling of an army in brigades or divisions drawn up in lines extending along the whole length of the front would be militarily impracticable.

This interpretation of the orography of the Himalayas is borne out by such maps as we possess, and especially by those maps attached to Messrs. Burrard and Hayden's valuable sketch of the Himalayas, which exhibit the facts, rather than Colonel Burrard's interpretation. In these it will be seen that the high peaks of the Himalayas do not form a single range, but rather a band crossed obliquely by a series of ranges, and if we are to group these individual ranges into a single system, and to include in it the lesser ranges lying to the north and south, there is no reason, geographical or geological, for separating it from the mountains of southern Tibet and the northern territories of Cashmere. Structurally and orographically, the whole of the mountains between the Indian plains and the lake region of central Tibet belong to one great system, and the term which Dr. Hedin wishes to introduce is either unnecessary or misleading; needless if it merely indicates the country north of the first belt of lofty, snow-clad peaks, misleading if meant as a name of a mountain range or system. Range it is not, for Dr. Hedin is clear enough on this point, as he repeatedly speaks of the separate ranges of which it is composed, and gives their number as no less than ten; mountain system it equally is not, having no separate existence. If a new name is required at all, it must be one which will unite these ranges with the Himalayas, not one which suggests a separation, for the valleys of the Sanpo and Indus no more separate the mountains on either side of them than, on a smaller scale, are the analogous valleys of the Rhone and the Rhine a reason for splitting up the unity of the Alps.

This criticism must not be taken as in any way a disparagement of Dr. Hedin's achievements; there can be but one opinion of the brilliance of his exploration and of the courage and determination with which he overcame the obstacles in his way. The publication of a detailed account of his travels will necessarily form an important addition to our knowledge of central Asia, but the fullest recognition of its importance does not involve an acceptance of Dr. Hedin's deductions, nor does a difference of opinion in regard to them imply any question of the accuracy of his observations.



Kailas from the south-west From the *Geographical Journal.*

THE TEACHING OF GEOMETRY.

THE circular recently issued by the Board of Education on "The Teaching of Geometry and Graphic Algebra" is an important document from at least two points of view. First, it has a very considerable educational value in indicating the successive steps or stages which it is proper for a teacher to take, and, secondly, it supplies information as to the way in which the changes, introduced mainly by the Mathematical Association, have worked out. Those who have advocated the reformation of the teaching of geometry will be glad to know that the verdict of the Board of Education is favourable. "It should be stated at the outset that the general effect has been beneficial."

The reformers had most serious difficulties to face, the greatest, perhaps, being the almost divine authority

attributed in England to Euclid's definitions, postulates, axioms, and propositions. Euclid's system was here regarded as the highest, and an infallible, type of logical accuracy. That it is still so regarded by some people is evident from the somewhat flippant and jesting comments made on the circular of the Board of Education in some of the daily papers. It may not be hopeless to point out to the writers of such comments that Euclid in at least one instance contradicts himself. His definition of a circle, for example, makes it to be, not a *curve*, but a *surface*: "a circle is a plane figure bounded by one line which is called the circumference." This clearly makes a circle to be a surface, and, moreover, it is lacking in definiteness, because it does not say whether the plane-bounded figure is that which is contained within the circumference, or that infinite external space which lies outside. Again, if a circle is a plane surface, what becomes of the proposition that two circles can intersect in only two points? Further, Euclid made the mistake of supposing that every geometrical concept can be *defined*, whereas there are some that can be only *described*: witness his attempted definition of a straight line, which merely encourages a pupil to deceive himself with a vague word.

The imperfections of Euclid are an old controversy which need not be enlarged upon. His merit as a logician is very great, and his logic is, on the whole, a type of accurate reasoning. Those who took part in reforming his system sought at once to preserve his logical excellence and to improve the subject-matter on which it was to be exercised. This they tried to do by familiarising the beginner with the main concepts of geometry in ways more natural and more easy than those adopted by Euclid—by an early use of rule and compass, for example, which dispensed with that somewhat complicated and ridiculous problem which forms the very second proposition of Book i., "through a given point to draw a right line equal to a given finite right line," a most gratuitous stumbling-block to the beginner. They assumed the potent Baconian principle that "examples give a quicker impression than arguments." There is no doubt that the new system has made geometry much more easy in its initial stages for the young pupil, but it contains one great element of danger—it may, to a great extent, replace strict logic by rule of thumb, and accurate expression by slip-shod language. Those who have to examine papers on geometry sent by pupils from scores of different schools must admit that this danger has not been averted, and the reason is easily found. *We are at present teaching geometry on syllabuses.* So long as this plan is adhered to, there will be most perplexing diversities in the sequence of assumptions and propositions in school teaching, not unmixed with inaccuracy of expression. The present writer knows from experience that it is necessary for an examiner to keep before him several books on geometry when dealing with the work of various schools, owing to the fact that a proposition which one pupil thinks it necessary to prove another assumes as an axiom. Moreover, the whole of the pupils of a school are sometimes found to speak of a circle as *touching* a triangle at its three vertices. This is a matter dependent on the individual teacher, and it cannot be cured by any syllabus.

There are, of course, several excellent text-books on geometry, with little difference in the order of propositions, but no one of them is universally adopted. The successful reformation of the teaching of geometry seems to require an authoritative text-book which will serve as a definite guide to all teachers—such as that sanctioned by the Minister of Education in France. In the absence of such a definite guide, the present somewhat chaotic system will continue.

The writer of this article suggested, in the columns of NATURE, in the early days of the reformed system, that such an authoritative book should be issued conjointly by the universities, but the university authorities felt difficulties. Why should not the Board of Education issue such a work? Its recent circular is in itself an excellent syllabus, but the practical teacher will regard it simply as one more added to the bundle which he already possesses.

There is one recommendation in the circular with which it is impossible to agree:—"Axioms and postulates should not be learnt or even mentioned"—that is to say, they are to be treated as suppressed premises. Now every mathematical physicist encounters occasionally what seems to be a fundamental contradiction of some proved result with other known results, and it is only after it is pointed out to him that his reasoning contains a suppressed premise that the difficulty is removed. The neglect of the explicit recognition of an axiom is the same in kind as the suppressing of an important premise.

Two excellent sentences, containing a fundamental truth, must be quoted from the circular:—"It should be frankly recognised that unless the power of doing riders has been developed, the study of the subject is a failure. Although examining bodies may continue to pass candidates who merely reproduce proofs they have learnt, eked out by definitions or other matter, masters should not be satisfied with this; *the only proof of knowledge worth having is the power of applying it to new matter.*" (The italics are ours.) This is, indeed, a great truth, the importance of which in the teaching of applied mathematics is still greater than it is in the teaching of geometry, and one which every teacher should lay to heart.

GEORGE M. MINCHIN.

PHOTOMETRIC UNITS.

AN important announcement with regard to the photometric units maintained at the Bureau of Standards, America, the Laboratoire Central d'Électricité, Paris, and the National Physical Laboratory, Teddington, has been issued by the Bureau of Standards in its Circular, No. 15, dated April 1, 1909.

It was at first intended to make this announcement simultaneously in America, France, and Great Britain, but circumstances prevented this. It is desirable, however, to state authoritatively that the agreement described in the subjoined memorandum has been arrived at, and has the approval of the gas referees; and that the photometric standards of the National Physical Laboratory are being maintained in accordance with it.

R. T. GLAZEBROOK.

Memorandum as to Photometric Units.

In order to determine as accurately as possible the relations between the photometric units of America, France, Germany, and Great Britain, comparisons have been made at different times during the past few years between the unit of light maintained at the Bureau of Standards, Washington; at the Laboratoire Central d'Électricité, Paris; at the Physikalisch-Technische Reichsanstalt, Berlin; and at the National Physical Laboratory, London.

The unit of length at the Bureau of Standards has been maintained through the medium of a series of incandescent electric lamps, the values of which were originally intended to be in agreement with the British unit, being made 100/88 times the Hefner unit.

The unit of light at the Laboratoire Central is the bougie decimale, which is the twentieth part of the standard defined by the International Conference on Units of 1884.

and which is taken, in accordance with the experiments of Violle, as 0·104 of the Carcel lamp.

The unit of light at the Physikalisch-Technische Reichsanstalt is that given by the Hefner lamp burning at normal barometric pressure (76 cm.) in an atmosphere containing 8·8 litres of water vapour per cubic metre.

The unit of light at the National Physical Laboratory is that given by the 10-candle-power Harcourt pentane lamp, which has been prescribed for use by the Metropolitan Gas Referees, burning at normal barometric pressure (76 cm.) in an atmosphere containing 8 litres of water vapour per cubic metre.

In addition to the direct intercomparison of flame standards carried out recently by the national loboratories in Europe, one comparison was made in 1906 and two in 1908 between the American and European units by means of carefully seasoned carbon filament electric standards, and as a result of all the comparisons the following relationships are established between the above units :—

The pentane unit has the same value within the errors of experiment as the bougie decimale. It is 1·6 per cent. less than the standard candle of the United States of America, and 11 per cent. greater than the Hefner unit.

In order to come into agreement with Great Britain and France, the Bureau of Standards of America proposed to reduce its standard candle by 1·6 per cent., provided that France and Great Britain would unite with America in maintaining the common value constant, and with the approval of other countries would call it the international candle. The National Physical Laboratory, London, and the Laboratoire Central d'Électricité, Paris, have agreed to adopt this proposal in respect to the photometric standardisation which they undertake, and the date agreed upon for the adoption of the common unit and the change of unit in America is April 1, 1909.

The following simple relations will therefore hold after that date :—

Proposed new unit = 1 pentane candle.
= 1 bougie decimale.
= 1 American candle.
= 1·11 Hefner unit.
= 0·104 Carcel unit.

Therefore 1 Hefner unit = 0·90 of the proposed new unit.

The pentane and other photometric standards in use in America will hereafter be standardised by the Bureau of Standards in terms of the new unit. This, within the limits of experimental error, will bring the photometric units for both gas and electrical industries in America and Great Britain, and for the electrical industry in France, to a single value, and the Hefner unit will be in the simple ratio of 9/10 to this international unit.

The proposal to call the common unit of light to be maintained jointly by the national standardising laboratories of America, France, and Great Britain the "international candle" has been submitted to the International Electrotechnical Commission, and through it to all the countries of the world which are represented on that commission.

It is hoped that general approval will be secured, and that in the near future the term "international candle" for the new unit will have official international sanction.

NOTES.

AT the anniversary meeting of the Linnean Society on Monday, the gold medal of the society was presented to Dr. F. O. Bower, F.R.S., regius professor of botany in the University of Glasgow.

WE regret to announce that Dr. G. von Neumayer, Foreign Member of the Royal Society, and for many years director of the marine observatory at Hamburg, has died at Neustadt, at eighty-four years of age.

EDMOND HALLEY, the second Astronomer Royal, died on January 14, 1742, and was buried in the churchyard of St. Margaret's, Lee by Blackheath, in the same grave as his wife, who had died five years previously. In 1854 the memorial stone being much out of repair, the Commissioners of the Admiralty, who by that time had the Royal Observatory in their control, evidently considered the tomb as a national monument, and replaced the stone by a new one, the old stone being removed to Greenwich Observatory, where it is now to be seen attached to a wall. By lapse of time the second stone now requires renovation, and we are glad to know that the Commissioners of the Admiralty have under consideration the question of the repairs to be done.

AN International Congress of Applied Photography is to be held from July 8–10 next at Dresden, in connection with a photographic exhibition. Particulars may be obtained from the secretary, Dr. Veisz, Winchelmannstrass, 27, Dresden.

WE regret to see the announcement, from the Berlin correspondent of the *Times*, that Prof. Wilh. Engelmann, professor of physiology in the University of Berlin, died on May 20, at sixty-five years of age. Prof. Engelmann, who held a professorship at Utrecht for many years before his removal to Berlin in 1897, was an eminent authority upon muscular and nervous, especially cardiac, anatomy.

PROF. C. D. PERRINE, of the Lick Observatory, has been appointed director of the Argentine National Observatory, Cordoba. His work with the Crossley reflector is to be taken over by Dr. H. D. Curtis, now in charge of the D. O. Mills expedition at Santiago, and the latter will be succeeded by Mr. J. H. Moore, of the Lick Observatory. Prof. Perrine will arrive at Cordoba at the end of this month, and he asks that all correspondence shall be directed to him there.

PROF. DAVID TODD, of Amherst College, Massachusetts, is about to undertake an experiment for determining the composition of the air at high levels, and the cause of mountain sickness. He intends to make several balloon ascents in a closed car from Canton, Ohio, the interior of the country being considered preferable owing to freedom from seaward air currents. Rarefied air will be pumped into the car to keep the pressure at normal. The Aëro Club of New England has offered Prof. Todd the use of its new balloon, the *Massachusetts*, of 56,000 cubic feet capacity, for the purpose of his experiments.

THE Blue Hills Meteorological Observatory, near Boston, is about to lose, by his resignation, the services of Mr. Henry Helm Clayton, who has been in charge of it since 1894, and has made it one of the most important weather stations in America. He is to be succeeded by Mr. A. H. Palmer, now at Harvard. Mr. Clayton intends to attempt shortly a balloon trip from San Francisco to the Atlantic coast, as a preliminary test of the possibilities of an air voyage over the Atlantic. He believes that he can accomplish these feats by taking advantage of an upper air current which appears to flow constantly eastward at a height of about two miles above the earth's surface.

AN incident reported from Wisconsin suggests something of the possibilities latent in "Christian science" and allied notions as a menace to public health. In the Legislature of that State there was recently introduced a Bill providing that, in connection with lessons in elementary hygiene, the pupils in the "public schools" should be taught how to avoid contagion and the commoner ailments. There immediately poured in hundreds of letters and petitions protesting against such a policy, as it would give children the impression that disease was real. The opposition was so strong that the Assembly Committee on Public Health, in spite of the efforts of three physician members, was intimidated into killing the proposal at its first hearing.

A DIRECTOR will be appointed shortly for the Australian Institute of Tropical Medicine, which has been founded to further the scientific study of the diseases peculiar to tropical Australia, and to afford opportunities for the training of medical men in this department of medicine. The institute will be situated in Townsville, Queensland, where a large and well-equipped general hospital exists. The general control of the institute is vested in a committee appointed by the Universities of Sydney, Melbourne, and Adelaide, and one representative of the Government of Queensland. The director will be required to organise and administer the institute, to conduct investigations into the tropical diseases of Australia, and to give such instruction in tropical diseases as may be determined upon, and superintend research work undertaken in the laboratories of the institute. The appointment will be, in the first instance, for five years at a salary of 600*l.* per annum. The selection of the director will be made by a committee of three representing the Royal Society, the London School of Tropical Medicine, and the Liverpool School of Tropical Medicine.

LAST week we referred to the new museum, at Truro, of the Royal Institution of Cornwall. At a meeting of the institution held on May 25 it was announced that the following letter had been received from the Duchy of Cornwall Office:—"The Prince of Wales has been pleased to sanction a donation of 200 guineas from the Duchy revenue to the fund for a new county museum at Truro. His Royal Highness directs that the donation may be given in memory of Sir Humphry Davy and Richard Trevithick, two great Cornishmen who commenced their careers with few advantages and left names which can never be forgotten. His Royal Highness hopes that with increased facilities for the study of science and art the great traditions of the Duchy may be more than maintained."

IN his article on "The Government and Aëronautical Research" in NATURE of May 13 Prof. Bryan remarked:—"The Aëronautical Society mainly exists for the purpose of promoting discussions on aëronautical matters." Mr. Eric S. Bruce, late honorary secretary of the society, writes to say that, from the days of its foundation in 1866, the society has had wider objects and aims than merely debate. Experiments have been encouraged, a "well-illustrated" journal has been published, and it is hoped that a well-equipped aëronautical laboratory may before long be established. "Another special object has been the establishment of a comprehensive aëronautical library, and many of the important works on aëronautics in various languages have already been collected." Prof. Bryan has favoured us with the following remarks upon the subject of Mr. Bruce's letter:—"No difference of opinion can possibly exist as to the value of libraries, laboratories, practising grounds, and properly conducted experiments in furthering the progress of aëronautics. But while the Aëronautical Society deserves full credit for all that it has done in the right direction, it would be invidious to single it out without referring in equal detail to claims of a similar or different kind possessed by the other two bodies under discussion. The Aëro Club also has its experimental ground, while the Aërial League attaches the greatest importance to scientific research, which it proposes to further by founding and endowing a college. If this movement receives the support which it deserves, that institution should certainly become the leading authority on all scientific developments of aëronautics. In the accounts of the amalgamation given in the daily papers a claim to that position was put forward on behalf of the Aëronautical Society. But the right of a society to rank among the leading scientific bodies must necessarily depend largely on the maintenance of a uniformly high standard of scientific value and accuracy in the communications published in its Proceedings, and an examination of the Journal shows that such a claim could not be admitted unchallenged in the columns of NATURE any more than the description of the Journal as 'well illustrated' could be allowed to pass without referring to the figures on pp. 52, 53, of the April number. For this reason the sentence quoted by the energetic and enterprising ex-secretary was chosen after careful consideration as indicating the special and distinguishing characteristics of the society better than any statement of a more ambitious character."

WHAT is perhaps the largest prehistoric relic found in England has just been secured for the Hull Municipal Museum. This is the well-known "dug-out" boat found during excavations at Brigg, Lincs, in 1886. The boat is cut from a single piece of oak, more than 48 feet in length and 6 feet in width—a much larger size than any oak tree living in Britain to-day. With the boat were found many interesting relics, and these have also been presented by Mr. V. Cary-Elwes. Mr. T. Sheppard, the curator of the museum, has successfully removed the boat to its new quarters, where it forms a welcome addition to the already large series of Lincolnshire antiquities.

A MAGNETIC storm of some size was recorded at Kew during May 14 and 15. It commenced suddenly at about 5.0 a.m. on May 14, the initial change of horizontal force —about 70 γ in five minutes—being unusually large. The total range was about 400 γ in horizontal force and 54′ in declination. The largest and most rapid changes took place between 4 p.m. and 6 p.m. on May 14. Westerly declination diminished by about 48′ between 5.12 p.m. and 5.18 p.m. The vertical force was continuously in excess of its normal value between 2 p.m. and 10 p.m. on May 14, the excess not falling short of 100 γ between 2.40 p.m. and 8.40 p.m. There were no large movements after 4 a.m. on May 15, but the curves remained somewhat disturbed until the evening. There was a marked appearance at times of continuous oscillatory movements of the type which usually accompany aurora.

IN his recent discourse at the Royal Institution, which we hope to publish in an early issue, Prof. Ronald Ross referred to the neglect of malaria prevention for ten years in many British possessions. In answer to a question upon the subject asked by Mr. Ramsay MacDonald in the House of Commons a few days ago, Colonel Seely referred him to the report of the advisory committee for the Tropical Diseases Research Fund for the year 1907 (Cd. 3992) containing reports relating to malaria. He added:—"These reports show, I regret to say, that nothing of any consequence had been done in the direction indicated at that time. The reports in question have, with the rest of the matter contained in the Blue-book, been brought to the notice of the schools of tropical medicine, but action to be effective must needs be taken by the Governments concerned, with the cooperation of the general community."

IN the House of Commons on May 20 Mr. Balfour asked the Prime Minister whether he could state the nature of the duties entrusted to the scientific committee on aërial navigation, and explain the relation of the committee to the executive officers who were understood to be

designing balloons and aëroplanes for naval and military purposes. In answer to the question Mr. Asquith said:—"It is no part of the general duty of the advisory committee for aëronautics either to construct or to invent. Its function is not to initiate, but to consider what is initiated elsewhere, and is referred to it by the executive officers of the Navy and Army construction departments. The problems which are likely to arise in this way for solution are numerous, and it will be the work of the committee to advise on these problems, and to seek their solution by the application of both theoretical and experimental methods of research."

ON Tuesday next, June 1, Dr. F. Gowland Hopkins will begin a course of two lectures at the Royal Institution on "Biological Chemistry"; on June 3 Prof. W. E. Dalby will commence a course of two lectures on "A Modern Railway Problem: Steam *v.* Electricity"; and on Saturday, June 5, Dr. F. F. Blackman will deliver the first of two lectures on "The Vitality of Seeds and Plants," (1) "A Vindication of the Vitality of Plants," (2) "The Life and Death of Seeds." The Friday evening discourse on June 4 will be delivered by Prof. J. A. Fleming, on "Researches in Radio-telegraphy," and on June 11 by Sir James Dewar, on "Problems of Helium and Radium." An extra discourse will be delivered on June 18 by Mr. A. Henry Savage Landor, on "A Recent Visit to the Panama Canal."

WE have received a copy of a special report on the establishment and organisation of a research laboratory at the Crichton Royal Institution, Dumfries, which has been submitted to the board of direction by Dr. C. C. Easterbrook, the physician superintendent. It is suggested that the laboratory shall be devoted to study and research in nervous and mental disorders. Dr. Easterbrook proposes that three Crichton fellowships be established for the promotion of psychiatrical research, one in clinical neurology and psychology, one in pathology and chemistry, and one in pathology and bacteriology. Each fellowship should be, he maintains, of the value of 250*l.* a year with residence in the institution, or 50*l.* additional in lieu thereof. Particulars are given of what might well be the general qualifications and previous training of candidates, and indications are supplied of how such fellows could, by working in a research laboratory, benefit the institution as well as medical science.

IN a note upon changes in the staff and administration of the London Zoological Gardens which appeared in NATURE of May 13, it was announced that the curators will have to devote their whole attention and time to the care of the animals under their charge, and therefore "will have no time to spend on scientific zoology." Dr. Chalmers Mitchell, secretary of the society, writes to say that while it is certainly intended that the first duty of the curators shall be the care of the living animals in their charge, "such work opens as wide a field for research in 'scientific zoology' as the anatomical and systematic investigations to which, by implication, the writer of your note would seem to restrict the phrase." He is convinced that "the council will welcome the scientific work of the staff in whatever direction that may be, so long as it is compatible with the discharge of their duties." In the *Times* announcement of the changes it was stated that the curators were expected to devote all their energies to "curating," an expression which the writer of the note took (and still takes) to mean that they were not to spend time on scientific work.

THE British Fire Prevention Committee, which was founded on the occasion of the great Cripplegate fire of 1897 and incorporated in 1899, is celebrating the tenth anniversary of its incorporation this week. The greater knowledge of building materials and appliances obtained by scientific independent tests at the committee's testing station has done much to obtain a better understanding of the value and also the limitations of different methods of construction and equipment, whilst considerable influence has also been exerted by the committee in guiding building and fire service legislation in directions where it is most effective to prevent loss of life and loss of property. The objects tested by the committee since its formation numbered 160 to the end of last year, and it should be understood that the investigation into any one object sometimes requires as many as twenty or thirty testing operations. Notable tests have been those with large reinforced concrete floors, a series of fifty fire-resisting doors, fire-resisting glazing, and latterly also with safety devices. Perhaps a final feature that claims remark is that the whole of the funds required for the establishment of the committee's testing station and the execution of its work have been raised voluntarily, that more than 20,000*l.* have been expended in ten years on the work of the committee, and that the whole of the services rendered by the committee and its officers are voluntary.

SOME interesting details of the scientific achievements of the British Antarctic Expedition under Lieut. Shackleton are given in Monday's *Times*. The communication is from the New Zealand correspondent of the *Times*, and is based upon information provided by Prof. Edgeworth David. From the article we learn that a number of the rotifers found in the lake muds were of the same variety as those already described by the biologist of the expedition (Murray) in Spitsbergen and Franz Josef Land. This was especially the case in regard to the species *Macrobiotus arcticus*. A point of special interest in regard to the marine fauna near Cape Royds is that it may provisionally be concluded that it bears some distant resemblance to the types of animal life of the Coal-measure series of Australia and Tasmania. The possibilities of the Antarctic having been an archipelago can no longer be entertained. There is a high continental plateau extending from the new mountains recently discovered by the *Nimrod* expedition forty-five miles west of Cape North to the magnetic pole across the plateau traversed by Captain Scott of the *Discovery*, and over the portion traversed by Lieut. Shackleton in his furthest south journey to beyond the South Pole itself—probably for a distance of 1800 miles. The most interesting geological discovery was that of Coal-measures at least 1500 feet thick in latitude 85° S. There were at least seven seams of outcrop in the cliff face of the great nunatak where the discovery was made; they varied in thickness from 1 foot to 7 feet. Abundant small fossil root impressions were present in the fire-clay found with some of the seams. The general geological results of the expedition show that there is a very ancient series of crystalline rocks similar to those already described by Ferrar, of the *Discovery*, forming the foundation platform from near the South Pole to Cape North. The whole of this basal series gives every promise of minerals of the rare earths in more or less abundance. Superimposed upon these basal beds is the sandstone formation already described by Ferrar as the "Beacon" sandstone. Above the sandstones, on a series of volcanic rocks, occur immense lava sheets more or less horizontally bedded. As regards volcanic eruptions, it is interesting to note that

Erebus, like Stromboli in the Mediterranean, formed a good barometer, for as the mercury fell in the barometers of the expedition so did the steam cloud over Erebus rise higher and higher. Nearly all the principal steam eruptions took place when the barometer was at its lowest.

WE have to acknowledge the receipt of vol. v., part ii., of the *Boletim do Museu Goeldi* (*Museu Paraense*), the greater portion of which is devoted to botanical subjects, although there is one paper, by Dr. Emilia Snethlage, on new Amazonian birds in the collection of the museum, and a second by the same author on certain new fishes from the Amazon and its tributaries, recently described by Dr. Steindachner.

THE categories of variation form the subject of the first and longer article, by Prof. S. J. Holmes, in the May number of the *American Naturalist*. After directing special attention to mutations, the author concludes as follows:—"If sudden mutations have been a not uncommon source of varieties of domesticated animals and cultivated plants, it does not follow that the selection of comparatively small variations has not been the predominant method of species-forming in a state of nature. After fifty years from the publication of Darwin's 'Origin of Species' we are still debating; and more lively than ever, the central problem of that epoch-making book; but it is not improbable the views of its sagacious author will prove more nearly correct than those of most of his modern critics."

IN describing, under the name of *Isocrinus knighti*, a new crinoid from the Upper Jurassic of Wyoming, we are glad to see that Mr. F. Springer, in No. 1664 of the Proceedings of the U.S. National Museum (vol. xxxvi., pp. 179–99), decides not to replace the well-known name *Encrinus liliiformis* or to transfer it to another species, although, according to strict interpretation of rules, there may be grounds for so doing. "I shall maintain," he writes, "that, irrespective of the merits of their original titles to priority, the names of Encrinus and Millericrinus have become valid simply by the lapse of time, by long usage in the sense in which they are now generally understood; and that by reason of universal acquiescence in such use for nearly a century, zoologists are now estopped from disputing them." These are golden words, and it is most satisfactory to find that Mr. Boulenger's revolt against the priority-fetish has spread to America, where the fetish is most highly worshipped. We trust the revolt will continue to spread.

BROWN-BEAR hunting in Alaska forms the subject of a very fully illustrated article, by Mr. G. Mixter, in the April number of the *National Geographic Magazine*, the article concluding with an extract of a report on these bears by Mr. W. H. Osgood. After mentioning that Alaska is unrivalled in regard to the number and variety of its bears, and that the brown bears are the largest in the world, with the exception of the Polar species and their own relations in Kamchatka, the latter author considers that the days of these bears are numbered, and that these animals will ere long be exterminated except in the more remote districts. The brown bears vary greatly in colour, ranging from dark seal-brown to buffish-brown, with the legs and under-parts generally darker than the back. Although the ends of the hairs are often paler than the bases, the silver-tipped fur of the grislies is never seen, while the front claws are shorter, thicker, and more sharply curved than those of the latter.

THE osteology and affinities of the Jurassic American iguanodont reptiles of the genus Camptosaurus form the subject of a long paper, by Mr. C. W. Gilmore, published as No. 1666 of the Proceedings of the U.S. National Museum (vol. xxxvi., pp. 197–332). As the result of additional materials, the author is enabled to give a new definition of the genus, while special attention is also directed to the three English reptiles which have been assigned to the genus by Mr. Lydekker. All three are admittedly very nearly allied to the American genus, and the author at present sees no reason for separating the Kimeridgian *C. prestwichi*, although in certain points it comes closer to Iguanodon than to the typical Camptosaurus. On the other hand, the femur from the Oxfordian on which *C. leedsi* was founded appears to come nearer to the corresponding bone of the American Dryosaurus, and the species may therefore be distinct from Camptosaurus, the same remark applying to the still more imperfectly known *C. valdensis* of the Wealden of the Isle of Wight.

WE have been favoured with parts of the *Journal botanique de la Société impériale des Naturalistes* of St. Petersburg (Nos. 2 to 6, 1908). Papers on the algæ of the Black Sea are contributed by Mr. K. N. von Deckenbach and Mr. N. N. Woronichin. The former provides new records for species and localities; the latter, a more extensive paper, deals with the identification of green algæ from several collections, and supplies a list of nearly fifty species, but none of them is endemic. Two articles on the distribution of plants are contributed, the one, by Mr. J. Perfiliew, on the government of Wologda, the other, by Miss H. Poplavska, on the government of Pskov. A genus, Luenovia, is created by Mr. W. Sukatscheff for a new blue-green alga under the order Hormogoneæ.

ADDITIONAL notes on the economic aspects of the oil palm, *Elaeis guineensis*, are given in the current issue (No. 4) of the *Kew Bulletin*, compiled from information supplied by officers in Nigeria, Sierra Leone, Gambia, and the Gold Coast. The chief factors affecting habitat are a rainfall of more than 70 inches and a soil rich in humus but well drained. Plantations are only occasionally met with, as among the Krobos of the Gold Coast, but there is no difficulty in raising young plants. The method of tapping the palms for "wine," which tends to the destruction of numbers of trees, is described. At the present time, and until transport facilities are improved the sources of supply are more than adequate.

PROF. C. F. CHAMBERLAIN has supplemented his paper on the female gametophyte of the cycad *Dioon edule* by an account, published in the *Botanical Gazette* (March), of spermatogenesis in the same plant. The staminate cones measure 10 cm. to 20 cm. in length; the numerous sporophylls bear about 250 sporangia, and the average output of a sporangium is placed at 30,000 spores. One persistent prothallial cell is developed. The sperms, produced in pairs in a mother-cell, are only slightly smaller than the sperms of Zamia, and, like them, are just visible to the naked eye, as they measure about 1/40-inch. The movement of cilia is accompanied by pulsating and amœboid movements. Two blepharoplasts are formed which eventually break up into granules from which the spiral ciliated band of the sperm is developed.

AN account of trees on the Dawyck estate, in Peebles, by Mr. W. B. Gourlay, is published in the latest number (vol. xxiii., part iv.) of the Transactions and Proceedings of the Botanical Society of Edinburgh, in which it is stated that larches were planted on this estate in 1725, or thirteen years before the first introduction to Dunkeld; the survivors are much weather-beaten, but the estate lies

in an extremely cold region. Silver fir, *Abies pectinata*, grows well, and some large trees, one of which reaches a height of 115 feet, date back to the year 1735. Two horse-chestnuts, said to be the first planted in Scotland, probably date back a few years earlier. Plantations of the common larch are subject to disease, but the Japanese larch is healthy, and the Douglas fir thrives in sheltered situations.

THE classic experiments by Moll concerning the absorption of carbon dioxide from the air will be familiar to most botanists, more especially as illustrations are given in Vines's "Physiology of Plants." The experiment where a leaf was inserted between two glass dishes has been further investigated by Dr. V. Zijlstra, who has embodied his results in a brochure on the transport of carbon dioxide in leaves. He finds that when part of a leaf is placed in an atmosphere devoid of carbon dioxide, and the adjacent part of the leaf is covered, then the carbon dioxide formed in this part of the leaf in respiration diffuses through the leaf, and a band of starch is formed beyond the screen. The band varies from 5 mm. in the dahlia to 2·5 cm. in wheat, while through the leaves of Eichhornia and Pontederia the gas can diffuse much more readily.

IN the May number of *Man* Dr. F. C. Shrubsall describes two crania and some long bones from ancient ruins in Rhodesia. The skulls seem to be of the Bantu, not of the Bushman, type; in other words, they belong to a negro race similar to the inhabitants of Rhodesia at the present day. The position in which these remains were found seems to indicate that they were coeval with the buildings near which they were discovered. While this does not, of course, prove that negroes were the builders of the famous ruins, it is significant to note that the remains do not belong to any of the more northern races. The fact that the bones were associated with valuable gold ornaments precludes the supposition that these negroes had been enslaved by the foreigners, who, according to one theory, were the builders of these remarkable structures.

WE have received copies of two fasciculi, one dealing with Oligochæta and Hirudinea, and the other with Nematodes, Gordiidæ, &c., of *Die Susswasserfauna Deutschlands, eine Exkursionsfauna* (Jena: G. Fischer). The parts (of which those before us are respectively numbered 13 and 15) are sold separately, at a price varying between one and two shillings each, and they are issued in narrow duodecimo form, so as to be convenient for carrying in the pocket. Each part is, moreover, written by a specialist, and sufficiently, although diagrammatically, illustrated, and the whole work appears, therefore, to be admirably adapted for the purpose for which it is intended, namely, as a companion for the field-naturalist.

THE report of the Bombay and Alibag observatories for the year 1908 has been received. White ants cause much damage at the Colaba (Bombay) Observatory; glass insulators filled with kerosene have been provided for the presses containing the records, but it is doubtful if they will prove efficacious. The rainfall for the year amounted to 53·54 inches, being 21·62 inches below the average for 1873–96; of that amount, 52·70 inches fell between June and September inclusive, the period of the south-west monsoon. Milne's seismograph registered forty-eight earthquakes, besides several small movements; great disturbances occurred on January 11, February 9, August 20, and November 2. A table prepared in accordance with the suggestion of the International Commission for Terrestrial Magnetism, representing the magnetic character of each day, shows that there were 135 calm days, the remaining days of the year showing small or larger disturbances; six of the latter were days of great disturbance. The mean declination was 1° 2′ east.

THE ballistic galvanometer method of measuring quantities of electricity has proved so convenient and flexible that it has been used to determine changes of magnetic induction in cases to which it was not strictly applicable. According to the simple theory of the instrument, the whole of the electricity must have passed through it before the moving part of the instrument has had time to move appreciably from its position of rest. Prof. O. B. Pierce, of Harvard, has investigated the behaviour of a d'Arsonval galvanometer the period of swing of which was raised to ten minutes by attaching to the coil a circular disc with a weighted rim. He finds that the simple theory is still applicable to such an instrument, and has by means of it measured the changes of magnetic induction through large electromagnets. His memoir forms No. 11 of vol. xliv. of the Proceedings of the American Academy of Arts and Sciences.

SOME comparison tests between the new Féry spiral pyrometer and a standardised thermoelectric Féry radiation pyrometer are recorded in *Engineering* for May 14. The spiral pyrometer has the advantage over other types of radiation pyrometers in that it is self-contained. The instrument consists essentially of a very small spiral made of a strip of two metals having very different coefficients of expansion, and having a pointer attached. The spiral unrolls when heated, and the pointer travels over a scale indicating the temperature of the furnace. Rays coming from the furnace are reflected by a concave mirror and sent to the spiral, any radiation passing through the spiral being reflected back to it by means of a second small mirror. The whole is contained in a tube furnished with a focussing arrangement by means of which the observer directs the instrument towards the furnace and obtains an image of it. Adjustment of the zero of the instrument is easily effected. The tests were conducted by Mr. G. C. Pearson in the retort-house of the Birmingham Gas Works, and ranged between 845° C. and 1260° C. The greatest difference between the readings of the two instruments amounted to 10° C. at 930° C.; the mean of twelve readings shows the spiral pyrometer to be reading about 1° C. in excess of the thermoelectric pyrometer. The maker's claim of an accuracy within 1 per cent. or 2 per cent. is thus amply justified. The instrument is being constructed in this country by the Cambridge Scientific Instrument Company.

A SERIES of special demonstrations on the use of microscopes, and various microscopic appliances and accessories, has been held during the past week or so at the London depôt, 9–15 Oxford Street, of Mr. Ernest Leitz, of Wetzlar. It is generally known that this firm was practically the pioneer in the production of cheap microscopes and objectives of Continental make, and an inspection of the apparatus now shown clearly indicates that, though a low standard of price is maintained, the apparatus produced is of a very high class. It is interesting to note that in the production of the new types of microscope stands the firm is being largely influenced by English ideas of design; the result is a type of instrument which combines to a considerable extent the Continental horse-shoe foot and the much more stable English tripod foot. Could Mr. Leitz carry this innovation somewhat further, he would be in a position to produce an instrument which in point of design and for general stability and convenience

in use would have few equals and probably no superiors. The episcopic and diascopic projection apparatus is of a very complete order, and admits of being used for photomicrographic work as well. The dark ground illuminators, and also some recently introduced appliances for metallurgical work, are of special interest. An entirely new design of apparatus, adapted for both visual and photographic purposes in metallurgy, is also exhibited, and in this a definite departure from existing methods is to be seen. The microtomes are also of new design, and are of very substantial construction. A visit to the premises of Mr. Leitz at the present moment cannot fail to be of interest to microscopists, or to those to whom the microscope may be of either practical or scientific value.

MR. JOHN MURRAY has just issued the fourth edition of Mr. W. C. D. Whetham's book on "The Recent Development of Physical Science." The book was published first in 1904, and was noticed in NATURE of January 26, 1905 (vol. lxxi., p. 291). The present issue is fundamentally the same as the third edition published four years ago, though a few additions have been made.

No. 168 of Ostwald's *Klassiker der exakten Wissenschaften*, published by Mr. W. Engelmann, Leipzig, contains papers on the stereoscope by Wheatstone, Brewster, Riddell, Helmholtz, Wenham, d'Almeida, and Harmer, edited and annotated by Mr. M. von Rohr. The volume makes an interesting contribution to the history of the stereoscope for German readers.

THE thirteenth revised and enlarged edition of "Prantls Lehrbuch der Botanik," edited by Prof. F. Pax, has been published by Mr. W. Engelmann, Leipzig. The text has been extended, and now occupies nearly five hundred pages. The price—six marks—for a volume of this number of pages, and almost the same number of figures, is remarkably low.

PROF. R. ZSIGMONDY'S valuable work upon the application of the method of ultramicroscopy to the study of solutions of colloids has been translated into English by Mr. T. Alexander, and published by Messrs. J. Wiley and Sons (London: Chapman and Hall, Ltd.) under the title "Colloids and the Ultramicroscope." An appreciative notice of the original German work appeared in NATURE of March 1, 1906 (vol. lxxiii., p. 410). The price of the English edition is 12*s.* 6*d.* net.

OUR ASTRONOMICAL COLUMN.

A GENERAL SOLUTION OF THE SPECTROHELIOGRAPH.—A paper by M. Deslandres, published in No. 15 of the *Comptes rendus*, describes a "general purposes" spectroheliograph recently set up at Meudon in which are combined four distinct instruments for the photographic registration of the phenomena of the solar atmosphere. All these instruments are fed by the same cœlostat and objective.

The first is an ordinary spectroheliograph giving the forms of the flocculi in Hα light, the dispersion and reflection being performed by a reflection grating. If the grating be removed from the path of the collimated ray the latter falls on a train of prisms, which deviates it into a second camera of 3 m. focal length giving K_3 and K_2 images, for comparison with the Hα images, of 80 mm. diameter.

If it is desirable to isolate a special line the camera objective of the second instrument is replaced by a plane mirror, so that the ray is reflected into the third spectroheliograph arranged for the easy isolation of any special radiation, whilst if this instrument be removed the ray passes into the fourth instrument, of much greater length and having three slits, so that very fine lines, or definite portions of broad lines, may easily be isolated. It is with the latter form that M. Deslandres has recently obtained the fine images, with K_3 and Hα radiations, showing the dark filaments.

The requisite motions are imparted to the objective forming the primary image, and to the photographic plate, by synchronised electric motors and speed transformers, and M. Deslandres states that the change from one instrument to another is a simple matter; the complications are more apparent than real.

THE BRIGHTNESS OF THE CORONA.—Lick Observatory Bulletin No. 153 contains a brief review, by Prof. Perrine, of the results obtained from the attempts to measure the total brightnesses of the corona during the total solar eclipses of 1905 and 1908.

Among other things, it is shown that the ratio of the intrinsic actinic brilliancy of the brightest parts of the corona to that of the surrounding sky is 744/1, whilst the ratio of total coronal, to full moon, light is 0·111. The results also indicate that there are sufficient differences of brightness of the corona at successive eclipses to be detected by the methods employed at Flint Island in 1908.

A STANDARD SCALE OF PHOTOGRAPHIC MAGNITUDES.—In Circular No. 150 of the Harvard College Observatory Prof. Pickering points out the urgent importance of fixing upon some standard scale of photographic magnitudes for international adoption, and describes the work already done in this connection at Harvard. The method of polar sequences, in which the region to be investigated is photographed on the same plate and under the same conditions as the polar region, has been found to give satisfactory results, and the absolute magnitudes of a sequence of forty-seven stars in the latter region have been determined. Other sequences are being prepared, and Prof. Pickering states that the Harvard College Observatory is prepared to devote a large part of its resources to the work if a satisfactory scale can be universally adopted.

THE ORIGINS OF SATELLITES.—In a telegram to the *Astronomische Nachrichten* (No. 4323, May 17), Prof. See announces that he has rigorously demonstrated that satellites were all captured, and states that he is sending a paper setting forth his demonstration.

THE SPECTRUM OF MOREHOUSE'S COMET.—With a quartz spectrograph attached to the 80-cm. refractor of the Potsdam Observatory, Prof. Hartmann obtained a spectrum of comet 1908*c* on October 27, 1908; the exposure was 140 minutes, and the slit width 0·1 mm. Three faint pairs of lines are shown at wave-lengths 3874·2, 3908·6; 4001·1, 4020·0; and 4252·8, 4275·8. The first of these is very broad, and corresponds to the head of the third cyanogen band, whilst the origins of the other pairs are as yet unknown (*Astronomische Nachrichten*, No. 4322).

THE ORBIT OF ξ BOÖTIS.—An orbit for ξ Boötis, previously published by Prof. Doberck, was determined by aid of Sir Wm. Herschel's position angles, and no longer represents the observations. Consequently, Prof. Doberck has determined a new orbit, using only the measures made since 1830, and publishes it, together with an ephemeris until 1915·5, in No. 4322 of the *Astronomische Nachrichten*; the following are the elements:—$\vartheta = 171^\circ\ 37'$, $\lambda = 346^\circ\ 52'$, $\gamma = 32^\circ\ 54'$, $e = 0{\cdot}5061$, $P = 179{\cdot}60$ years, $T = 1907{\cdot}84$, $a = 5{\cdot}015''$, retrograde. The hypothetical parallax of this system is $0{\cdot}158''$.

THE BIRTH OF WORLDS.—In *Cosmophysics*, "an international journal of astrophysics," described as the organ of the Wainoni Park Astrophysical Society, Christchurch, New Zealand, Prof. A. W. Bickerton sets forth his complete theory of stellar creation. Numerous recent observations of stars, novæ and their spectra are introduced into this summary in order to demonstrate that lucid stars are formed by the collision of two cosmical masses. The new body, however, is not the combined mass, but, according to Prof. Bickerton's theory, is a third body formed by the masses detached from the colliding bodies by the force of the impact; the latter, after their impact, go on their respective journeys as variable stars.

SELECTIVE WIRELESS TELEGRAPHY.

A PAPER by Dr. Alex. Muirhead and myself, on some experiments and measurements in accurate wireless tuning with open-circuit radiators, and the conditions under which perfect selection is possible, was read to the Royal Society in January of this year, and will appear in a forthcoming issue of the Proceedings.

The essence of it is that in signalling across land both radiator and receiver must be completely insulated from, and elevated above, the earth, if they are to be persistent oscillators such as are capable of accurate tuning. Earth connection damps out the vibration and spoils tuning: and to get the best effect the lower capacity area must be not only insulated, but must be elevated above the earth until its capacity with respect to the upper aërial is a minimum.

To prove this, the received energy was measured at a distant station by a Duddell hot-wire meter; and several series of measurements were taken with the lower capacity at different heights above the earth, and also when connected with the earth.

The sensitiveness of a thoroughly tuned Lodge-Muirhead system is extreme; small power is sufficient, and the inductive connection of the collector to the receiving instrument may be separated by a surprising interval without stopping communication.

Under these non-earthed conditions every other station, even near and powerful ones, can be tuned out and their disturbance eliminated.

Directly earth connection is made, tuning of the radiator and collector is nearly gone, for they no longer have any persistent free vibration period. Samples of a large number of measurements are recorded in the paper.

But from the paper as originally sent in an account of the most striking experiment to illustrate the facility and perfection of tuning on this system, when insulated capacity areas are employed without any earth connection, was accidentally omitted, though it has since been communicated to the society. The experiment was made on May 14, 1907, and may be briefly described.

Preliminary Information.

Each aërial of the Lodge-Muirhead system consists of a pair of capacity areas in the form of a couple of very open "Maltese crosses" or squares of wire suspended horizontally from four posts like the framework of a carpet, one above the other, and both well insulated from the earth. Connection with each is made in the middle by a special elaborately stranded cable to the instruments, but no earth connection is made at all.

A wheel coherer—revolving steel disc dipping into oiled mercury—is employed as detector under the conditions of accurate tuning; or sometimes a point coherer, similarly treated with oil. An electrolytic coherer is even more sensitive, but its leakage damps vibrations out and prevents the accumulation of impulses necessary for accurate tuning, whereas the film of oil on the wheel coherer insulates until the oscillations in the receiving tuned condenser circuit have mounted up sufficiently to break it down and overflow through the detector.

That is in brief summary the way signalling works, and the following account has reference to signalling across Kent between Elmer's End and Downe.

Experiment in Diplex Telegraphy.

At two stations, Downe and Elmer's End respectively, the upper capacity area of each aërial was bisected diagonally, the two triangular halves being insulated from each other, and each connected to its own independent receiving or sending arrangement. The lower aërial was not bisected, but was doubled, an additional insulated area being placed a few feet below the ordinary one. By this means each station was practically doubled, and the two halves at each station made to correspond to a different wave-length.

Two senders at Elmer's End were then set to work simultaneously, one to transmit the word "Liverpool" continuously for a long time, the other the word "steamships" continuously in the same way. Two independent receivers at the Downe station—one of them a siphon recorder and one a telephone, though both might easily have been automatic recorders—each of them inductively connected with one half of the aërial there, now received simultaneously, one of them a succession of "Liverpools," the other a succession of "steamships," without the slightest confusion or interference or overlapping of any kind.

In other words, diplex telegraphy (as distinct from duplex) was found quite easy on this system of tuning, which was specified by one of us in 1897.

Experiment in Selection or Tuning Out.

Another experiment more recently tried is the following. Two stations were arranged at Downe, 1200 feet apart, either of which could speak with great ease to Elmer's End, and was strong enough to speak to a station thirty miles away. One of the Downe stations was then switched on to "receiving," and both Elmer's End and the other station at Downe were set speaking to it.

The wave-length of one was 300 metres, of the other 660 metres, so as to compare Civil with Admiralty conditions.

By the mere motion of a handle the frequency of the receiving station could be altered at will so as to correspond either with the neighbouring sending station 1200 feet off, or with the distant sending station seven miles off—which distance might, however, have been increased immensely without any difficulty. A few trees intervened between the neighbouring stations.

In these circumstances, when properly adjusted, each station could be heard separately; that is to say, messages could be received first from one tuned-in station and then from the other, without any disturbance from the station tuned-out, although both stations were sending all the time strongly and simultaneously. The ease and large margin with which selection could be achieved shows that the two neighbouring stations could have been put still nearer, while still retaining the power of complete tuning-out.

Testing of Margin of Selection.

Further experiments in the same direction were conducted as follows:—

The two stations at Downe, 400 yards apart, were rearranged so that there were no trees between, only a few low hedges, thus making the test manifestly more severe. A given power was then employed for sending at one of these neighbouring stations, and the same power at the distant Elmer's End station, while the other neighbouring station was arranged for receiving from either of these two at pleasure. Experiment was now directed to determine the conditions under which the neighbouring station could be completely cut out, while still the distant one could be clearly heard. In other words, to determine the amount of separation between the primary and secondary of the inductive connection which would eliminate all disturbance from the neighbouring station adjusted to ordinary commercial wave-length, while it would permit perfect signals to be received on the siphon recorder from the distant tuned station of longer or more nearly naval wave-length.

Case 1.—Elmer's End sending with a wave-length of 580 metres. Neighbouring Downe sending with a wave-length of 300 metres. The receiving Downe station was attuned so as to cover a range of wave-length about 580 metres on the average, but extending more than 20 metres above and below. Under these conditions it was possible completely to cut out the local station on a coupling of $3\frac{1}{2}$ inches, that is, with $3\frac{1}{2}$ inches separating primary and secondary coil of the inductive connection; whereas from Elmer's End perfect signals could be obtained without disturbance on any coupling between $3\frac{1}{2}$ inches and 7 inches. Indeed, as the exact pitch was reached at the receiving adjustment, the signals received boomed out, as it were, very strongly.

Case 2.—The Elmer's End wave-length was shortened to 510 metres, the local Downe station remaining at 300 metres, and again a series of readings was taken at the receiving Downe station adjusted to an average of 510 metres wave-length.

The coupling separation, which now just managed to cut out the local station, was 4 inches. Anything above

4 inches gave perfect signals from Elmer's End, and no disturbance.

Case 3.—On shortening the distant wave-length still more, so as to make it 450 metres, the neighbouring station could not be completely cut out without at the same time introducing a trace of superposed disturbance into the messages received from the distant station.

Case 4.—The difference of wave-length between the two stations was now, therefore, again slightly increased, the Elmer's End wave-length being adjusted to 480 metres, with the local station still remaining at 300.

In this case perfect and strong signals could be received from Elmer's End again, but the separation of the inductive connection had to be as much as 6 inches in order completely to cut out the local signals from the neighbouring station.

It follows, therefore, that when two powerful stations are so excessively near each other as they were in this case—namely, in adjoining fields—a distant signal can be heard with perfect clearness, *i.e.* without any trace of disturbance, only when its wave-length is more than half as great again as that of the neighbouring station; but that undisturbed signalling is much more easy when it approaches double that magnitude, or, of course, when the neighbouring stations are not quite so close together.

In no case was any trace of harmonic detected; *e.g.* when a station was sending 300 metres, and the neighbouring receiving station was attuned to 600 metres, it did not necessarily feel any disturbance. The waves emitted and received by these radiators appear to be practically pure. OLIVER LODGE.

MARINE BIOLOGY IN THE TORTUGAS.[1]

THE volumes referred to below contain a series of nineteen papers based on work done or material collected at the Marine Biological Laboratory of the Carnegie Institution, situated on Loggerhead Key, off the south-west coast of Florida. The observations recorded bear ample testimony to the exceptionally favourable situation of the laboratory for the prosecution of marine biological research, and also to the facilities afforded on a liberal scale for work on a wide variety of subjects.

Dr. A. G. Mayer, the director of the laboratory, describes the annual breeding swarm of the Atlantic palolo (*Eunice fucata*, Ehlers), which occurs within three days of the day of the last quarter of the moon between June 29 and July 28. The worm when mature (and immature worms take no part in the swarming) is about 10 inches long, and its sexual products are limited to its posterior half. Before sunrise on the day of the annual breeding swarm the worm crawls out backwards from its burrow in the coral or limestone rock until the whole of the sexual portion is protruded. By means of vigorous twisting movements this portion is detached, swims vertically upwards to the surface of the water, and there continues to swim about with its posterior end in front. These sexual portions of the worms, which show no tendency to congregate, are present in great abundance at Tortugas, scarcely a square foot of the surface above the coral reefs being free from them. At sunrise the worms undergo violent contractions, which cause the expulsion of the sexual products through rents or tears which are formed in the body wall; the torn and shrivelled remains of the body wall then sink down to the bottom and die. Although light is probably a contributory cause, it is not the sole cause of this spasm of contraction, which takes place, though it is somewhat delayed, in swimming worms which have been removed to a dark room. After casting off its posterior sexual segments the anterior part of the worm crawls back into its burrow, and regenerates a new sexual end. The author has attempted to determine the nature of the stimulus to which the worm responds when it swarms, and he shows that the worms never swarm when moonlight is prevented from falling upon the rocks in which they are ensconced. The paper is a most interesting contribution to the study of this remarkable phenomenon.

[1] Papers from the Tortugas Laboratory of the Carnegie Institution of Washington. Vol. i., pp. v+191; vol. ii., pp. v+325. (Washington: Carnegie Institution, 1908.)

Dr. Mayer describes a series of experiments on the scyphomedusan *Cassiopea xamachana*, from which he concludes that the stimulus which causes pulsation is due to the constant formation of sodium oxalate in the terminal endoderm cells of the marginal sense organs. The sodium oxalate precipitates calcium as calcium oxalate, thus setting free sodium chloride, which he shows acts as a nervous and muscular stimulant. Pulsation is thus caused by the constant maintenance at the nervous centres in the sense organs of a slight excess of sodium over and above that found in the surrounding sea-water.

The late Prof. W. K. Brooks and Mr. B. McGlone have studied the origin of the lung of Ampullaria. They find that the gills, the lung, and the osphradium arise simultaneously, or nearly so, that they are developed from a ridge or thickening of the mantle, and that they should therefore be regarded as a series of homologous organs specialised among themselves in different directions. The lung becomes functional before the gill, as is shown by the fact that the newly hatched young quickly die if they are prevented from leaving the water, while adults can survive an immersion of a month or more. Other papers, the last productions of the late Prof. Brooks, contain a discussion of the subgenus Cyclosalpa, a description of the rare *Salpa floridana* (Apstein), and of a new appendicularian—*Oikopleura tortugensis*—to the tail of some of which a new species of Gromia was found attached.

Prof. Reighard discusses the significance of the conspicuousness of the coral-reef fishes of the Tortugas. He concludes, as the result of a long series of ingenious experiments, that the coral-reef fishes do not possess that combination of conspicuousness, with unpleasant attributes, necessary to the theory of warning coloration. The conspicuousness of these fishes, since it is not a secondary sexual character and has no necessary meaning for protection, aggression, or as warning, is without biological significance. These fishes have no need of either aggressive inconspicuousness, because they feed chiefly on fixed invertebrates, or of protective inconspicuousness, for they are afforded abundant protection by the reefs and their own agility. Selection has therefore not acted on their colours or other conspicuous characters, but these have developed, unchecked by selection, through internal forces. An attempt is made to apply this conclusion to the "warning coloration" of conspicuous insects.

There are other memoirs on the formation of chromosomes in various echinoderm ova; on the spermatogenesis of the "walking-stick" phasmid, *Aplopus mayeri*, in which the history of the accessory chromosome is traced and its probable significance as a sex determinant discussed; on the habits and reactions of the crab *Ocypoda arenaria*, of Aplopus, and of the woody and sooty terns; on the early development of the scyphozoon Linerges, on actinian larvæ referable to the genera Zoanthella and Zoanthina; on the rate of regeneration in Cassiopea; on regeneration of the chelæ of Portunus, on the life-history of the booby and man-o'-war bird, and on the cestodes of the Tortugas.

THE RELEVANCE OF MATHEMATICS.

ONE of the most important achievements of the thought of the last fifty years has been the conclusive proof of the logical nature of all mathematical conceptions and methods, in opposition to Kant's view that mathematical reasoning is not strictly formal, but always uses *a priori* intuitions of space and time. This does not, of course, imply that the methods of investigation followed by individual mathematicians are essentially different from those followed by other inquirers, the objects of whose researches are not purely logical; it is well known, in fact, that, though a proposition A may logically imply a proposition B, yet B may be deduced from A by considerations quite outside those of logic. Thus the existence of the solution of a certain important and famous mathematical problem—known as "Dirichlet's principle"—was, we may say, *felt*, and actually applied in domains of pure mathematics, for certain physical reasons connected with the equilibrium of statical electricity long before rigorous logical methods were discovered for proving the existence in question. The fact that propositions are

connected logically by no means implies that this connection is obvious, nor does it preclude their being discovered, even in a correct form, by the exercise of what is popularly called "intuition."

By the side of this ever-deepening investigation into the principles of mathematics went on an inquiry, carried on by entirely different men, into the nature and purposes of our conceptions in physics. Through the work of these men, the true relation of mathematics to physical science, which had been a subject on which there had been until then much confusion of thought, appeared clearly. We will glance at the history of mathematics and of the application of mathematics to physics.

From the earliest times until the seventeenth century mathematicians were chiefly occupied with particular questions—the properties of particular numbers and the geometrical properties of particular figures, together with simple mechanical questions concerning centres of gravity, the lever, and so on. The only exception to this was afforded by *algebra*, in which symbols (like our present x and y) took the place of numbers, so that, what is a great advance in economy of thought and other labour,[1] a part of calculation could be done with symbols instead of numbers, so that the *one* result stated a proposition valid for a whole class (often an infinity) of different numbers. Such a result is that which we now write:—

$$(a+b)^3=a^3+3a^2b+3ab^2+b^3,$$

which remains valid when we substitute any particular numbers for a and b, and labour in calculation is often saved by the formula, even in this very simple case.

The great revolution in mathematical thought brought about by Descartes in 1637 [2] consists in the application of this general algebra to geometry by the very natural thought of substituting the numbers expressing the lengths of straight lines for those lines. Thus a point in a plane (for instance) is determined in position by two "co-ordinates" or numbers denoted by x and y, x denoting the distance from a fixed point along a fixed straight line (the abscissa) to a certain point, and y denoting the distance from this last point along a perpendicular (an "ordinate") to the abscissa to the point in question determined by x and y. As the point in question varies in position, x and y both vary; to every x belongs, in general, one or more y's, and we arrive at the most beautiful idea of a single algebraical equation between x and y representing the whole of a curve—the one equation, called the "equation of the curve," expressing the general law by which, given any particular x out of an infinity of them, the corresponding y or y's can be found. Thus $y=3x+2$ gives *one* y for each x, $y^2=3x+2$, or, more generally, $y^2=mx+n$, where m and n stand for any fixed numbers, gives *two* y's, one positive and one negative (above and below the abscissa respectively), for each x, except when x is zero.

The problem of drawing a tangent—the limiting position of a secant, when the two meeting points approach indefinitely close to one another—at any point of a curve came into prominence as a result of Descartes's work, and this, together with the allied conceptions of velocity and acceleration "at an instant" [1] which appeared in Galilei's classical investigation, published in 1638, of the law according to which freely falling bodies move, gave rise at length to the powerful and convenient "infinitesimal calculus" of Leibniz and the "calculus of fluxions" of Newton. It is now clearly established that those two methods, which are theoretically—but not practically—the same, were discovered independently; Newton discovered his first, and Leibniz published his first, in 1684. The finding of the areas of curves and of the shapes of the curves which moving particles describe under given forces showed themselves, in this calculus, as results of the inverse process to that of the direct process which serves to find tangents and the law of attraction to a given point from the datum of the path described by a particle. The direct process is called "differentiation," the inverse process "integration."

Newton's fame is chiefly owing to his application of this method to the solution, which, in its broad outlines, he gave, of the problem of the motion of the bodies in the solar system, which includes his discovery of the law according to which all matter gravitates towards (is attracted by) other matter. This was given in his "Principia" of 1687; and, for more than a century afterwards, mathematicians were occupied in extending and applying the calculus.

Of the great mathematicians of this time—the brothers Bernoulli, Euler, Clairaut, d'Alembert, Maclaurin, Lagrange, Laplace, Legendre, Fourier, Poisson, and others—most were Frenchmen; and the successful application of mathematics to celestial and molecular mechanics, to hydrodynamics, to the theory of the conduction of heat, and to electricity and magnetism, brought about, in a great measure, that enthusiastic trust in science, that faith that the whole mystery of life and of our lives was about to be uncovered by it, and that waning of faith in religion, which are so characteristic of France in the eighteenth century, and which are met with in the highest degree in Laplace.

Whether or not it was due to the indirect influence of Kant, whose "Critique of the Pure Reason" first appeared in 1781, an increasing tendency towards critical examination into the validity and the limits of validity of mathematical conceptions and methods appeared in the mathematics of the nineteenth century. First of all we must mention Gauss, who, in an unexampled degree, combined the power of discovery and profound critical insight; so that in the seven volumes of his publications, in the collected edition of his works, there is hardly a page which is not both important in the history of mathematics and free from error. But perhaps of still greater influence was the work of the French mathematician Cauchy; it is he who must be regarded as the chief inspirer—perhaps indirect—of Weierstrass; it is Weierstrass who was the chief inspirer of Georg Cantor, and it is to the influence of Cantor and Dedekind, most of all, that we owe that trend of thought which, with modern mathematical logicians, has resulted in the great discovery of the logical nature of mathematics.

Of course, in this short description there is no implication that the nineteenth century has been poor in the more technical achievements or physical applications of mathematics; in England alone the names of Stokes, Thomson

[1] In *The New Quarterly* for October, 1908 (vol. i., p. 498), Mr. N. R. Campbell has objected to the idea of Mach that "economy of thought" is the end for which scientific theories are formed, for reasons based, it seems to me, on a misunderstanding of what Mach really meant. Perhaps the phrase "economy of thought" is not well chosen, and may lead to such misunderstandings; for the principle directs attention to a rule of scientific method which can be readily admitted, and certainly the goal of science, as guided by this principle, will not "have been attained when its students have ceased to think." This rule may be thus described. As science advances, besides actually overcoming an obstacle, it, consciously or unconsciously, leaves marks of guidance for those who come after; so that those obstacles which required great genius to overcome in the first instance afterwards became quite easily so. This is necessary in order that our energies may not be spent by the time that we reach a new obstacle not hitherto surmounted; and "economy of thought" means that we are to be spared waste of the energy of thought whilst treading the path already trodden by our predecessors, so that we may keep it for the really important new problems—not that we may cease to think about problems, new or old.

And thus we have legacies left by great men, such as Lagrange's analytical mechanics and Fourier's theory of the conduction of heat, which are merely inventories of extensive classes of facts, arranged with wonderful compactness. In this description of an *infinity*, perhaps, of facts by a *few* formulæ, there is undoubtedly an æsthetic motive and value; but, apart from this, there is this important economical aspect, that a multitude of particular facts and "laws," which we had hitherto to remember, actually or artificially (in a note-book or library), is, in the theory, comprised in a few symbolical formulæ, which only require *logical* development to get at the particular cases. From this point of view we get the apparent paradox that "economy of thought" leads to the replacing of memory by reason. The solution of the paradox is that logical development can be made more mechanical even than memory, and that thus thought is spared, so that we can concentrate it on the unsolved problems which are always coming into our field of vision as we advance.

The tendency to economy of thought, which is shown in the growth of physics—for example, in the inclusion of the particular Biot's law of the distribution of temperatures in Fourier's theory—may also be seen in the symbolism of pure mathematics.

[2] We need hardly point out that this change was not sudden—that Descartes's "Géométrie" was not a "proles sine matre creata," but that here, as everywhere, the development of mathematics has followed the principle of continuity.

[1] Mathematically, the finding of the tangent at a point of a curve, and finding the velocity of a particle describing this curve when it gets to that point, are identical problems. They are expressed as finding the "differential coefficient," or the "fluxion" at the point.

(Lord Kelvin), and Maxwell, and those of many living show this; and in Germany one of the greatest influences in pure mathematics was Riemann, who is usually contrasted with Weierstrass as a type of the creative, as opposed to the critical, genius.[1] But in this article we are only concerned with questions in the theory of knowledge, with the principles of mathematics, and the basis of their application to physics, and, through these questions, with the relevance of mathematics to our whole civilisation and, what is still more important, to our whole lives.

The critical inquiries into the nature and purposes of our conceptions in physics, which have been mentioned above, have put in a clear light the fact, which seems to have been overlooked by Laplace in that flush of enthusiasm which a mathematician can so readily understand, and which, without the excuse of the sudden illumination brought about in the eighteenth century by the development of mathematics, is still overlooked by the cruder physicists, that the "world" with which we have to deal in theoretical (mathematical) mechanics, for example, is but a mathematical scheme the function of which it is to imitate by logical consequences of the properties assigned to it by definition certain processes of nature as closely as possible. Thus our "dynamical world" may be called a model of reality, and must not be confused with the reality itself.

That this model of reality is constructed solely out of logical conceptions results from our conclusion that mathematics is based on logic, and on logic alone; that such a model is possible is indeed surprising, and the surprise only goes when we follow up in history the growth of the application of mathematics to physics. The need for completing facts of nature in thought was, no doubt, first felt as a *practical* need—the need that arises because we feel it convenient to be able to predict certain kinds of future events. Thus, with a purely mathematical model of the solar system, we can tell, with an approximation which depends upon the completeness of the model, the relative positions of the sun, stars, and planets several years ahead of time; this enables us to publish the "Nautical Almanac," which is so useful to sailors, and makes up to us, in some degree, for our inability "to grasp this sorry scheme of things entire . . . and re-mould it nearer to the heart's desire."

The need of the completion of facts in thought is not merely practical; it is also intellectual. The striving after logical completeness, whether in generality of results or consistency of its own premisses or those of its models of reality,[3] is accompanied by a feeling of æsthetic pleasure or of intellectual honesty, or of both. We may say that mathematics has an æsthetic and a moral value.

Mathematics is relevant to those who go down to the sea in ships, to those who stay on dry land and build bridges or locomotives, and to those who observe the sun's corona during a total eclipse to find out what the sun is made of. Mathematics is relevant to the philosopher, for not only has it investigated and does it investigate its own foundations, but also it explains what is meant by the philosophers' own phrases, such as "the postulate of the comprehensibility of nature" (which seems to be the postulate that a purely logical model is possible), and the "laws of uniformity, continuity, and causality." And lastly, mathematics, besides being relevant to æsthetics and morals in the above sense, is of moral significance in another respect. Since the basis of mathematics is logic, and logic alone,[1] all those personal, national, and historical questions which are from time to time mixed up with mathematics—however essential some of them may be to the understanding of certain points and to education—show themselves, when looked at from a higher plane of truth, to be irrelevant.

PHILIP E. B. JOURDAIN.

[1] On a closer consideration, this distinction breaks down almost entirely. Apart from the numerous instances which can be quoted of particularly critical work by Riemann and particularly creative work by Weierstrass, surely it is always true both that there should be no creation without criticism (otherwise we run the risk of building castles in the air) and that there cannot be any relevant criticism which does not add to our knowledge, and is in so far creative.

[2] *Cf.* A. Voss, "Über das Wesen der Mathematik." Pp. 3–4. (Leipzig and Berlin: B. G. Teubner, 1908.)

[3] I have tried to show by some examples that we can and ought to examine the details of our models with the aid of the most refined conceptions of modern mathematics, in order to be certain that the models are logically consistent ("On some Points in the Foundation of Mathematical Physics," *The Monist*, April, 1908, vol. xviii., pp. 217–26; *cf.* Voss, *op. cit.*, pp. 71–2). An example of the results of critical investigation into applied mathematics is the discovery—which has also obvious practical results in the avoidance of labour doomed to unfruitfulness—by Poincaré of limits of validity for certain of Laplace's formulæ.

THE IRON AND STEEL INSTITUTE.

THE fortieth annual general meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers on May 13 and 14, under the chairmanship of Sir Hugh Bell, who retains the office of president for another year, and will be succeeded next May by his Grace the Duke of Devonshire. The report of the council for the past year shows that the affairs of the institute are in a prosperous condition. Five Carnegie research scholarships had been awarded, and Mr. Carnegie had presented 11,000 dollars, the income of which would assist in meeting clerical expenses and those incurred in issuing special memoirs.

The proceedings on May 13 opened with three papers, taken together for discussion, dealing with corrosion and protection of iron and steel. The paper by Mr. W. H. Walker, of Boston, U.S.A., contains the fundamental conceptions involved in the modern electrolytic theory of the corrosion of iron, develops this theory from the facts now known, and shows that the older carbonic-acid theory can be, and is, included therein, and points out some of the practical applications of this theory to the problem of corrosion. Mr. Allerton S. Cushman, of the United States Department of Agriculture, contributed a paper on the preservation of iron and steel. The author favours the view of corrosion as an electrochemical phenomenon, and deals with the questions of the production of a metal highly resistant to corrosion, of protective coatings, and of the passive condition which iron is capable of assuming. It seems to be a fact that carefully made open-hearth metal, in which the ordinary impurities are cut down to mere traces, and in which the heat treatment has been carefully controlled, is much more resistant to corrosion than the ordinary types of metal with a comparatively high percentage of impurities. The preservation of iron and steel by application of other metals to the surface, and of paint and other coatings, is fully discussed, and certain experiments having the object of determining their relative values under ordinary weathering conditions, which are now being carried out in America, are described and illustrated with photographs. Mr. J. Cruickshank Smith, of London, contributed a paper on physical tests for protective coatings for iron and steel. Tests are described for examining the following points:—that the proper proportion of pigment and vehicle has been obtained with the minimum of free oil space in the dry film; the smallness and uniformity of size of the pigmentary particles; the possession of the property of minimum tendency of the pigment and vehicle to separate; the determination of the thickness and uniformity of the film and its strength and elasticity; the permeability and hardness of the film.

An important paper on the solubility of steel in sulphuric acid was contributed by Messrs. E. Heyn and O. Bauer, of Gross-Lichterfelde. This paper contains 120 pages of matter, together with plates, and can only be briefly noticed here. The authors' researches show that the transition from the martensite of hardened steel to pearlite of annealed steel is not continuous through the intermediate stage of tempering as has been hitherto supposed. There is an intermediate metastable form to which the authors have given the name of "osmondite," in honour of Osmond. The fact is shown by the curve of solubility in dilute sulphuric acid attaining a sharply defined maximum at 400° C. The researches dealt with the influences of the quenching and tempering of steel on its solubility, of quenching and re-heating soft mild steel, and of the quenching temperature; the influence of cold working and annealing on the solubility of mild steel, and of the

[1] Mathematics is a wonderfully refined *symbolic* (for the importance of this character, see Voss, *op. cit.*, pp. 25–26) logic, the product of thousands of minds, and so adapted as to spare all waste of thought on unessentials.

chemical composition of iron on its susceptibility to attack by dilute sulphuric acid; the influence of the nature of the sulphuric acid employed on the solubility of iron. The regularity and trustworthy character of the results obtained prove the great utility of this method of deducing the nature of the previous treatment of the metal under examination.

A paper on the chemical physics involved in the decarburisation of iron-carbon alloys was read by Mr. W. H. Hatfield, of Sheffield. In this the author refutes the view of Dr. Wüst that it is necessary that the temper-carbon be precipitated before elimination. There generally remained at least 1 per cent. temper-carbon in so-called decarburised malleable cast iron.

The proceedings on May 14 opened with the presentation of the Bessemer gold medal to Mr. A. Pourcel, who first manufactured ferro-manganese and silico-spiegel in the blast furnace. A paper was then taken on the electric furnace and the electrical process of steel-making, by W. Rodenhauser, of Saarbrücken. Such furnaces can be divided into two groups, electric arc furnaces and those in which the arc is avoided. The paper contains working drawings and photographs of many furnaces of these types, and notes of their working and defects.

A paper on fuel from peat was read by Dr. M. Ekenberg, of London, dealing with the author's researches for finding a suitable process for converting peat into fuel without air-drying. An experimental apparatus for wet-carbonising peat-pulp and a peat briquette factory are described and illustrated.

A heat-treatment study of Bessemer steels was contributed by Prof. M'William and Mr. E. J. Barnes, of Sheffield University. This paper gives a large number of tests carried out by the authors on commercial English steels of varying carbon content. Many tables of results are appended.

The Bristol recording pyrometer was described by Messrs. P. Longmuir and T. Swinden, of Sheffield, together with notes of tests made with this low-resistance "shop-tool" at the works of the Sheepbridge Coal and Iron Company. Mr. C. E. Stromeyer, of Manchester, added another paper to his previous work on the ageing of mild steel and the influence of nitrogen. The net result of the experiments may be summarised as follows:—(*a*) the usual tensile and bending tests do not detect those treacherous steels which, after behaving well under the steel-works' tests, fail in the workshop; (*b*) the test strips which have been injured on their edges by chisel nicks and then bent clearly indicate that mild steel does change some of its qualities with time, and these changes can be accelerated by heating the samples to the temperature of boiling water.

Papers were contributed on high-tension steels, by Mr. P. Longmuir; on tests for hardness, by Prof. Turner, of Birmingham; and on the determination of carbon and phosphorus in steel, by Mr. A. A. Blair, of Philadelphia, U.S.A. Papers from the Carnegie research scholars dealt with the special steels in theory and practice, the strength of nickel-steel riveted joints, the preparation of carbon-free ferro-manganese, steels suitable for gears, and gases occluded in steel.

SCIENTIFIC WORK IN THE ENGLISH POTTERIES.[1]

THE English Ceramic Society, founded in 1900, has just issued the seventh volume of its annual Transactions. The membership report shows a steady growth from thirty members in the first two years to a little more than 200 during 1907 and 1908. Ten meetings were held during the session 1907–8, at Tunstall, Longton, Hanley, and Fenton. For the current session the president is Mr. F. H. Wedgwood, and the secretary Dr. J. W. Mellor.

Special attention appears to have been directed to the question of gas-firing, which formed the subject of a paper read by Dr. Seligman in December, 1907; of a second paper, by Mr. Schmatolle, read in January, 1908; and of a discussion in March, 1908; as the former speaker dealt with Continental types of furnace, and the latter came over from Berlin, it is evident that those who control the English potteries have something to learn from their Continental colleagues. The advantages claimed for gas-firing are economy of fuel (especially when a battery of kilns is arranged to work in series, using the same gas-current to cool one furnace and heat the next), a great reduction in breakages and in wear and tear, and, finally, the complete abolition of the smoke nuisance, which has made the "Potteries" and the "Black Country" synonymous terms.

An important paper is contributed by Messrs. Moore and Mellor on the adsorption and dissolution of gases by silicates, a question that derives great commercial importance from the tendency which some glazes show to "spit-out" by the liberation of bubbles of gas; the conclusion is drawn that, although the glaze itself may sometimes be responsible for the spitting, the trouble is usually due to the presence of moisture or of organic matter in the "body," and that the nature of the glaze is usually of secondary importance. The uninitiated may well wonder at the nature of the topics referred to in the discussions on "blungers" and on "pugging," but the address on "Porcelain," by the retiring president, at least is free from this obscurity of nomenclature.

In addition to arranging for scientific meetings, the society has appointed a committee for the purpose of adopting, in conjunction with workers in other countries, a standard method of clay analysis. The volume under review affords the fullest confirmation of the statement of the incoming president that, whilst "the society can easily make a president, it is the secretary who makes the society," his contribution including a share in the authorship of six of the seventeen papers now published.

[1] Transactions of the English Ceramic Society, vol. vii., Session 1907–8. Pp. xii+170. (Published by the Society, County Pottery Laboratory, Stoke-on-Trent, Staffordshire.) Price, Non-members, 21*s.*; Members, 10*s.* 6*d.*

THE CULTIVATION OF TEA.[1]

THIS little pamphlet of sixty-eight pages deals with the cultivation, and particularly with the manuring, of tea. A considerable amount of information on the subject has been gained through the experiments of Dr. Mann and others, and has been drawn on freely by the author. Tea requires a heavy rainfall—100 inches is mentioned as a suitable amount—and rather special conditions of cultivation obtain in consequence. Many of the plantations are situated on very sloping ground, and the soil is liable to be washed away; the difficulty is met by several devices, among others by growing plants with big leaves alternately with the tea plants, and thus covering the ground so far as possible. Leguminous plants like crotalaria, ground-nuts, dadaps, &c., are commonly used, and when they die or are cut down they supply both nitrogen and organic matter to the soil. Other nitrogenous manures are, however, in use, including oil cake (rape or castor), which is one of the cheapest, and ammonium sulphate. Potash manuring has been found to be very effective, and also phosphates, but lime is not popular among tea-growers.

The question of quality is dealt with at some length. As a rule, the higher the position of the plantation the better the quality of the tea, but the yield per acre is less; probably the lower temperature of the high ground is the determining factor. Heavy dressings of manure are prejudicial to quality, but Dr. Mann's experiments are quoted to show that light dressings frequently applied will increase the crop without injuring its quality.

The results of the manurial trials on the Pitakande Estate, Ceylon, are discussed in detail, and a very useful little chapter is given on the way to conduct such trials. "It is of paramount importance," says the author, "that every owner of a tea plantation should be in a position to experiment for himself and ascertain the most profitable way to manure his crops." This is a very sound position to take. The manures found most profitable at Pitakande would not necessarily be most profitable elsewhere; the real lesson for the tea-planter is to make his own experiments, and so to discover the fertiliser or mixture of fertilisers giving the best results on his own plantations.

[1] "The Fertilisation of Tea." By George A. Cowie. (*Tropical Life* Publishing Office.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following have been appointed members of the board of electors to the professorship of astrophysics:—Sir George Darwin, K.C.B., Sir Robert Ball, Sir William Huggins, K.C.B., O.M., hon. LL.D., Mr. Fitzpatrick (president of Queens' College), Dr. Hobson, Dr. Liveing, Sir J. J. Thomson, and Dr. R. T. Glazebrook.

The Rede lecture will be delivered on Thursday, June 24, at 12 noon, in the Senate House, by Sir Archibald Geikie, K.C.B., P.R.S. The subject will be "Darwin as Geologist."

The special board for biology and geology has reappointed Mr. J. J. Lister to be a manager of the Balfour fund for five years to June, 1914.

LONDON.—The governors of the Imperial College of Science and Technology, following on the appointment of Prof. Adam Sedgwick as professor of zoology at the college, and of Prof. McBride as his special assistant, have lost no time in making their intentions known with regard to the work of next session. Provision has been made, quite apart from the general work of the department, for a series of special courses of lectures. These include marine biology and fishery science with practical work at the college, and, during the summer vacation, at the Plymouth station of the Marine Biological Association by Dr. E. J. Allen, director; an advanced course of vertebrate embryology, by Mr. Richard Assheton; and, in addition, courses of entomology and the physiology of development, the lecturers for which have still to be appointed. In addition to the above, the governors have appointed Mr. Dobell as special lecturer in cytology and protistology, subjects of rapidly growing importance so intimately concerned with the phenomena and the causes that underlie the conditions of heredity, health, and disease.

At the meeting of the Senate of the University on May 19, the degree of D.Sc. in physiology was granted to Dr. N. H. Alcock, an internal student of the physiological laboratory, for a thesis entitled "The Physiology of the Peripheral Nerves, especially with regard to their Electrical Phenomena," and other papers. The degree of D.Sc. was also granted to the following external students:—in chemical physiology, to Mr. Charles Dorée, for a thesis on "Cholesterol," and other papers; and in geology, to Mr. John Ball, for a thesis entitled "A Description of the First or Aswan Cataract of the Nile," and other papers.

Mr. F. W. Twort has been appointed superintendent of the Brown Animal Sanatory Institution in succession to Dr. Gregor Brodie, resigned.

Mr. A. R. Brown has been appointed university lecturer in ethnology for the session 1909–10, under the Martin White benefaction.

The principal of the University (Dr. H. A. Miers, F.R.S.) has been appointed a member of the governing body of the Imperial College of Science and Technology in succession to Prof. D. S. Capper, resigned.

The certificates of the joint matriculation examination of the northern universities have been recognised under certain conditions as exempting from the London matriculation examination.

MR. C. A. EALAND, staff instructor in biology at the Essex County Laboratories, Chelmsford, has been appointed principal of the laboratories.

PROF. G. ELLIOT SMITH, F.R.S., professor of anatomy in the Government School of Medicine, Cairo, has been appointed to the chair of anatomy in the University of Manchester.

LORD CURZON OF KEDLESTON, Chancellor of the University of Oxford, was the principal guest at the summer dinner of the Oxford Graduates' Medical Club on May 20. Replying to the toast of "The Visitors," Lord Curzon said that to most people Oxford is identified with the study of what is properly known as humane culture. Very few people outside the colleges are aware of the fact that Oxford was once the home of the school of medicine, and that it has turned out some of the most distinguished physicians who have cast lustre upon the English name. After eulogising the achievements of Linacre, Sydenham, Wren, Harvey, and Radcliffe, the Chancellor went on to remark that about the middle of the last century the condition of science at Oxford might almost be compared to that of the Dark Ages, and the attitude towards medical science in particular, and to science in general, was one of suspicion if not of active hostility. "In 1850, when the first commission was about to commence its labours at Oxford, there was not a single scientific laboratory in that University, and had the whole of the medical students in Oxford at that time been sent down, they could have been taken to the station, if station there was, in a single four-wheeled cab. But even when the night was darkest, the dawn was nigh; and there has been no more dramatic, more inspiring, or more creditable page in the history of learning than the steps by which science fought its way back into Oxford until, at the present moment, it sits enthroned alongside the humanities and has a crown of equal authority and prestige upon its brow."

THE Department of Agriculture and Technical Instruction for Ireland has published the results of an inquiry, by Mr. F. C. Forth, director of technical instruction for Belfast, into the number of students of each age enrolled in the classes of the Belfast Municipal Technical Institute, together with notes on the increase in attendance that is possible at technical classes. The statistics published in the report are rendered more intelligible when it is remembered that the population of Belfast in 1901 was 349,180, and that about one-fifth of the population, or 63,870, were from five to fourteen years of age, of whom 50,000 were on the rolls of national schools; 7000 were fourteen years of age, of whom only 730 were attending national schools. A satisfactory feature of the statistics is the great increase they show in the number of students at each age during the seven years of the institute's existence. It is clear, too, that the students now begin their evening studies at an earlier age after leaving the day school than was formerly the case. In 1901 there were more students at seventeen than any other age; in 1907 the largest number were sixteen years of age. Another outstanding fact is the large increase in the number of women students as compared with the men. Mr. Forth discusses what he calls "ideal" conditions of education, and arrives at some interesting results. He takes one-sixth of the population to be of elementary-school age and about 2 per cent. as of fourteen years of age—which he thinks might be taken as the age for leaving the day school and entering evening classes. If half the number of children of fourteen years of age joined the evening classes and followed up their studies, that would mean 1 per cent. of the population, and if certain other "ideal" conditions prevailed 5½ per cent. of the population would be undergoing technical instruction, and this in the case of Belfast would raise the total number of students' scientific and technological subjects from about 5000 to 20,000 students.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 20.—Sir Archibald Geikie, K.C.B., president, in the chair.—Observations on the urine in diseases of the pancreas: P. J. **Cammidge**. In the course of a series of observations on the metabolic changes associated with diseases of the pancreas it was found that if the urine of a patient suffering from an inflammatory affection of the gland were boiled with hydrochloric acid, the excess neutralised with lead carbonate, and the freed glycuronic acid precipitated out with tri-basic lead acetate, treatment of the filtrate with phenylhydrazine, after the excess of lead had been removed, with sulphuretted hydrogen, yielded a crystalline product which varied in amount with the intensity and stage of the disease. Normal urines, and specimens from patients suffering from diseases in which there was no reason to think that the pancreas was involved, gave no reaction. Twenty-eight cases in which the urine had been examined during life were investigated *post-mortem*, and the results of the urinary examination confirmed. The urines of three dogs

with experimentally induced acute or chronic pancreatitis were found to give a characteristic reaction. A detailed examination of a large quantity of urine from each of eight patients giving a well-marked reaction showed that it was due to a sugar having the reactions of a pentose, and yielding an osazone with a melting point of 178° C. to 180° C. Attempts to isolate the mother-substance were not successful; it would appear to be derived from the pancreas, and is probably set free as the result of degenerative changes in the gland, passing into the blood, and being excreted in the urine.—*Trypanosoma ingens*, n.sp.: Sir David **Bruce** and Captains A. E. **Hamerton**, H. R. **Bateman**, and F. P. **Mackie**.—The incidence of cancer in mice of known age: Dr. E. F. **Bashford** and Dr. J. A. **Murray**. The relative frequency of cancer at different age periods in female mice has been determined on animals bred for the purpose, the ages, sex, and parentage being carefully recorded. The diagnoses have been made by combining clinical observation with microscopical examination and transplantation of the tumours, and with *post-mortem* examination of the animals. Following Jensen, the authors demonstrated in 1903–4 that cancer can be transmitted artificially from one individual to another of the same species by the implantation and continued growth of living cancer-cells, and have shown that this form of transmission is not responsible for the great frequency of the disease. Other authors have since described "epidemics" of cancer in animals, especially mice. In the course of a year the present authors observed nineteen cases of cancer in their mice. This aggregation of cases corresponds to the "epidemics" adduced as evidence that the disease is infective. The cases have been analysed with reference to the age at which the tumours were first observed. The following table gives the liability to cancer at different age-periods:—

Age	6–9 months	9–12 months	12–15 months	15–18 months	18–21 months	21–24 months and over
Total ...	135	110	94	21	6	—
Cancer ...	3	4	7	3	2	—
Per cent. ...	2·2	3·5	7·4	14·2	33·3	—

The progressive increase shown in the table presents a remarkable parallel with the age-incidence of cancer in the human subject, and confirms the earlier statements (Proc. Roy. Soc., January, 1904, &c.) that in animals, whatever their length of life, the recorded frequency of cancer varies, as in man, with the opportunity for examining a sufficiently large number of adult and aged individuals. The observations also add a statistical confirmation to the results of the comparative histological and biological studies of the Imperial Cancer Research Fund, which have shown the close parallel, amounting in many particulars to complete identity, between malignant new growths in man and other vertebrates. They demonstrate that the law of the age-incidence of the disease holds for the shortest-lived mammals as it holds for man. Since the facts agree with the less perfect data for other vertebrates, the general application of the law of age-incidence is probable, and, therefore, any explanation of the etiology of cancer must accord with the circumstance that, when considered *statistically* cancer is a function of age, and when considered *biologically* a function of senescence.—A method of estimating the total volume of blood contained in the living body: Dr. J. O. W. **Barratt** and Dr. W. **Yorke**. The principle employed in this method is that of injecting into the blood stream a known amount of dissolved hæmoglobin, and then determining the degree of the resulting hæmoglobinæmia. This enables the volume of the blood plasma to be calculated, and, with the aid of a hæmocrit determination of the composition, by volume, of the blood, the total amount of blood present in the living body is ascertained. The hæmoglobin employed is obtained from the red blood cells of the subject of observation. No ill-effect has been observed after injection of dissolved hæmoglobin. The estimation of hæmoglobin is generally made with von Fleischl's hæmoglobinometer, the scale of the instrument having been previously standardised by means of solutions containing known amounts of red blood cells. When the depth of the natural colour of the blood plasma, before injection, is markedly increased, as sometimes happens, it is difficult to obtain hæmoglobinometer readings of the amount of dissolved hæmoglobin present after injection. In such cases the blood plasma, suitably diluted, is matched, by means of a comparison spectroscope, with solutions containing known amounts of dissolved hæmoglobin.

Zoological Society, May 11.—Prof. E. A. Minchin, vice-president, in the chair.—(i.) Hitherto unrecorded specimens of *Equus quagga*; (ii.) differentiation of the three species of zebras; (iii.) a portion of a fossil jaw of one of the Equidæ: Prof. W. **Ridgeway**.—The batrachians and reptiles of Matabeleland: E. C. **Chubb**.

Royal Astronomical Society, May 14.—Sir David Gill, K.C.B., F.R.S., president, in the chair.—Spectroscopic comparison of *o* Ceti with titanium oxide: A. **Fowler**. The spectrum of the star had been taken by Mr. Slipher at the Lowell Observatory, and that of titanium oxide at South Kensington. The two spectra were, for the most part, identical, and their comparison forms a contribution to the analysis of the third type of spectra, showing the titanium oxide origin of many bands in the red, the details of which are not given by Vogel and Dunér.—Solar parallax papers, No. 7: A. R. **Hinks**. The present paper gives the details of the general solution from the photographic right ascensions of Eros at the opposition of 1900, the resulting parallax being about 8·807″. A further communication, giving results from micrometric observations, will shortly be presented.—An easily constructed sun-dial: W. E. **Cooke**. The sun-dial shown was of wood; it could be made by an ordinary carpenter, and was being introduced among the planters and farmers of Western Australia. An adjustment, to be made once for all, reduced local to standard time, and a further adjustment for the equation of time enabled the dial to be read to within about half a minute without the necessity of consulting tables.—Researches on the solar atmosphere: H. **Deslandres**. M. Deslandres gave an account of his spectrographic work at Meudon Observatory, illustrated by photographs showing the faculæ, &c., in monochromatic light.

Royal Anthropological Institute, May 18.—Prof. W. Ridgeway, president, in the chair.—Tibetan and Burmese amulets: Dr. W. L. **Hildburgh**. The author first referred briefly to the general principles underlying the employment of amulets. He touched on the beliefs in demons or evil spirits as producers of certain diseases, and on the use of protections against such diseases and against others not necessarily caused by similar influences. He also outlined the principal reasons guiding primitive peoples in their choice of amulets. Passing to Tibetan amulets, the author divided them, for convenience of reference, into religious, secular, and natural amulets. The religious amulets consist principally of the well-known printed paper charms, of which a considerable number were exhibited, small images of deities or the like, and relics and other articles with which religious ideas are associated. The secular amulets are such as are formed artificially, but in which the intercession of supernatural beings is not immediately concerned. Such are twisted metal bracelets against strains in the arms, or charms of plaited cords. The natural amulets consist of natural substances in which the protective or curative virtues are inherent, frequently so because of supposed sympathetic connection. Such are parts of the tiger, the elephant, the musk-deer, and other animals, particularly such parts as the teeth, claws, bones, or hairs. The medicinal use of such objects was also mentioned. The paper on Burmese amulets covered the ground in much the same manner. Amongst the principal Burmese amulets referred to by the author were rings made of genuine or imitation elephant hair, ornaments of elephant-nail, parts of various animals, coral, amber ornaments, representations of animals, and objects which had been subjected to magical ceremonies.

Royal Meteorological Society, May 19.—Mr. H. Mellish, president, in the chair.—The anticyclonic belt of the northern hemisphere: Colonel H. E. **Rawson**. In a previous communication the author brought forward some facts regarding the anticyclonic belt of the southern hemisphere, derived from an examination of the South

African records from the year 1841 to 1906. He found that the indications of a cyclical oscillation of the belt to and from the equator over South Africa were strong enough to encourage the belief that an analysis of Australian records on the one side, and of Argentine on the other, would prove that all the action centres of the atmosphere were moving together over this wide area, and that a similar oscillation existed in the northern hemisphere. He subsequently found that investigations of Mr. H. C. Russell and Dr. W. J. S. Lockyer supported his conclusion that there is a period of about 9·5 years between the greatest north and greatest south position of the anticyclonic belt in the southern hemisphere, the double oscillation thus taking nineteen years. He has since extended the inquiry into the movements of the action-centres in the northern hemisphere with the view of ascertaining whether they show any similar oscillation to and from the equator, which is not to be explained by seasonal changes of position. Dealing with the Nile floods, he draws the inference that the high-pressure systems which affect North-east Africa are farther north when the floods are in excess and nearer to Egypt when they are deficient. He also made an analysis of the tracks of the hurricanes which passed north and south of Manila Observatory, and found that these throw an interesting light upon the oscillations of the action-centres of the atmosphere.—Errors of estimation in thermometric observations: A. **Walter.** In examining the returns from a newly inaugurated series of second-order meteorological stations in Mauritius, it was noticed that a large percentage of the thermometer readings was in whole or half divisions. This led the author to analyse the returns, and he gave in the paper the frequency curves of the "tenths of estimation."

Institution of Mining and Metallurgy, May 20.—Mr. Edgar Taylor, president, in the chair.—Notes on the Zangezour copper mines: Dr. A. L. **Simon.** A brief description of the geology, mines, and mining conditions and costs of mining, reduction and production of copper in this district of the Little Caucasus.—The determination of tungstic acid in low-grade wolfram ores: H. W. **Hutchin** and F. J. **Tonks.** A description of a new method introduced by the authors, for which it is claimed that it combines the accuracy of the mercurous nitrate method with an improvement in the attack of the mineral, fusion with alkalis being replaced by digestion with caustic soda solution. The preliminary treatment with hydrofluoric acid becomes unnecessary, and the charge of ore can be much larger than is customary. The paper consists of two parts, section i. dealing with the working details of the assays employed, with a tabulation of results for comparison, whilst section ii. is supplementary, and consists mainly of an investigation of conditions affecting the aqua regia method and that here brought to notice.—Cupellation experiments; the thermal properties of cupels: C. O. **Bannister** and W. N. **Stanley.** The authors here record a series of careful experiments made for the purpose of comparing patent cupels (*i.e.* cupels made with a magnesite base) with bone-ash cupels, as regards their relative diffusivity of heat, specific heat, and rate of cooling, &c., and the result of their tests was to establish the existence of great differences in the thermal properties of the two classes of cupel mentioned, notably as follows:—the diffusivity of heat and specific heat of patent cupels are greater, and the actual temperature of the cupelling button is much lower, at the same temperature of muffle, in patent cupels than in those made of bone-ash, and silver beads take longer to solidify and spit, and are, indeed, much less likely to spit, on patent than on bone-ash cupels.—The bessemerising of hardhead: D. M. **Levy** and D. **Ewen.** The authors found, in the course of researches conducted to that end, that it is possible by bessemerising to convert hardhead, which is one of the waste products of tin smelting, into a highly ferruginous slag, and a fume consisting to a large extent of arsenic oxide with some tin oxide, whilst nickel and cobalt gradually concentrate in the diminishing button. The heat evolved by the operation is sufficient to keep the products molten and the process self-supporting. It remains to be ascertained, however, whether the slags can be obtained of sufficiently low tin contents to make the process a commercial success.—The use of standards in reading gold pannings: S. J. **Lett.** Having procured for his own use weighed standards of gold dust for comparison when reading pannings, the author submitted a description of these for the benefit of others requiring a handy and portable apparatus by means of which it is, the author claims, possible to gauge accurately a much smaller quantity than 1 dwt.—Notes on the scaling and sweating of copper battery plates: S. F. **Goddard.** This is a brief account of the results of cleaning two copper plates after fifty months' running, during which period 33,000 tons of quartz ore were crushed. It was found subsequently, by melting the plates, that only an exceedingly small percentage of gold was actually absorbed by the copper, and that only in the upper portion.

MANCHESTER.

Literary and Philosophical Society, May 4.—Mr. F. Jones, president, in the chair.—The tent-building habits of the ant *Lasius niger*, Linn., in Japan: Dr. Marie **Stopes** and C. G. **Hewitt.** The species of ant constructing the nests, which were cylindrical in shape, is *Lasius niger*, the common brownish-black ant occurring in our English gardens. In this particular district of Hayama, within fifty miles of Tokyo, it constructs shelters of minute grains of sand cemented together on the twigs of the Ilex as axes. The object of these nests is to afford shelter for aphides or "plant-bugs" which live upon the plant and are looked after by the ants for the sake of the "honey-dew" which they secrete. The shelters not only keep the aphides warm, and so increase their yield of "honey-dew," but also prevent them from escaping and protect them from their enemies and other ants. For their own convenience the ants also construct covered galleries of the sand detritus, which wind round the trunk of the tree and communicate with the tents in which the aphides are confined and with their own nest on the ground. This is the only case described of *L. niger*, which has a world-wide distribution, constructing tents of this kind.—The permanent change of volume effected in cast irons by repeated heatings: Prof. H. F. **Rugan** and Prof. H. C. H. **Carpenter.**

DUBLIN.

Royal Dublin Society, April 20.—Mr. J. E. Gore in the chair.—Mechanical stress and magnetisation of iron: W. **Brown.** Results have been obtained with iron wires in a perfectly uniform magnetic field throughout their entire length by varying the magnetic field, the load, the size of wire, and the magnitude of the current through the wire.—Methods of determining the amount of light irregularly reflected from rough surfaces: Prof. W. F. **Barrett.** The amount of light irregularly reflected from rough surfaces is a matter of considerable practical importance, especially in the case of large surfaces, such as walls and buildings, but no satisfactory data appear to be obtainable. The law of inverse square being inapplicable to such surfaces, the author has employed two methods, which yield satisfactory results. A Lummer-Brodhun or other similar type of photometer is employed, and the intensity of the stronger light reduced by (1) a rapidly revolving opaque disc having a sector cut out, the size of which can be accurately adjusted until a photometric balance is obtained, or (2) by an adaptation of the author's instrument for determining the "light-threshhold" of the eye. In this case the stronger light is reduced by absorption through a column of liquid of neutral tint, the length of the column being capable of easy and accurate adjustment. By this means measurements can be made of the light diffused at various angles from small surfaces, which are used to replace the silvered mirror that reflects the standard light through the liquid column. This arrangement also affords a convenient method of testing different systems of lighthouse illuminants.—A new form of polarimeter for the measurement of the indices of refraction of opaque bodies: Prof. W. F. **Barrett.** By means of Brewster's law the index of refraction of opaque non-metallic bodies can be found if the angle of maximum polarisation by reflection can de determined. In the instrument devised by the author this angle is expeditiously found by causing the telescope, which projects a parallel incident beam on to the reflecting surface, and

the collimator which carries the analyser, to move simultaneously through equal angles by means of a simple form of link motion. A source of monochromatic light (a small glow-lamp in a coloured globe) is rigidly attached to, and moves with, the telescope. To enable opaque liquids to be examined, the graduated circle over which the telescope and collimator move is fixed in a vertical plane. Fusible substances are contained in a porcelain capsule, which can be heated by steam or by an electric current, so that a reflecting liquid surface is thus obtained. Further observations on the powdery scab of the potato, *Spongospora subterranea* (Wallroth): Prof. T. **Johnson.** The author brought forward evidence in favour of the view that the organism responsible for the scab is a true slime-fungus identical with the *Erysibe subterranea* described by Wallroth in 1842. He also gave an account of experiments conducted last year to prevent the scab.

PARIS.

Academy of Sciences, May 10.—M. Émile Picard in the chair.—Critical examination of the monochromatic images of the sun with the hydrogen lines: H. **Deslandres** and L. **d'Azambuja.** A further instalment of the results obtained with the large spectroheliograph at Meudon, a description of which instrument is given in an earlier paper. For the red hydrogen line, the first-order spectrum with a grating gave sufficient dispersion. With this arrangement, not only has the entire line been isolated, but also separately the centre of the dark line and its edges. The image of the centre, representing the upper layer of hydrogen, has been compared with the corresponding layer K_3 of calcium, and was found to present the same characters, although somewhat weakened. Some of the phenomena previously observed are shown to be due, not to peculiarities in the emissive or absorptive power of hydrogen, but to an instrumental cause, a defect of the spectroheliograph.—The unsymmetrical enlargement of the lines of the arc spectrum and their comparison with those of the solar spectrum: Ch. **Fabry** and H. **Buisson.** When the arc is produced between iron poles in a vacuum it is less luminous than when produced at atmospheric pressure and all the lines are much finer. Certain lines, which in the air arc are distinctly thickened, in a vacuum cannot be distinguished from the others. The observations form a complete confirmation of the explanation given by the authors of the anomalies observed in the comparison of the sun and arc spectra.—A recent note of M. Stekloff: E. **Goursat.** A claim for priority.—Problems of elasticity in two dimensions: C. **Kolossoff.**—The nomographic representation of equations with four variables: Maurice **d'Ocagne.**—An arrangement of a carrying surface for an aëroplane: Maurice **Caron.**—An apparently abnormal fact which occasionally occurs in commercial transformers: M. **Gacogne** and A. **Léauté.** The anomaly described is due to the capacity of the transformer.—An influence of radium on the velocity of crystallisation: Louis **Frischauer.** Comparative measurements were taken of the rate of crystallisation of droplets of surfused sulphur, a portion of the sulphur only being exposed to the radiation from radium salt. In the latter case the velocity of crystallisation was increased. The radium emanation gave a similar result, but exposure to the Röntgen rays was without influence. It would thus appear that it is the α rays which are active in this respect.—Thermo-endosmosis: M. **Aubert.**—The charge of a negative ion of a flame: Georges **Moreau.** The charge found $e=4{\cdot}3\times10^{-10}$, and may be compared with the value for the charge of an electron found by Millikan (4·06), Perrin (4·1), and Rutherford (4·65), all divided by 10^{10}.—The discharge of inductors: E. **Caudrelier.**—The teleautocopyist for the transmission of images to a distance: Laurent **Sémat.** A description is given of the apparatus and of the method of securing the necessary isosynchronism. All the operations take place in daylight, and are controlled by purely mechanical methods, neither photography nor selenium being used. About five minutes are required to transmit a plate measuring 7 cm. by 12 cm.—Wireless telephony: MM. **Colin** and **Jeance.** The special advantages of the apparatus described are the arrangements of the negative electrodes of the arcs to ensure steadiness, the utilisation of an intermediate circuit for giving a simple constant oscillation, and the arrangement of the microphones.—The radium emanation: A. **Debierne.** The volume of emanation in equilibrium with 1 gram of radium was found to be, in mean, 0·58 cubic millimetre, in close agreement with the results of Rutherford and Royds, but much smaller than the 7 cubic millimetres of Ramsay and Cameron. From the curves of decrease of the intensity of the radiation a diminution to one-half takes place in 3·81 days.—The anhydrous combinations of thorium chloride with the alkaline chlorides: Ed. **Chauvenet.** Anhydrous thorium chloride combines with the alkaline chlorides, giving compounds of the type $ThCl_4.2MCl$ with the metals Li, Na, K, Rb, and Cs, and $ThCl_4.4MCl$ with Rb and Cs only. Ammonium chloride forms the exceptional compound $ThCl_4.NH_4Cl$.—Benzoylacrylic acid. The condensation of glyoxylic acid with some ketones: J. **Bougault.** In alkaline solution glyoxylic acid readily condenses with acetophenone and analogous ketones, forming diphenylacetic acid or analogous acids. Dianisylacetic and diperacylacetic acids, prepared by this reaction, are described.—The modifications of anthesterol and its benzoate: M. T. **Klobb.**—A nephelinic syenite from the Transvaal: H. A. **Brouwer.**—The energy necessary for kneading by machinery: M. **Ringelmann.**—Observation of ovules of the rabbit with two germs, contained in a common envelope of albumen secreted by the oviduct: Cl. **Regaud** and G. **Dubreuil.**—A popular remedy for cancer: Robert **Odier.**—The regulation of the secretions by d'Arsonvalisation: Foveau **de Courmelles.** The high-frequency treatment leads to increased secretion of urea, uric acid, and chlorides, together with a diminution in the amount of phosphate eliminated.—Costiasis and its treatment in young trout: Louis **Léger.** The use of a weak solution of formalin (35 c.c. to 40 c.c. of the 40 per cent. solution in 100 litres of water) is suggested for destroying the parasite (*Costia necatrix*), the cause of the disease. The young trout are not injured by this solution. Another trout disease gyrodactylosis, is cured by the same treatment.

May 17.—M. Émile Picard in the chair.—Biaxial crystallised liquids: Fred. **Wallerant.** Liquid azoxyanisol shows the true properties of biaxial crystals. This is regarded as an argument in favour of the absolute identity of liquid and solid crystallised bodies.—A new Australian Onychophorus: E. L. **Bouvier.** The new species resembles *Peripatoides Suteri*, but this resemblance is only superficial, since many distinctive characters are different.—Surfaces of total constant curvature: C. **Guichard.**—The value of the invariants ρ and ρ_0 for surfaces of the fourth order with double isolated points: L. **Remy.**—The residues of measurable functions: Frédéric **Riesz.**—The principle of Dirichlet and the development of harmonic functions in polynomial series: Serge **Bernstein.**—Linear differential equations and uniform transcendentals of the second order: René **Garnier.**—An example of the Zeeman effect, positive and longitudinal, in the emission spectra of vapours: A. **Dufour.**—The chromatic circle according to Young's hypothesis: A. **Rosenstiehl.** The new chromatic circle designed by the author gives colours possessing the following qualities of the fundamental colours required by Young's theory:—the complementary of the orange is the first green-blue; the third yellow-green, of which the complementary is the first violet; and the third blue, having as complementary the yellow placed between the first and second yellow. The defects of the old colour circle are discussed.—Measurements of the Brownian movements in gases and the charge of particles in suspension: M. **de Broglie.** From an ultramicroscopic study of the motion of a charged particle of tobacco smoke in an electric field, followed by the application of the formulæ of Stokes and Einstein, the value for the charge e is deduced as $4{\cdot}5\times10^{-10}$, agreeing well with the results obtained by different methods.—The lower harmonics: G. **Sizes** and G. **Massol.**—Kathodic projections: L. **Houllevigue.** It is known that a kathode placed in a vacuum projects, besides corpuscles deviable by a magnet, particles of itself. Since these are not appreciably deviated by a magnetic field, it follows that these particles have either a relatively large mass, a small electric charge, or a high velocity. The experiments here recorded accord

with the first hypothesis.—The freezing point of gaseous mixtures at very low temperatures: Georges **Baume.** An apparatus is described and figured by means of which accurately measured volumes of pure gases can be mixed and frozen, and the freezing point determined. The apparatus has been applied to the cases of mixtures of methyl oxide and hydrochloric acid, methyl oxide and sulphur dioxide, and methyl oxide and methyl chloride.—The theory of organic bases according to the viscosity of their solutions: D. E. **Tsakalotos.** From measurements of the viscosity of aqueous solutions of trimethylamine, pyridine, piperidine, and nicotine, the conclusion is drawn that all these bases form molecular combinations with water.—Study of the system water, liquid ammonia. Concordance of the results with the hypothesis of ammonium hydrate: E. **Baud** and L. **Gay.** Measurements were made of the heat disengaged and the contraction accompanying the mixture of water and anhydrous ammonia. The experimental results agree with the hypothesis of the existence in aqueous solutions of ammonia of the hydrate $NH_3.H_2O$, in equilibrium with water and free ammonia.—The colouring properties of lead chromate: Léo **Vignon.** Chromate of lead in suspension is taken up by cotton, wool, and silk, the depth of dye varying with the proportion of chromate in the bath, but being nearly identical for all three materials.—Dipropargyl: magnesium derivative, octadiinedioic acid: MM. **Lespieau** and **Vavon.**—The gaseous, respiratory exchanges of the aërial vegetative organs of the vascular plants: G. **Nicolas.**—The presence of indol-producing bodies in culture broths: Ch. **Porcher** and L. **Panisset.** The use of the indol reaction as a test for certain bacteria is liable to lead in certain cases to erroneous conclusions, since the reaction may sometimes be given by the original culture fluid.—The action of the Bulgarian ferment *yoghourt* on various sugars: Gabriel **Bertrand** and F. **Duchäcek.** Arabinose, xylose, sorbose, maltose, saccharose, and mannitol are not fermented by this agent, but glucose, mannose, galactose, levulose, and lactose are easily fermented. In all cases the fermentative products contain *d*- and *l*-lactic acids, a small proportion of formic and acetic acids, and succinic acid.—The influence of boric acid on diastatic actions: H. **Agulhon.**—The ichthyological fauna of Lake Tchad: J. **Pellegrin.**—The stratigraphical characters of the layers of the French and Swiss Alps: Émile **Haug.**—The tectonic of the southern slopes of the *massifs* of Canigou and Puigmal: O. **Mengel.**—The stratigraphical results of an expedition in Chaouïa, Morocco: Louis **Gentil.**—The cranial capacity of fossil men of the type known as Neanderthal: Marcellin **Boule.** Direct measurements of the capacity of the fossil skull from La Chapelle-aux-Saints gave a volume of about 1600 c.c., and it is suggested that the volume of the Neanderthal skull is of the same order, and that the 1230 c.c. attributed to it by Schaafhausen, Huxley, and Schwalbe is too small.—The bend of the Rhine at Bâle: Gabriel **Eisenmenger.**

DIARY OF SOCIETIES.

THURSDAY, MAY 27.

ROYAL SOCIETY, at 4.30.—Notes concerning Tidal Oscillations upon a Rotating Globe: Lord Rayleigh, O.M., F.R.S.—The Absolute Value of the Mechanical Equivalent of Heat in Terms of the International Electrical Units: Prof. H. T. Barnes.—An Approximate Determination of the Boiling Points of Metals: H. C. Greenwood.—Some Results in the Theory of Elimination: A. L. Dixon.—The Liquidus Curves of the Ternary System Aluminium-Copper-Tin: J. H. Andrew and C. A. Edwards.—Studies on the Structure and Affinities of Cretaceous Plants: Miss M. C. Stopes and Dr. K. Fujii.

ROYAL INSTITUTION, at 3.—Newfoundland: J. G. Millais.

INSTITUTION OF MINING ENGINEERS, at 11.—Presidential address: Dr. R. T. Moore.—Electricity in Coal-mines: R. Nelson.—Comparison between the Value of Surplus Gas from Regenerator Bye-product Coke-ovens and Steam produced by the Waste Heat from Bye-product Coke-ovens, with Special Reference to the Evence Coppée new Bye-product Ovens: M. H. Mills.

FRIDAY, MAY 28.

ROYAL INSTITUTION, at 9.—Advances in our Knowledge of Silicon as an Organic Element: Dr. J. Emerson Reynolds, F.R.S.

INSTITUTION OF MINING ENGINEERS, at 10.30.—The Use of Concrete for Mine Support: Prof. W. R. Crane.—Mining in British Columbia: Mrs. Rosalind Young.

SATURDAY, MAY 29.

ROYAL INSTITUTION, at 3.—The Secret Societies of the Banks' Islands: Dr. W. H. R. Rivers, F.R.S.

TUESDAY, JUNE 1.

ROYAL INSTITUTION, at 3.—Biological Chemistry: Dr. F. Gowland Hopkins, F.R.S.

WEDNESDAY, JUNE 2.

ENTOMOLOGICAL SOCIETY, at 8.—On the Colonisation of New Nests by Myrmecophilous Coleoptera: H. St. J. Donisthorpe.

SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, JUNE 3.

ROYAL INSTITUTION, at 3.—A Modern Railway Problem: Steam *v.* Electricity: Prof. W. E. Dalby.

LINNEAN SOCIETY, at 8.—On the Alcyonaria of the *Sealark* Expedition: Prof. J. A. Thomson.—On the Cephalochorda of the *Sealark* Expedition: H. A. S. Gibson.—Report on the Porifera collected by Mr. C. Crossland in the Red Sea: R. W. Harold Row.

RÖNTGEN SOCIETY, at 8.15.—Annual General Meeting.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

FRIDAY, JUNE 4.

ROYAL INSTITUTION, at 9.—Researches in Rodiotelegraphy: Prof. J. A. Fleming, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Fossiliferous Lower Keuper Rocks of Worcestershire: L. J. Wills.

SATURDAY, JUNE 5.

ROYAL INSTITUTION, at 3.—The Vitality of Seeds and Plants: (1) A Vindication of the Vitality of Plants: Dr. F. F. Blackman, F.R.S.

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