THURSDAY, DECEMBER 23, 1909.

THE CAMBRIDGE NATURAL HISTORY.

The Cambridge Natural History. Vol. iv., Crustacea, by G. Smith and the late W. F. R. Weldon; Trilobites, by H. Woods; Introduction to Arachnida, and King-Crabs, by A. E. Shipley; Eurypterida, by H. Woods; Scorpions, Spiders, Mites, Ticks, &c., by C. Warburton; Tardigrada (Water-Bears), by A. E. Shipley; Pentastomida, by A. E. Shipley; Pycnogonida, by Prof. D'Arcy W. Thompson. Pp. xviii+566. (London: Macmillan and Co., Ltd., 1909.) Price 17*s.* net.

WITH the present volume, the last to be issued of the ten volumes forming the Cambridge Natural History, that carefully planned and well-executed work is completed. The editors, Dr. S. F. Harmer and Mr. A. E. Shipley, are to be congratulated upon having brought their enterprise to a satisfactory conclusion, and upon having placed at the disposal of advanced students of zoology, both professional and amateur, an authoritative account of each of the principal phyla of the animal kingdom.

The section on the Crustacea had been entrusted to the late Prof. Weldon, and the one chapter dealing with the Branchiopoda, which he had completed before his death, is so clearly the work of a master-craftsman that it is hardly possible not to feel a sense of regret that he was unable to finish the task so well begun, and not to realise dimly what an original and valuable contribution to crustacean literature his completed work might have been. Prof. Weldon's pupil, Mr. Geoffrey Smith, was placed at a disadvantage in having to continue this work at short notice and under pressure of time, and it was not to be expected that he would be able to carry it on upon the same lines as those on which it had been begun. Where he is speaking of matters with which his own researches have given him knowledge at first hand, Mr. Smith had done excellently. Thus there is a very careful account of the order Anaspidacea, and an even more interesting and suggestive section on the parasitic cirripedes Peltogaster and Sacculina, which infest other Crustacea. Other portions of the section, which are clearly compiled from the literature, are, unfortunately, not so satisfactory, and there is great lack of a due sense of proportion in dealing with many groups. Thus the interesting order Cumacea is dismissed in about a page and a half, and the information which is given is so summarised as to be of little value. It cannot but be a matter for regret, also, that in a work of this character on the Crustacea so little attention has been paid to internal anatomy. It is true that much investigation is still necessary before a really adequate account of the morphology of the internal organs in this group can be compiled, but at the same time a very large literature dealing with the subject already exists which has been only very lightly dealt with.

Mr. Henry Woods contributes to the volume a clear and well-illustrated account of the Trilobites. He takes the view that their affinities are with the Crustacea, more particularly with the Phyllopoda, and recognises sixteen families. He is unable, however, to accept either Salter's classification of the families into four groups, or the modification of that classification proposed by Beecher.

The principal chapters on arachnids are by Mr. Cecil Warburton, who has written a very valuable treatise on this group. Mr. Warburton's work is to be especially commended in that he has done such full justice to all aspects of his subject. The anatomy and morphology of scorpions, spiders, and mites are dealt with authoritatively and with great accuracy of detail, whilst at the same time that side of the subject which results from the work and observations of the field naturalist is treated in an equally satisfactory way. Chapter xiv., dealing with the habits of spiders, is, indeed, one of the most interesting in the whole series of volumes of the Cambridge Natural History. The subject is a fascinating one in itself, and the author has, by a judicious introduction of his own personal observations on familiar British species, given to it an air of reality which adds greatly to the pleasure of the reader and to the value of the information given.

Chapters on the king-crabs (Xiphosura) and on Tardigrada (water-bears) and Pentastomida are added by Dr. A. E. Shipley. With regard to the affinities of the latter group of parasites, in which the structure is obviously much modified, the author does not commit himself to any very definite opinion, but contents himself with referring, in somewhat general terms, to those characters which they possess in common with some arachnids. A useful list is given of all the known species, with their primary and secondary hosts.

The concluding chapter of the volume is by Prof. D'Arcy Thompson, and deals with the Pycnogonida. Prof. Thompson writes with somewhat greater elaboration of literary style than is generally adopted by present-day scientific authors, but whether always with happy results we are inclined to doubt. Thus the chapter opens with this sentence:—

"Remote, so far as we at present see, from all other Arthropods, while yet manifesting the most patent features of the Arthropod type, the Pycnogons constitute a little group, easily recognised and characterised, abundant and omnipresent in the sea."

The enthusiasm of the last clause of this sentence would, we fear, be somewhat damped by a sudden call to find, say, fifty living specimens in any but some specially favoured locality.

The chapter is, however, taken as a whole, clear and accurate, and is certainly the best account of the pycnogonids available for English students. With regard to classification, Prof. Thompson considers that Decolopoda is probably the most primitive form known, and that Colossendeis is closely allied to it. The Eurycydidæ and Ammotheidæ are allied to Colossendeis, whilst the true position of Rhynchothorax is very doubtful. On the other hand, the Nymphonidæ, in which is included the five-legged Pentanymphon, described by Hodgson from the Antarctic, also show a minimum of degeneration, and must, therefore, also be regarded as primitive, though separated from Decolopoda by many differences. The Pallenidæ are closely allied to the Nymphonidæ. The Phoxichilidiidæ have points of resemblance with the Pallenidæ, and the Pycnogonidæ are probably allied to them. The ideas here expressed as to the relations of the different families have, however, recently been questioned by Carpenter, whose views have received support from Calman. According to these authors, the fifth pair of legs in Decolopoda and in Pentanymphon may possibly represent a comparatively new development and not a primitive character.

MORTALITY TABLES.

The Theory of the Construction of Tables of Mortality and of Similar Statistical Tables in Use by the Actuary. A course of lectures delivered at the Institute of Actuaries, Staple Inn Hall, during the Session 1904–5, by G. F. Hardy. Pp. iii+141. (London: C. and E. Layton, 1909.) Price 7*s*. 6*d*.

THIS course of lectures, which was delivered under the auspices of the Institute of Actuaries, deals with the construction of mortality and similar tables which, as the author justly observes in his opening sentence, lie at the very basis of actuarial work. They deal succinctly with familiar methods of graduation, such as the graphic and Woolhouse's difference method, but are for the most part devoted to more modern theories of curve-fitting, and to the application of Makeham's hypothesis in dealing with the somewhat intractable curve which arises from the fact that, with assured lives, the rate of mortality is for several years a function of time that has elapsed since medical examination rather than of age.

It may be remarked that a subject involving much technical mathematical detail cannot be satisfactorily dealt with in the form of lectures. Mr. Hardy's first two lectures deal with methods of graduation which are familiar to most actuaries, and can be suitably presented in this form, but the remaining four lectures contain much original work, which can only be thoroughly understood after careful reading and study. Fortunately, Mr. Hardy appears to have realised the limitations of his medium, and in its present form the work is well suited to the actuarial student.

The publication of this book is of special interest, as a perusal of it shows that modern development in the graduation of tables of mortality has, singularly enough, had its impulse and inspiration from outside the actuarial profession. To Prof. Karl Pearson's original work in the field of biological statistics, actuaries are indebted for the new calculus, which was applied by Mr. Hardy in the graduation of the principal mortality tables compiled from the experience of lives assured in British offices, and published a few years ago. Actuaries, indeed, cannot be said to have taken very readily to the new method, and during the last three years there has been a surprising number of contributions in the Journal of the Institute of Actuaries dealing with the development of those finite difference formulas to which Mr. Hardy devotes only half-a-dozen pages in this book, and which will, we hope, in a few years be considered obsolete.

The most interesting part of the book is that dealing with the Pearsonian frequency curves, and it is suggestive of the exhaustive nature of the work done by Prof. Pearson to find that so original a thinker as Mr. Hardy has practically nothing to add to the information we have already received about this important family of curves. He, in fact, refers the reader to Prof. Pearson's works, and to the treatise of Mr. W. Palin Elderton, for fuller information. The latter work was published only three years ago for the benefit of actuaries, and will, we think, hold the field as the only text-book on the subject for some years. In these circumstances, it may perhaps be regretted that Mr. Hardy has seen fit to re-number the types of curves, as this may easily confuse anyone who finds occasion for reference to both books, or to Pearson's original work, which Elderton follows. The student will also be in difficulty at the outset owing to Mr. Hardy giving the differential equation from which these curves are derived as

$$\frac{1}{y}\cdot\frac{dy}{dx}=\frac{hx-x^2}{a-bx-cx^2},$$

instead of the one to which we are accustomed,

$$\frac{1}{y}\cdot\frac{dy}{dx}=\frac{x+a}{b_0+b_1x+b_2x^2+\ldots},$$

and we may mention that a misprint would appear to have been introduced here, as it does not seem possible to derive Pearson's Type I. from the first-mentioned equation.

It is unfortunate that Mr. Hardy has not illustrated this part of his subject by reference to the chief mortality table, in the graduation of which the method of frequency curves has been employed, and was carried out by himself. When it is remembered that this will now be the standard mortality table for many life-insurance purposes, it seems strange that so favourable an opportunity should have been missed.

In justice, however, to the author, it may be as well to say that, taking into consideration the space at his disposal, he has done wisely in devoting so large a proportion of it to the study of the Makeham curves, in the knowledge and manipulation of which he is so able an exponent. At the second International Congress of Actuaries, one of the most eminent of Continental actuaries stated that, in his opinion, the day had entirely gone past in which Makeham's graduation would be practically applied in the graduation of tables; and it is a singular commentary on this statement that the select annuity and assurance tables of the recent experience have been graduated by the application of the formula in question. In order to prove the importance of this matter to actuaries, it is only necessary to point out that the value of an annuity payable during the joint life of two persons of any age can be found from a table giving the annuity values for two lives of equal age, whereas, in the case of a table graduated on different principles, a large volume would be required.

Mr. Hardy's illustrations of the application of

Makeham's curve to the general population will be of great interest to all statisticians.

The publication of these lectures marks, we hope, a turning-point in actuarial graduation; it means that the study of curve-fitting has now become a part of the curriculum of the actuarial student, and a knowledge of frequency curves must be acquired before the diploma of the Institute is won. This recent development has enormously increased our power of interpreting statistics, and Mr. Hardy will have done actuarial science a great service if this book induces the other members of his profession to follow in his footsteps.

MODERN ORDNANCE.

The Engineering of Ordnance. By Sir A. Trevor Dawson. The Gustave Canet Lecture, delivered at the Twenty-fifth Anniversary Meeting of the Establishment of the Junior Institution of Engineers, at the Hall of the Worshipful Company of Fishmongers, June 30, 1909. Pp. iv+53. (London: Percival Marshall and Co., 1909.) Price 2*s.* 6*d.*

IT is generally understood that progress made in the construction of guns, gun-mountings, explosives, and projectiles during the last half-century far exceeds that made in the preceding five hundred years; but the causes of this great advance, and the methods by which it has been accomplished, are not so well known. In this small book, of little more than fifty pages, the author has summarised the facts in a clear and interesting style, in a fashion perfectly intelligible to ordinary readers. The descriptions of ordnance are assisted by means of a series of excellent illustrations representing ancient weapons as well as the most recent types.

The author is an eminent authority on the subjects of which he treats, and he is a master in the art of exposition. As director in charge of the Ordnance Department of Vickers, Maxim and Co., Sir Trevor Dawson has been able to utilise the valuable training and experience he had previously gained in the Royal Navy, and to play a prominent part in recent advances. The value of the work done by him has just been recognised by a knighthood, and many professional friends will join in congratulating him upon this well-deserved honour. The Junior Institution of Engineers was fortunate in obtaining the services of such a man as their first lecturer and gold medallist under the Canet bequest.

M. Gustave Canet was a most distinguished French ordnance engineer who received his principal training in this country under the late Mr. Joseph Vavasseur, and subsequently did much to advance the design and construction of ordnance in his native country in association with the great firm of Schneider and Co., of Creusot. M. Canet was president of the Institution of Junior Engineers in 1907–8; his death occurred at the close of his term of office, and his family founded a Canet Gold Medal as a memorial in accordance with a wish he had expressed. No fitter tribute to his professional eminence could have been paid than that which the volume under review contains—a tribute from a British ordnance engineer of the first rank to the work which his French collaborateur had done in improving ordnance for both sea and land purposes.

The author has compressed and condensed a considerable mass of material into the modest limits mentioned above, at the same time indicating the great range and variety of the subjects affecting the design of modern ordnance. He has also maintained his sense of proportionate value in dealing with each item. He shows how important have been contributions made by metallurgists, chemists, and mechanical engineers, and how essential has been the work of each. Improvements in steel manufacture lie at the root of advance in gun-construction and the making of projectiles. The chemist has played a great part in these improvements, and has devised much more powerful "propellants" to take the place of gunpowder, as well as high explosives which can be safely fired from guns and be capable of working havoc on an enemy's forces or ships. The mechanical engineer has been no less useful; indeed, it is his lot to utilise all that metallurgists and chemists can do so as to embody their latest discoveries in designs for more powerful and accurate artillery, or in the construction of more efficient gun-mountings. Hydraulic, electric, and pneumatic methods of transmitting and utilising power in connection with ordnance all find a place and use, their relative value and efficiency being differently assessed by different authorities.

Sir Trevor Dawson states the case fairly, and records his own opinions in many instances. For example, what he says in regard to "wire-wound" and "solid-steel" systems of gun-construction is well worth study; and equally so are his remarks on the advantages and disadvantages of hydraulic or electrical power for working and loading heavy guns; or his comparisons of nitro-glycerine and nitro-cellulose powders. All these questions must be studied in the original volume, as limits of space prevent even a summary being given of the author's conclusions. Every reader of the book will gain a clear idea, not merely of the ingenious devices now in ordinary use for loading and working heavy guns or quick-firing guns of moderate size and weight, but of the means by which present practice has been attained. Behind the complete control and apparently easy handling of the largest guns there lies a mass of complicated machinery for the proper maintenance and use of which highly trained staffs are necessary. The "sweet simplicity" which prevailed before steam-power and armour-defence came into use has entirely disappeared, and cannot be restored. One comparison may be mentioned in conclusion. In 1864 the most powerful 12-inch gun was a muzzle loader, twelve calibres in length, weighing about 23·5 tons; its charge of powder weighed 85 lb., the muzzle velocity of the 614 lb. projectile was 1300 feet per second, and it could perforate 16 inches of wrought-iron armour at the muzzle, or 8 inches at the maximum range of 6000 yards. The 12-inch gun of 1909 is a breech-loader, fifty calibres long, weighing nearly 70 tons. Its projectile weighs 850 lb., the muzzle velocity is 3000 feet per second, its perforative power is measured by 52 inches of wrought iron at the muzzle, 37 inches at

6000 yards, and 17·5 inches at 24,000 yards. Readers interested in the subject will find in the book many equally instructive comparisons, illustrating the great strides made during recent years in the engineering of ordnance. W. H. W.

VEGETABLE PROTEINS.

The Vegetable Proteins. By Dr. Thomas B. Osborne. Pp. xiii+125. With Bibliography. [Monographs on Biochemistry. Edited by Dr. Aders Plimmer and Dr. F. G. Hopkins.] (London: Longmans, Green and Co., 1909.) Price 3*s.* 6*d.* net.

THE extent to which the knowledge of the proteins has increased during the last decade is abundantly witnessed by the fact that this is the fourth in this series of biochemical monographs which is devoted to them. Dr. Osborne is undoubtedly the leading authority on the chemistry of the vegetable proteins, and much of the matter considered in this essay was originally made known by his researches. The vegetable proteins are of importance, not only on their own account, but also because of their analogy to the animal proteins, which are being so closely studied at the present time. For this reason, this monograph will be welcomed by animal physiologists.

The author has chosen to treat the subject broadly, and to give a general discussion of the chemical and physical properties of vegetable proteins rather than to describe the individual proteins. Whilst this method of treatment will commend itself to many, it must not be forgotten that there is nothing fundamental to distinguish vegetable from animal proteins as a whole, and there is a danger of setting up some artificial distinction between the two classes.

A clear distinction is made between the proteins of the plant embryo and the reserve proteins of seeds, which so far have been the materials chiefly examined. The reserve proteins are all very characteristic and yield large proportions of some particular amino-acid when hydrolysed. As Pfeffer has pointed out, they are to be regarded as excretory products, for they can take no further part in metabolism, and are lost to the plant. The reserve proteins are far more stable towards chemical reagents than are the living tissue proteins; this property has enabled them to be more drastically purified than most of the proteins of animal origin.

Perusal of the monograph will very rapidly convince the reader of the great experimental difficulties attending work in this field, partly on account of the great tendency to form colloidal precipitates which are difficult to manipulate, and partly because no absolute methods are at present known which enable one protein to be separated from another.

Although, on the whole, it must be admitted we are only just beginning to gain some insight into the chemical nature of proteins, yet a work of this kind, like the other monographs which have preceded it in the series, is so stimulating, and suggests so many possibilities of research, that it requires no other justification for its issue, and it should be in the hands of every earnest student of biochemistry.

We could have wished the author to have been more exhaustive in his treatment, and to have included, for example, some discussion of Dr. H. T. Brown's recent work. The inter-relationship of the proteins of wheat likewise deserves much fuller discussion.

In conformity with the editors' plan, a bibliography of no fewer than 608 papers, arranged alphabetically according to the authors' names, has been added. The publishers may be congratulated on the improved cover. A further advantage in the style of the series is the possession of the wide margins, which enable the reader to amplify the text by his own notes.

E. F. A.

MORPHOLOGY AND MEDICINE.

Clinical Commentaries deduced from the Morphology of the Human Body. By Prof. Achille De-Giovanni. Translated from the second Italian edition by John Joseph Eyre. Pp. xii+436. (London: Rebman, Limited, 1909.) Price 15*s.* net.

THE object of the author of this work is to lay anew the foundations on which the principles and practice of the physician's art are based. The new foundations are the principles of morphology—morphology as expounded by Haeckel, Gegenbaur, and other great anatomists. Like all enthusiastic reformers, as one may infer from the following passage (p. 206), he has evidently suffered considerably at the hand of his Italian confreres:—

"The academicians (I call them academicians because, according to their way, they have made known that the epithet of colleague is not suitable)—the academicians will not demean themselves by accepting these stupid things. Then there are those who, posing as reforming geniuses, let fly a smile of compassion, and others who, from the Olympus of the hypercritical criticism of which they seem specialists, qualify these things in the presence of the credulous public as works of magic, because they do not seek to comprehend them."

By way of apology for Prof. De-Giovanni's medical confreres, the reviewer must confess that a full comprehension of these new doctrines is not an easy matter. As in some of the more recent novels of Henry James, one is puzzled to know whether the obscurities are due to a lack of sense on the part of the reader or of the writer. At least, from the following passage in the preface, in which Prof. De-Giovanni explains his purpose—and there are passages equally obscure on every page of the book—it is evident that the translator has found an equal difficulty, and, apparently, has abandoned as hopeless the task of making the meaning of the original clear:—

"Therefore I think that every clinical investigation should be conducted on the basis of the individuality morphologically verified, for every other verification of the facts and phenomena in relation to doctrine and practice in their turn in every concrete case individualise themselves, or, to speak better, present themselves, not such as they may be according to the data of general biological experience, but such as they must be in the morphological type of the individual under examination."

Instead of speculating on the exact meaning of the passage just cited, it will be more profitable to follow Prof. De-Giovanni into his clinic, attached to the University of Padua—the university where Harvey was taught the anatomy of the heart well-nigh on three centuries ago—and note the manner in which he applies his morphological doctrines to the treatment of disease. He wishes "to establish whether the heart is adequately proportionate to the body or not." He applies the following law, which is given here in italics, as in the original (p. 226):—

"*If one measures the thickness of the right fist (in left-hand persons of the left), placing the tape-measure on the extremities of the first phalanges of the index and little fingers, which articulate with the respective bones of the metacarpus, and fix the ends of the measure surrounding the joints in such a way that it includes their thickness, one will have the measure of the base of the heart.*"

Prof. De-Giovanni's law has several disadvantages; in the first place, it cannot be applied until the patient is dead, and, in the second, it does not hold true even then. Those who are unaware of Prof. De-Giovanni's researches find, in the manner in which the heart responds to its work, a safe indication of whether it is "adequately proportionate to the body or not."

The scientific value of this book may be judged from the passages which have been cited. It is much to be feared that its doctrines will meet, from English-speaking medical men, the same reception as has been accorded to them by Prof. De-Giovanni's Italian "academicians." A. K.

ELEMENTARY BOOKS ON BOTANY.

(1) *Pronunciation of Plant Names.* (Reprinted from *The Gardeners' Chronicle.*) Pp. v+94. (London: *The Gardeners' Chronicle,* Ltd., 1909.) Price 1*s.* net.

(2) *Botany.* By Prof. J. Reynolds Green, F.R.S. Pp. 128. (Dent's Scientific Primers.) (London: J. M. Dent and Co., n.d.) Price 1*s.* net.

(3) *Essentials of Botany.* By Joseph Y. Bergen. Pp. ix+380. (Boston, New York, Chicago, and London: Ginn and Co., n.d.) Price 5*s.*

(1) THIS is a distinctly useful little book. Although primarily intended to encourage uniformity of pronunciation on the part of those engaged in horticulture, it will also, in these days of neglect of the classics, repay perusal by the professional botanist. Even the latter is occasionally guilty of a false quantity. To take a single example, one frequently hears Conium pronounced Co′-ni-um, though Co-ni′-um (*cf.* the Greek κωνειον) is, of course, more correct. But in some cases the compiler has wisely retained Anglicised pronunciations, even though less strictly correct, in deference to established usage. One is tempted to express the wish that more uniformity could be secured in the pronunciation, not only of plant names, but also of botanical technical terms.

(2) Prof. Green's book will probably prove helpful to school teachers and students who have some previous knowledge of the subject. For such it may tend to broaden their conceptions and offer a new point of view. One of the best features of the book is the rather striking and somewhat novel way in which the general adaptation of the plant-body to its environment is constantly emphasised. For instance, the author points out that the effect of the branching of the plant-body (both shoot and root) is to bring the plant

"into relationship with as large a portion of the environment as possible. Here is clearly an indication or suggestion of an interchange of material between the two."

But the book is rather seriously marred by a want of accuracy, some carelessness of expression, and a few antiquated views to be found in certain of its portions, particularly those dealing with anatomy, *e.g.* the descriptions of root-structure on pp. 35 *et seq.* In fact, all through the treatment of the physiological is much more satisfactory than that of the anatomical portions. Some of the illustrations, too, leave much to be desired; indeed, in a few cases the figures are badly drawn and inaccurate. Perhaps the worst are Figs. 20, 22, and 30.

(3) Though not without blemishes, "Essentials of Botany" may be characterised as an excellent elementary text-book. It is brightly written, and combines in an attractive manner information with directions for laboratory work. The reading of the book is obviously intended to be accompanied by actual examination of specimens, and throughout the work questions are constantly suggested which the student is left to answer for himself by direct observation. The illustrations are, for the most part, thoroughly good, though in a few cases they are not above criticism. For instance, in Fig. 20 centrosomes are figured (though not named) in a cell from one of the higher plants. Again, the flowers of the willow (Fig. 100) would be improved by the addition of the characteristic nectary.

As many of the plants selected are North American species, the book is naturally more suitable for use in American than in English schools. It may, however, be heartily recommended for use also on this side of the Atlantic, though it is to be regretted that the author did not supplement the use of American plant names by the addition of the Latin names as footnotes. This is only done in some cases (*e.g.* p. 183, &c.).

We thoroughly endorse Dr. Bergen's opinion that ecology (except in the most elementary form), and also the detailed discussion of evolution, are better omitted from the average school curriculum.

OUR BOOK SHELF.

Geology in the Field. The Jubilee Volume of the Geologists' Association (1858–1908). Edited by H. W. Monckton and R. S. Herries. Part i. Pp. iv+209. (London: Edward Stanford, 1909.) Price 5*s.* net.

IN commemoration of their jubilee, which took place on December 17, 1908, the council of the Geologists' Association decided to bring out a volume dealing with the geology of those parts of England and Wales which have been visited by the Association during the course of its excursions. The volume, which promises to attain a much larger size than was expected, is to be issued in four parts, the first of which is now before us. It is a well-printed work of 209 pages, with four plates and thirty-four text-illustrations; and it deals with the district north of the Thames from Oxfordshire to Bedfordshire and the eastern counties. It comprises seven articles, with the following titles: (1) Middlesex and Hertfordshire, by Mr. J. Hopkinson; (2) Essex, by Mr. T. V. Holmes; (3) The Pliocene Deposits of the Eastern Counties, by Mr. F. W. Harmer; (4) The Pleistocene Period in the Eastern Counties, by Mr. Harmer; (5) Cambridgeshire, Bedfordshire, and West Norfolk, by Mr. R. H. Rastall; (6) Buckinghamshire, by Dr. A. Morley Davies; and (7) The Oxford and Banbury District, by Mr. J. A. Douglas.

In the articles relating to the several counties we have admirable summaries of what is known of the local geology, with discussions on some controverted questions, and a good deal of new and original matter, special attention being given in most cases to the localities visited during excursions of the association. Accounts brought up to date are given of the classic sections, such as those near Watford and Bushey, at Ilford, Upminster, and Grays, at Shotover Hill, Aylesbury, and Upware. The Palæolithic gravels of Rickmansworth, and the derived sarsen stones lately found there, are illustrated in photographic plates; the Hertfordshire Bourne and the Colne swallow-holes near South Mimms; the Dene-holes of Essex; the physiography of the Cambridge area; the relations of the Jurassic and Cretaceous formations, and of the Shotover Sands and Lower Greensand, are among the many topics discussed, apart from the more particular descriptions of the strata and their fossils. The vagaries of modern palæontological nomenclature are noticeable in different articles, as in the case of *Ammonites varians* (p. 4) and *Schloenbachia varians* (p. 168), to say nothing of some other names, the changes in which form the most serious stumbling-block to the student.

The subject of glaciation is dealt with in several of the articles, and more fully in that by Mr. Harmer on the East Anglian Boulder-clays. His essay, illustrated by two maps showing the distribution of the Drifts and the direction of movement of the ice-sheets, is in itself an important contribution to the advancement of science.

The work will thus be of great practical value to the field-student, and it must be consulted by everyone interested in the progress of geology in this country. At the same time, for historical purposes, the original records of excursions published in the Proceedings of the association must not be neglected.

Who's Who, 1910. Pp. xxiv+2162. (London: A. and C. Black.) Price 10*s*. net.
Who's Who Year Book for 1910. Pp. vii+162. (London: A. and C. Black.) Price 1*s*. net.
The Writers' and Artists' Year Book, 1910. Pp. viii+127. (London: A. and C. Black.) Price 1*s*. net.
The Englishwoman's Year Book and Directory, 1910. Edited by G. E. Mitton. Pp. xxvi+382. (London: A. and C. Black.) Price 2*s*. 6*d*. net.
Hazell's Annual for 1910. Edited by Hammond Hall. Pp. lxiii+608. (London: Hazell, Watson and Viney, Ltd.) Price 3*s*. 6*d*. net.

IT would be difficult to select for the busy man a more useful set of works of reference than the new issues of the five annual publications under notice. Each one of them is so well known that it is sufficient in every case to say that, not only has there been no diminution of accuracy and interest, but the various editors have all succeeded in adding to the completeness of the books entrusted to their care.

The long obituary at the beginning of the book, and the addition of some fifty pages to "Who's Who," serve to indicate that there have been material changes made in the new issue. "Who's Who Year Book" continues to be an indispensable supplement to the larger work, to which, indeed, it is a really useful key.

Writers, artists, and photographers will find in the third periodical information which it is difficult to obtain elsewhere.

The volume specially intended for women has been revised very thoroughly. Full information is provided concerning the part now taken by women in professional and other work, and the book may be recommended especially to schoolmistresses and parents desirous of finding suitable avocations for girls leaving secondary and other schools.

Among the new features of "Hazell's Annual" may be mentioned the introduction of signed articles. For example, Sir Oliver Lodge, F.R.S., contributes an article on the new physics, Sir Hiram Maxim writes on the evolution of the flying machine, and Mr. C. C. Turner on aërial navigation in 1909.

The New Physics: Sound. By Joseph Battell. Pp. xvi+274+xlvii. (Middlebury, Vt., U.S.A.: The American Publishing Co.; London: A. F. Bird, 1909.) Price 6*s*. 6*d*. net.

VERY few pages of this new treatment of physics need be read before we reach the conclusion that "the old is better." Mr. Battell's object in writing this book is to give "a condensed but complete exposure of the errors in the present theory of sound." He has been "for years opposed to all undulatory theories, as at variance with the fundamental principles of creation, and otherwise not only entirely, but very foolishly, erroneous," and while anxious to give every credit to such men as Koenig and Helmholtz, he comes to the rescue of truth with a book to prove that "sound, like light and odour, is composed of infinitesimal particles of matter." It is really extraordinary how such an effort as this can secure a publisher. No matter where a reader begins, whether at the beginning, the middle, or the end, the result is the same; it is impossible to interpret the author's meaning. Here and there, it is true, there are a few intelligible sentences, but in the main they are obscure and apparently unconnected with what precedes and follows. As an example of this we may quote the following, and leave it to the reader to gather what information he can.

"That light is made by bodies made to make it, as the sun or a lamp; or odour by things made to make it, as a sweet pea or water lily,—that is, by things having light-making or odour-making machinery, and that they can make no other light or odours than those they were made to make, or have the machinery to make,—is no more true, than that nothing can make Sound unless made to make it, or any sound except what it was made to make, and that means any unless it has the machinery to make it."

The author is, without doubt, ingenious in his way of making his particles submit to his theory. Perhaps this results from his acquaintance with horse-rearing. (It should be mentioned that among Mr. Battell's other publications are several volumes of the "American Stallion Register.") For instance, in order to account for the fact that sound is not propagated in a vacuum—at first sight a difficult thing to do on a corpuscular theory—the author naïvely suggests that the reason is the same as that which makes birds unable to fly without air.

Those who have read Mr. Battell's previous scientific work, "Ellen, or Whisperings of an Old Pine," will find this volume equally amusing, and from that point of view the book is, perhaps, worth its price; but those buying it in the expectation of a reasoned text-book for the study of physics will be disappointed.

LETTERS TO THE EDITOR.

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

The Function of Reissner's Fibre and the Ependymal Groove.

Thanks mainly to the investigations of Porter E. Sargent, Reissner's fibre is now known to occur throughout the vertebrate series from the lamprey upwards. Not long ago Mr. G. E. Nicholls directed attention in these columns to its occurrence in the frog, and Sir Victor Horsley (*Brain*, vol. xxxi., 1908) has recently shown that it occurs in monkeys (Macacus). I have myself already described it in Geotria, and have lately observed it in the tuatara and in the cat. Its position and relations are remarkably constant. Commencing beneath the posterior commissure, it extends backwards to the hinder extremity of the spinal cord, lying, at any rate for the greater part of its length, quite free in the iter, the fourth ventricle, and the canalis centralis. Anteriorly it breaks up into very slender fibrils, which are attached to the columnar epithelium of the ependymal groove.

The ependymal groove, though its existence has been strangely ignored by most observers, also occurs throughout the vertebrate series from cyclostomes to mammals. It is found typically as a deep longitudinal furrow on the ventral aspect of the posterior commissure, lined by high columnar epithelium, very different in appearance from that which lines the greater part of the brain-cavity. In this highly specialised condition I have observed it in the lamprey, the tuatara, and the cat. I suggested some years ago, in the case of the lamprey, before the connection of this structure with Reissner's fibre was known, that it might aid in the circulation of the cerebro-spinal fluid, by means of cilia which I thought I had detected on the epithelial cells. Whether this be so or not, I now think that the ependymal groove may have another, and perhaps more important function as an intra-cerebral sense-organ.

Sargent, as is well known, has interpreted Reissner's fibre as a nervous structure which serves for the "short-circuiting" of motor (optic) reflexes, and he regards the epithelium of the ependymal groove merely as an attachment plate for the fibre. This seems to me hardly a sufficient explanation of the existence of such a highly differentiated organ.

The nervous nature of Reissner's fibre is very far from having been demonstrated, and though I was formerly led to agree with Sargent's opinion on this subject, I can do so no longer. Sir Victor Horsley and Dr. McNalty (*loc. cit.*) have shown that electrolytic lesions do not cause any degenerative changes in Reissner's fibre such as would be expected if it were a nerve-bundle, and this result is, of course, totally opposed to that of Sargent's earlier experiments, by which he endeavoured to establish the truth of the optic reflex theory. On the other hand, there is a certain amount of evidence to show that Reissner's fibre is highly elastic, and therefore more of the nature of connective tissue. Thus it is often found that when the spinal cord has been cut across, the fibre has "sprung" and twisted itself into a knot or gnarl in some part of the brain-cavity. This seems to indicate that the fibre in life is under considerable tension. My colleague, Mr. Nicholls, who has for some time past been working at Reissner's fibre in this laboratory, will, I hope, bring forward some further evidence on this head very shortly.

I now wish to suggest, for the consideration of physiologists, that Reissner's fibre and the epithelium of the ependymal groove may form part of an apparatus for regulating flexure of the body. Any such flexure would, it appears to me, tend to alter the tension of Reissner's fibre, and thereby exert a mechanical stimulus upon the cells of the ependymal groove to which it is attached. We may suppose that the stimulus received by these sensory cells is transmitted to appropriate nerve-cells in the brain, and that the deviations of the long axis of the body from the normal position may possibly be regulated by reflex action. We may compare the function of the semicircular canals of vertebrates; also that of the "statocysts" of many invertebrates, which serve, by means of mechanical stimuli due to the action of gravity, automatically to regulate the orientation of the body.

The position of Reissner's fibre, entirely enclosed within the brain and spinal cord, renders it extremely difficult to perform any experiments to test the truth of this hypothesis, but I hope that the ingenuity of experimental physiologists may overcome even such a formidable obstacle as this.

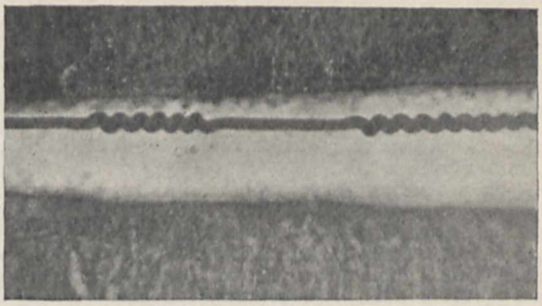
Arthur Dendy.
Zoological Department, King's College,
Strand, W.C.

With reference to Prof. Dendy's remarks on Reissner's fibre and the suggestion that he puts forward as to its function, I may perhaps be permitted to add a few words.

Of the preformed nature and of the universal occurrence of the fibre throughout the vertebrate series there can remain, I think, no possible doubt.

During the past two years in which I have been engaged in investigating this structure I have examined sections of the brains of a large number of specimens of more than five-and-twenty different genera taken at random from all the great classes of vertebrates, and in *no case* have I failed to find the fibre in properly fixed material. Any of the commonly employed fixing reagents may be used, but it is essential that the material shall be fixed immediately after death.

I have been greatly impressed with the extraordinary elasticity of the fibre, which in life appears normally to be under considerable tension, so that if it be severed in the fresh state the free ends recoil sharply. In one case, where in removing the brain of a toad the fibre was accidentally snapped, so considerable was this recoil that, as subsequent examination of the sections revealed, the free end of the fibre sprang forward into the cavity of the fore-brain, the thin roof of which it actually perforated. Another striking instance of this same character is furnished in certain sections of the terminal portion of the spinal cord of the lamprey, a photomicrograph of which, kindly taken for me by Mr. R. W. H. Row, is here reproduced.



Photomicrograph of a section of the terminal portion of the spinal cord of the lamprey. ×600.

In this case the cord was severed when fixation was only partially effected, and a sudden recoil having been prevented by the partial fixation, the fibre was withdrawn backwards towards its attached end by a more gradual retraction that resulted in the production of a number (twenty-nine) of close coils, two of which appear in the photograph.

From these and other facts I am persuaded that the structure is *not* a nerve, but rather an elastic rod with a merely mechanical function, and to my mind the suggestion Prof. Dendy puts forward as to its function is quite a reasonably probable one.

GEO. E. NICHOLLS.

King's College, December 17.

Nitrogen-fixing Bacteria and Non-Leguminous Plants.

I REGRET that owing to Mr. A. D. Hall's letter of July 12 (NATURE, July 22) appearing during vacation, I had not an opportunity of seeing it until my return to college at the commencement of term. I trust that, in spite of the long delay, I may yet be allowed to reply to some of Mr. Hall's questions.

Mr. Hall commences by stating that my conclusions are based "on experiments to show that Pseudomonas, the bacterium associated with the leguminous plants, will fix more nitrogen, &c." This is not correct, for it is definitely stated in the abstract that both the Pseudomonas and the Azotobacter used for the nitrogen determination results quoted were obtained from a non-leguminous plant—the root tubercles of Cycas.

There are four non-leguminous plants possessing root tubercles which contain nitrogen-fixing organisms. In all four a species or variety of Pseudomonas is present, but in Cycas only is Pseudomonas found living outside the cortical cells, in the algal zone, and in Cycas only is Pseudomonas found in association with Azotobacter. As stated in my paper, the nitrogen determinations quoted had reference only to these organisms from Cycas, and were made in order to determine to what extent, if any, Cycas *Azotobacter* assisted Cycas *Pseudomonas* in assimilating free nitrogen.

"Pseudomonas, the bacterium associated with the leguminous plants," and the use of "a reasonably active culture" of Azotobacter, to quote Mr. Hall, had nothing to do with the determination experiments. On what grounds, then, does Mr. Hall state that "the only conclusion that could be drawn from Prof. Bottomley's figures would be that Pseudomonas injuriously affects the power of Azotobacter to fix nitrogen"? Naturally, a determination of the amount of nitrogen fixed by the Azotobacter alone was made (for Mr. Hall's information I may say that it was very small, −0·56 mgr.), but as the immediate object of the experiment was to determine the effect of Cycas *Azotobacter* on Cycas *Pseudomonas*, it was not thought necessary to quote the figures for Cycas *Azotobacter* alone, especially as this will be dealt with in a future paper.

Again, when speaking of the experiments with oats, Mr. Hall says that the mean error of ±10 per cent. found in Rothamsted experiments "would more than cover the differences observed by Prof. Bottomley's experiment with oats." The figures given for oats are:—average weight per plant, untreated, 0·42 grm.; treated, 0·74 grm.; increase, 0·32 grm., or 76 per cent. Surely Mr. Hall cannot have read the abstract carefully or he would not have stated that a mean error of ±10 per cent. more than covers an increase of 76 per cent.! As regards probable experimental error, the abstract states that the oats were "grown in sand, dressed with phosphates, potash and lime." Why, then, should Mr. Hall assume that they were grown "in soil which presumably already contains both organisms"?

As regards the field experiment with barley, duplicate samples were not taken from different parts of the untreated plot, but the total yields from treated and untreated plots were kept separate, and the treated showed an increase of 13·6 per cent. The sample for estimation of nitrogen content was taken from the bulk in each case.

The treated bulbs gave an increased yield of 18·6 per cent. They were not selected as being specially "suitable for experiments on nutrition," but to determine the effect of the mixed culture of bacteria on a totally different kind of plant from any of the other experiments. The bulbs were already planted when the experiment commenced, hence the original weight of the bulbs is not available. As, however, the bed contained 500 bulbs, and was divided into two equal halves with 250 bulbs in each, one may assume that the original weight in each half was approximately equal.

As regards the culture solution "being a considerable factor in any beneficial effect experienced," it is difficult to comprehend how 4½ grs. potassium phosphate and ½ gr. magnesium sulphate dissolved in a gallon of water for the culture solution, and this afterwards diluted with fifty gallons of water before applying, could possibly produce any appreciable effect on growing crops. Assuming that the bacteria had not used up any of the culture salts in their growth to produce the culture solution, can one imagine any benefit to plants by watering them with a solution containing 1/50,000 part of potassium phosphate and 1/450,000 part magnesium sulphate?

Mr. Hall appears to consider his questions "somewhat critical." True and fair criticism is always welcome in scientific investigation, for it is only thus that one can get at the truth of things, but misstatements of fact or misrepresentations of results exceed the bounds of criticism. So far as Mr. Hall correctly states the experiments and results given, one welcomes his criticisms.

W. B. BOTTOMLEY.

King's College, Strand, W.C.,
November 25.

IN Prof. Bottomley's paper in the Proceedings of the Royal Society I cannot read that he makes any claim that the Pseudomonas and the Azotobacter he isolated from Cycas were in any way different in kind from the usual forms of these organisms. When I used the expression "Pseudomonas, the bacterium associated with leguminous plants," it was as a sort of explanatory label for the lay reader, but if it has confused the issue at all I would still repeat my former criticism on Prof. Bottomley's basis that the Pseudomonas and Azotobacter he used are special and unlike all others. The question was if "the association gave an increased power of assimilating free nitrogen," and Prof. Bottomley's figures are:—

Control...	0·48 mgm.	nitrogen
Pseudomonas alone	0·91 ,,	,,
Pseudomonas + Azotobacter ...	1·24 ,,	,,

and I asked if the action of Azotobacter alone ought not also to be known before any answer is possible. Prof. Bottomley now tells us that Azotobacter alone fixes 0·56 mgm., so that I still conclude that Pseudomonas and Azotobacter together (1·24) are less effective than when grown separately (0·91+0·56), were I not more inclined to think that all the differences are within the limits of experimental error.

To pass to the experiments with plants, by an error which the context rendered sufficiently obvious I wrote "oats" instead of barley when dealing with Prof. Bottomley's first-quoted experiment with soil. The oat experiment is beside the point; it only demonstrates fixation of nitrogen by Azotobacter and Pseudomonas—a fact on which we are all agreed; but when Prof. Bottomley claims increased crop production due to inoculation with the two organisms in the open ground, we do want the means of judging what weight to attach to the results. He gives for the first barley experiment a gain of 13·6 per cent.; in barley 2 the increase cannot be estimated; the Galtonia experiment shows 18·6 per cent. increase, the parsnips 21·7 per cent. Such percentage differences are not outside the limits of error for a single plot experiment worked on a large scale with every condition in favour of accuracy; when they are differences between lots of 250 bulbs or 68 parsnips I have no hesitation in regarding them as without any significance whatever. I have just had pulled and weighed two lots of fifty successive roots of mangolds growing side by side in neighbouring rows on the same plot, inside rows perfectly similar to the eye and on a very uniform plot, yet one lot weighed 220 lb., the other lot 176 lb., a difference of 25 per cent. The assistant who gathered the roots was quite unaware of the question involved; his instructions were to begin inside the plot and take fifty consecutive roots along a row, then another fifty roots alongside; the difference in the weights merely represents the error of random sampling when numbers are small.

Prof. Bottomley is very scornful over my suggestion that the nutrient salts in the bacterial culture may have brought about an increase in yield, but if it is easy to represent their quantity as small to the verge of ridicule, exactly the same argument might be turned against the bacteria he added. No factor should be neglected to equalise the conditions of the controls and the treated plots. I can give Prof. Bottomley examples in which the nutrient salts accompanying a bacterial inoculation have not been negligible in their effects.

I put my questions to Prof. Bottomley because he does not seem to recognise how large an experimental error he must expect; the conclusions he reaches are of such importance as to demand a more serious body of evidence than the specially selected cases he has put before us.

A. D. HALL.

The Rothamsted Experimental Station, December 13.

Positions of Birds' Nests in Hedges.

WHAT has puzzled Lieut.-Colonel Walsh (NATURE, December 16) may be referred to the law of protective devices on the part of birds, and I may say that his facts have been long familiar to other field naturalists and myself. I do not think that the direction north-south or east-west has anything to do with the selection of the nest site. If, at this season of the year, hedges are examined, even very careful "bird boys" and men will be astonished at a much larger number of nests than they observed in summer. If an explored hedge skirts on one side a public road, an "occupation" road, or right-of-way paths, it will be generally found that the nests are on the field side of the hedge, and, therefore, when looked for from the other side, much more difficult to discover than if they were placed on the road or pathway side. In cases where the hedge divides a field from a plantation, the nests are invariably on the plantation side. I knew that very well when I was a boy "nester," and was struck with it only a few days ago on examining a long stretch of hedge-fencing from a semi-public road near my home. However, there may be some esoteric law of bird-life in what Lieut.-Colonel Walsh says. Certainly his facts are most interesting.

G. W. MURDOCH.

Woodbine House, Bentham, Yorkshire, December 17.

RADIUM AND CANCER.

THE *Revue générale des Sciences* of November 30 contains a lengthy and important article by Dr. Louis Wickham on the therapeutic action of radium on cancer, based upon observations made on 1200 patients suffering from tumours, half of which are stated to have been malignant. Dr. Wickham himself has demonstrated recently in London and in Belfast the nature of the results he has obtained, and full reports are available in the Proceedings of the Royal Society of Medicine and in the *British Medical Journal*. Therefore there is no need to reproduce the details of the article. The illustrations in the *Revue générale des Sciences* are even more startling than those which have appeared in the English journals cited. The appearances presented before and after treatment are such as will, almost surely, carry conviction to all laymen, whether healthy or suffering from cancer, that radium can cure the disease. But Dr. Wickham does not write in a corresponding spirit of optimism. Indeed, the only note of triumph is the phrase "It is delightful to think that the whole evolution of radiotherapy (the marvellous discovery of radium by P. Curie and Mme. Curie, the construction of perfected apparatus, therapeutical applications) is almost entirely French." No one may grudge this full measure of recognition to the advances made possible in Paris, on the biological action of radium, by collaboration between laboratories of physics, chemistry, and pathology. Not the least measure of praise is due to Dr. Wickham himself, both for his initiative and for his achievements.

Persons who possess an intimate knowledge of the clinical course and pathology of cancer will be less impressed by the pictures of cured cases than by what Dr. Wickham writes and what he omits to refer to. The evidence of diagnosis and of microscopical structure is imperfect. The duration of the period of benefit after treatment, as well as the ultimate fate of the patients, are the criteria by which the success of surgery is measured; but the evidence advanced in Paris falls short of good standards in both respects. Dr. Wickham lays no claim to successful treatment of secondary deposits; he says severe cases ought only to be treated when the surgeon can do nothing, and that it is too early yet to say if radium is the means which ought always to be employed. A warning is given of the necessity for caution in appraising the value of any new treatment, and, above all, of the necessity of avoiding the risk of depriving patients of other treatment which has proved itself superior, especially of surgery.

The results obtained in Paris have attracted the attention of the world. The hopes they have aroused have awakened yet greater expectations for the future, when larger quantities of radium shall be available, and the technique better mastered. Meantime, notwithstanding Dr. Wickham's caution, the writer considers a further note of warning is necessary. All that is claimed for radium is a beneficial action when applied directly to primary growths. Secondary growths inaccessible to direct surgical removal are inaccessible to radium in consequence of the restricted penetration of the rays. Whether or not means will be devised for attacking deep secondary deposits—the very site of which it may be impossible to determine—remains to be seen. The actual injection of emanation solution has met with no success. Nor is the evidence that radium has a marked elective action for cancer tissue so strong, at present, as to arouse any great hopes from more efficacious means of flooding the body with radio-activity. In short, radium does not appear to be nature's remedy for cancer, but an empirical remedy with the same shortcomings as all other such in the case of cancer, in that the local condition alone is attacked and the constitutional conditions are unassailable.

That the body can generate powers of its own, leading to constitutional changes which enable it to deal effectively with cancer, has been abundantly demonstrated by recent experiment. In given circumstances, 100 per cent. of animals bearing transplanted tumours can cure themselves. The facts ascertained show that the natural forces of the body can cope both with secondary deposits and with primary growths. Though this process of natural cure is not, and may not speedily, be elucidated, still, it is not too sanguine an expectation to anticipate that ultimately it will be. The means for checking the ravages of cancer will be found, not by searching the surface of the earth for a vegetable remedy, nor the bowels of the earth for a mineral one, but by following the definite clue, that in the living body itself forces can be elicited which effectively combat the disease. Until that goal shall be attained, when surgery fails or is unavailable, relief may be sought, but cannot be guaranteed, by resorting to treatment with radium, the full possibilities of which are not yet developed, even in Paris.

E. F. B.

THE GREAT WALL OF CHINA.[1]

IT is two thousand years since Chi-Hwangti established his fame by building the Great Wall. Dr. Geil, in the preface to his book, suggests that after so long an interval we remain ignorant of the features of this greatest of all mural ramparts. "There is a Great Wall of China; so much the geographers tell everybody, but they do not make it clear whether it is built of China; or why it is, or how long it is, or how long it has been." We must remind the author that accurate details concerning the wall have been available for at least two centuries. The Jesuit missionaries under the auspices of the Emperor Kang-hi surveyed the wall from the eastern seaboard to the desert of Turkestan. Its course was set down on their map, published in 1718, the first authentic map of the Empire. This was accompanied by a narrative of their survey, giving an account of the wall, its measurements, its length, and the material used in building. Later geographers followed.

The work done, however, by previous travellers need not detract from the merit of the journey made by Dr. Geil. His route lay over one thousand miles in a very rough country, and among people who are not given to welcoming the stranger at their gate, yet the author seems to have covered the ground rapidly, and to have enjoyed immunity from the delays, discomforts, and accidents that impede the progress of the explorer in eastern Asia. He must be congratulated also on securing an admirable series of photographs to illustrate his volume. Taken alone, they supply a valuable pictorial representation of this wonderful barrier, affording evidence of the skill of the builders who at that early period and with the most primitive appliances overcame engineering difficulties that would prove formidable in our own day with all the facilities afforded by science.

Dr. Stein has recently discovered that the wall extends much further west than was previously known, along a desert track in Turkestan, hitherto unexplored. He also found documentary evidence to show that part of this western extension was erected two centuries B.C., during the reign of Chi-Hwangti.

Dr. Geil gives an account of the life and work of Chi-Hwangti at some length, whom he calls "Chin."[2] He was a reformer who built the Great Wall to shut out the Huns, extended and consolidated the Empire, made highways to facilitate intercommunication, and was a promoter of agriculture and industry. He was a prince of hustlers, with an eye to national development and the filling of his treasury. He was a man of boundless ambition and fantastic wickedness. In order that he might pose, and be handed down to posterity, as first Emperor of China, he burnt the classic writings and ancient chronicles of the Empire, and put to death more than four hundred followers of Confucius, an act which earned for him the lasting hatred of the literati. The building of the wall, his greatest work, was accomplished by forced labour, and the builders, under pain of death, had either to give their unremitting toil or be built into the wall as part of the material for their country's defence. "Chin" was an economist.

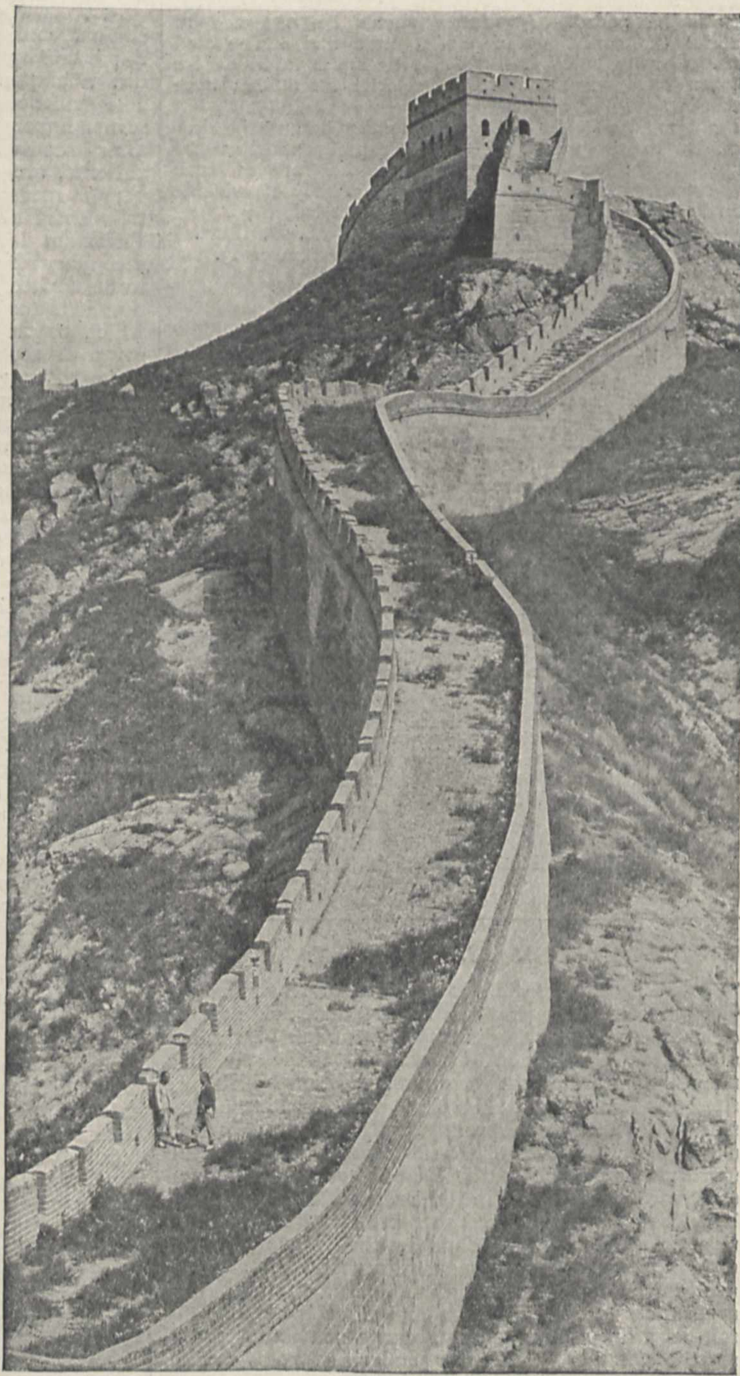


Photo. by H. G. Ponting.

FIG. 1.—The Great Wall ascending a Steep Declivity near the Nankow Pass. From "The Great Wall of China."

[1] "The Great Wall of China." By Dr. William Edgar Geil. Pp. xviii+351. (London: John Murray, 1909.) Price 21s. net.

[2] Chi-Hwangti, Second Emperor of the Tsin dynasty.

The author admires this potentate's pushfulness, and would welcome the advent of such another ruler, or a reincarnation of Chin, to awaken China from her sleep of ages—that is, Chin modernised and shorn of his wickedness. He may not have long to wait. Dr. Geil's historical notes on the life and doings of this famous emperor are written with force and an entertaining display of humour. But, after all, the manner of building, it is a sordid tale of suffering, of which the wall is a lasting memorial.

Dr. Geil pauses at intervals in his journey to copy ancient tablets of local wall interest, and to consider, at length, the myths and superstitions of the Chinese, and the condition of the world coeval with Chin the hero. The rise and progress of Genghis Khan, "the red raider," who eventually pierced the barrier and conquered China, are dealt with. He is described as "A man of elemental fury beyond the sweep of twentieth century imagination," whose bloody career did not end until he had slain as many people as now live in all New England, New York, and Pennsylvania—a monster of cruelty. Yet his grandson, Kublai Khan, who came to the throne, proved one of the most enlightened monarchs known to Chinese history. He excavated the Grand Canal, and extended his sway as far as Moscow and the Levant. Dr. Geil gives a brief *résumé* of mediæval China since the building of the wall to the present dynasty—the Manchu. He eulogises the good work done by the Christian missions, and hails the light of a reformation that in the future will make China a world Power of the first rank.

To anyone who knows the intellectual, as well as practical, potentialities of the Chinese, the eventual rise of this Yellow Peril seems far from impossible. Besides the missions of peace that are at work, there are other and rival missions from the armed camps of Europe and Japan urging forward the Chinese, aiding them in rearing a great wall of militarism more formidable than the barrier built by Chi-Hwangti to bar all foreign interference with the internal affairs of "The Central Flowery Land."

In conclusion, this modern view of the Great Wall, with its wealth of illustrations, and the author's discussions over a wide field, should afford instruction and entertainment to the general reader. As a book of travels, further details regarding the route traversed would have been welcome.

J. T.

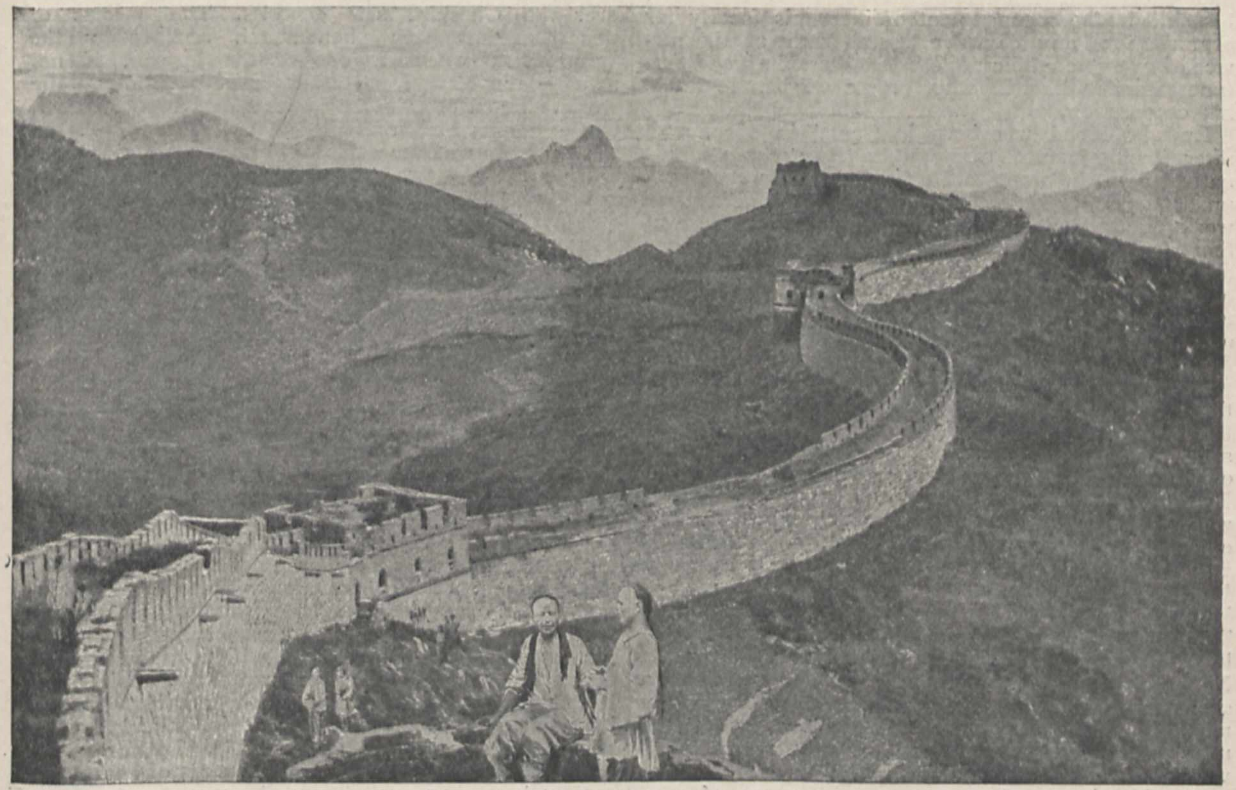


FIG. 2.—Lienhwacnih. From "The Great Wall of China."

DR. LUDWIG MOND, F.R.S.

BY the death of Dr. Ludwig Mond this country has lost one of the most eminent of her chemical technologists, and the world is the poorer by the passing away of one who, himself a man of science of no mean attainments, gave liberally of the wealth which his knowledge and skill as a technologist brought him in order to promote the dignity and usefulness of science. Dr. Mond, as he would have been the first to admit, undoubtedly owed much to England, and he gave practical recognition of the extent of his indebtedness by the open-handed generosity with which during his life-time he supported and endowed her scientific institutions. He never forgot that it was through science he had prospered, and he was ever ready to return to the service of science a large measure of the riches she had conferred upon him.

The International Catalogue of Scientific Literature, and the establishment and endowment of the Davy-Faraday Laboratory, are splendid monuments more enduring that brass. With these Dr. Mond's name will for ever be associated. But in reality they constitute only a fraction of the benefits he conferred upon science, for there was hardly a single movement connected with the advancement or spread of physical science which did not find in him a generous and, at times, an enthusiastic and inspiriting supporter. In one other respect, too, his substance was always at the service of science. No appeal from those who enjoyed his confidence, or in whose judgment he had learned to trust, on behalf of the weak brother who had fallen by the wayside, was ever made in vain; and numberless acts of kindness, of sympathy, and of substantial help of which the world knows little or nothing, and of which even the recipients in many cases never knew the source, are recorded to his credit.

But it was not only by his wealth that Dr. Mond served science. In the organisation of science and in her councils he gave of his mental and intellectual powers with the same unstinted liberality that he gave of his material possessions. His knowledge and experience, his remarkable business aptitudes, his skill in the management of men, his faculty for organisation and direction, were freely at the service of every scientific society that had the good fortune to enlist his sympathy, or the wisdom to invite his cooperation.

Ludwig Mond was born in Cassel in 1839, and, after having passed through the Polytechnic of his native place, he went to Marburg to study chemistry under Kolbe. Thence he repaired to Heidelberg to work under Bunsen, and to enjoy his full share of that alternation of study and play—each as strenuous as the other—which characterises the university life of that famous seat of learning. At Heidelberg he took his degree, and, attaching himself to technology, obtained situations in chemical works in Germany. At about this time he was attracted by a problem which had long baffled practical chemists, namely, the recovery of the sulphur employed incidentally in the Leblanc process in the conversion of common salt into soda, and which had passed from the oil of vitriol into the bye-product known as alkali-waste. He devised and patented a process for treating alkali waste, which, although long since superseded by others more economical in working, had a considerably measure of success for a time. He came to England with a view to the introduction of his method into the great alkali works of South Lancashire, Tyneside, and the Clyde district, and it was adopted by a number of manufacturers, notably in Widnes, in Newcastle, and by the Tennants of Glasgow. After a short stay in Holland, where he erected, and for a time managed, a factory to work the Leblanc process, he returned to this country and entered the chemical works of Hutchinson and Earle at Widnes.

Dr. Mond was then twenty-eight years of age. In the previous year he had married his cousin, Miss Frida Loewenthal, and he settled down in the most dismal of all the manufacturing towns in Lancashire with the intention of devoting his talents and energy to the business of manufacturing alkali and the other products commonly associated with it. At this period soda was exclusively made in this country by the Leblanc process, which involves the use of sulphuric acid and the production of large quantities of hydrochloric acid, as well as the formation of the alkali waste already referred to. Other processes had been suggested, and some had actually been brought into successful operation, as, for example, the cryolite process invented by Julius Thomsen, of Copenhagen, and worked so far back as 1857. It was known that common salt might be changed to some extent into bicarbonate of soda by the action of carbonic acid in presence of ammonia. Dyar and Hemming had worked out a method based on this principle, but their efforts to compete with the Leblanc soda resulted in failure, and the firm was ruined. In theory the process was seductively simple, but all attempts to determine the practical conditions needed to ensure complete conversion were unavailing until the method was systematically investigated by two young Belgian chemical engineers, the brothers Solvay, who, in the early 'seventies, devised the modification of the Dyar and Hemming process which has since been known as the ammonia-soda or Solvay process.

Dr. Mond was afforded an opportunity of judging the practicability of the process as thus improved, and so sanguine was he of its commercial possibilities that he determined to embark his little capital in acquiring a licence to work the ammonia-soda process in England. He enlisted the sympathy of his friend Mr. J. T. Brunner (now the Right Hon. Sir John Brunner, Bart., M.P.) with the enterprise, and the result was the formation of the firm of Brunner, Mond and Co., who acquired the Winnington Hall estate, near Northwich, and erected their works over the Cheshire salt deposits. The success of this firm has been phenomenal, and to-day the Winnington works is one of the largest, if not actually the largest, manufactory of the kind in the world. Much of this success was due, in the outset, to the genius and inventive skill of Dr. Mond. In the beginning innumerable difficulties were met with. During the first twelve months, as Sir John Brunner recently said, everything that could explode exploded, and everything that would break broke, until the partners had little left but their credit and their licence from Ernest Solvay. Thanks in large measure to the energy and resourcefulness of Dr. Mond, these troubles were circumvented, and in a surprisingly short space of time the process became a magnificent success. Leblanc soda would have become a thing of the past had it not been for its bye-product, the hydrochloric acid, which alone saved it from extinction.

If the Leblanc process wasted its sulphur, the ammonia-soda process equally wasted its chlorine, and Dr. Mond made repeated attempts to remove this blot on the theoretical cycle of operations upon which the method is based. At one time it seemed as if success had attended his efforts, but the result showed that the economical production of bleaching powder from calcium chloride under existing conditions is a problem which still remains to be solved. Whether the ammonia-soda process has within it the basis of permanent success, time alone can show. As regards the production of ammonia and the means taken for its recovery and preservation, it is difficult to see where fresh economies are possible. In the meantime, new, or at least improved, sources of energy are rapidly becoming available, and every decade shows progress in the methods of transforming this energy into work. Dr. Mond himself devised plans for greatly augmenting its supply, and in the Mond gas there is a relatively cheap source of power which, while it may contribute incidentally to the supply of the all-essential ammonia, may indirectly undermine the stability of the very process with which his name is primarily and more particularly associated. The economical production of alkali from common salt by electrolytic methods in this country is largely a question of the transformation of the potential energy in coal into electrical power, and although theoretically a definite quantity of ammonia is capable of turning an indefinitely large quantity of salt into soda, this can only be effected by the expenditure of energy which itself costs money to produce and apply.

Dr. Mond had a remarkable aptitude for pushing his experimental inquiries into abstract fields of research, and for promptly turning the results to practical account. His discovery, in collaboration with

Langer and Quincke, of an entirely new and altogether unlooked-for group of chemical compounds, now known as the metallic carbonyls, is an admirable illustration of this faculty. The formation of nickel carbonyl—a most interesting substance produced by the direct combination of carbon monoxide with nickel—led to the establishment by him of a new process for the extraction of the metal from its ores which is now in successful operation by the Mond Nickel Company at Swansea.

Dr. Mond was a well-read man of liberal culture and artistic tastes, broad-minded and tolerant, and of a judgment ripened by contact with leading men of all conditions and countries. His merits as a man of science and a technologist were widely recognised. He was an honorary graduate of universities at home and abroad; a Fellow of the Royal Society, and a member of the Accademia dei Lincei. He was president of the Society of Chemical Industry in 1889, and of the chemical section of the British Association in 1896. He was offered the presidency of the Chemical Society a year or so ago, a distinction he was unable to accept owing to the state of his health.

He died on December 11, 1909, in the seventy-first year of his age, and was buried at the St. Pancras Cemetery, East Finchley. T. E. THORPE.

We have received the following short statement of generous assistance afforded by Dr. Mond to the progress of science, in addition to the foundation and endowment of the Davy-Faraday Research Laboratory, of which we hope to give an account in another issue.

Dr. Mond did not restrict his benefactions in science to the direct encouragement of physical and chemical researches. He was an original member of the council of the British Institute of Preventive Medicine (which subsequently developed into the Lister Institute), and gave 2000*l.* towards its foundation in 1893. He also, three years ago, furnished 500*l.* for installing an apparatus for the investigation of caisson disease and of the problems of deep-sea diving. The work in connection with this investigation was carried on by Drs. Haldane and Boycott, and Lieut. Damant, and their results were published in the *Journal of Hygiene*, and in a report to the Admiralty. At Dr. Mond's suggestion, and with the aid of a subsidy from him, a research into the toxicology of nickel carbonyl, a substance he had himself discovered and put to practical use in the manufacture of pure nickel, was carried out by H. W. Armit, who published the results in two papers in the *Journal of Hygiene*.

In the year 1904 Dr. Mond contributed 10,000 lire towards the cost of erecting a laboratory and hostel at Col d'Olen in connection with the International Laboratory of Physiology on Monte Rosa, on the understanding that the Royal Society should have the permanent nomination to two posts in the laboratory.

Shortly after his election into the Royal Society in 1891, he gave practical effect to the deep interest which he felt in scientific bibliography. Indeed, but for his generous and active cooperation it would probably have been impossible for the Royal Society to continue its great undertaking of publishing a catalogue and index of the scientific literature of the last century.

In the second year of his fellowship of the Society Dr. Mond made a donation of 2000*l.* towards the cost of preparing the remaining material of the Catalogue and Subject Index of Scientific Papers, of which the third series was then approaching completion; and at the same time gave a promise of further assistance. This promise was amply fulfilled. Ten years later, in 1902, when the task of dealing with the mass of material published in the last seventeen years of the nineteenth century had to be faced, Dr. Mond offered 6000*l.* in four yearly instalments of 1500*l.* for the purpose of the completion of the catalogue and of the index. Again, in 1906, on the expiry of the four years, he gave a further 6000*l.* in three yearly instalments of 2000*l.* each for the same purpose; and, towards the end of the year 1908, he promised an additional donation of 2000*l.*, with the view of accelerating the publication of the catalogue, and more particularly of the three subject-index volumes for mechanics, physics, and chemistry.

Dr. Mond also took an active part in the inauguration of the International Catalogue of Scientific Literature, now in its seventh year of publication, and his interest in that undertaking continued unabated to the end of his life.

SIR ALFRED JONES, K.C.M.G.

OF all the "slings and arrows of outrageous fortune," I have not often experienced one sharper than the news of the death of Sir Alfred Jones. I am not sure that, broadly looked at, the loss of a battle would not have been more tolerable. For a defeat may be retrieved, but the loss of a commander may be irremediable.

This is to rate his loss pretty high, but not, I think, too much so. For the man was of a quality of which I have not met with the like in the past, nor do I expect to do so in the future. I cannot pretend that I knew him intimately, for he was of that Napoleonic sort which does not invite intimacy. But we were brought together by common interest in public work, where we each strove strenuously by different paths, and where success attended Jones more than could have been hoped for.

Part of the story is told admirably by a sympathetic hand in the *Times*. If I lift the veil a little further, the official indiscretion, if it be such, must be condoned in justice to Jones's memory. An old-fashioned firm, Elder, Dempster and Co. were the shipping agents of Kew in Liverpool. They carried on the trade with the West African colonies which has always been centred there; and in this firm Jones was originally a clerk.

But at the start these colonies were mere trading settlements on the coast which no one at home troubled about so long as they did not trouble. Then came the partition of Africa; the hinterlands were brought under British control, and a new problem immediately arose. If tribal wars are to cease, and an orderly government is to be maintained, a revenue to support it must be raised; and in the last resort this can only be achieved by the promotion of native agriculture and the supply of produce for an export trade.

With these ends in view, Kew succeeded in establishing a number of cheap botanical stations, where plants suitable for cultivation could be grown and propagated, and where the natives could learn cultural methods by inspection. The attempt, for the most part, was rather acquiesced in than encouraged by the colonial officials on the spot, and Jones was perhaps the first to impress spontaneously upon the Colonial Office its importance. He had by that time grasped the future of West Africa, had bought out his old masters, and placed West African trade on an entirely new footing. Incidentally he restored prosperity to the Canaries, and introduced the banana into England. Amongst the principal products of West Africa are various sorts of oil-seeds; for these Liverpool was hardly more than an *entrepôt*, as their principal market was in France. To utilise them at home, Jones started large oil-mills. All this, so far as it goes, only reveals the enterprise and sagacity of a far-seeing man of business; but his subsequent work for the West Indies shows a different side to his character.

The sugar-bounty system had crippled the sugar-industry in the West Indies, and there was much distress amongst the planters and population. In 1896 Mr. Chamberlain sent out a Royal Commission to report on the position, and I willingly assented to the Assistant Director, now Sir Daniel Morris, accompanying it as scientific adviser. I sat one evening under the gallery of the House of Commons to hear Mr. Chamberlain make an eloquent appeal for a subsidy in aid of the distressed colonies. It was passed without demur. But something more than temporary aid was needed, and in 1898 Morris left Kew on his appointment as Imperial Commissioner of Agriculture in the West Indies. On the eve of his departure, happening to be at the Colonial Office, I was told that it was desired to get in touch with Alfred Jones. At that time I had never even seen him, but I invited him by telegraph to meet Morris and the Colonial Office men at dinner. That night the Direct Line was virtually agreed upon. As Jones left he remarked to me that the dinner had only cost him a quarter of a million. Later on he wrote that he was having steamers built in every available yard in the kingdom. At a semi-official gathering this year, the last time I saw him, Jones remarked that the dinner was still not paid for. But throughout his object was not limited to commercial success. He wanted to do for the West Indies what he had done for the Canaries. Morris, by botanical stations and agricultural instructors, sought to turn the negroes into peasant cultivators; Jones to provide an outlet for the produce. But he did much more, and in order to attract tourists he took the defunct hotel industry in Jamaica into his own hands.

Jones was, of course, a man of business, but in no ordinary sense. Commercial success was necessary to him as a justification of his plans, but I think still more as supplying means for extending them. It is no affectation to say that he, of all men, thought imperially. To knit the interests of the home country, and not least of Liverpool, with those of our colonial possessions was the real aim of his life. He offered the Rhodes scholars a free passage from any port at which his ships were available, and one of his latest schemes was to send out parties of undergraduates to make the personal acquaintance of the West Indies. On his last visit to them he took out a large number of distinguished guests. The event was tragic: in the earthquake Sir James Ferguson was killed in the street, and Jones himself was only extricated from the ruins of a falling hotel by little short of a miracle. It may be feared that the strain and shock left effects which were unperceived at the time.

But two other even greater achievements must be mentioned. In 1890–1 I had succeeded in getting the cultivation of cotton experimentally tested in West Africa, and had had samples grown there valued at Manchester. But there the thing ended; it required a more vigorous impulse than mere demonstration. Jones habitually projected his ideas into the future. He saw that cotton-growing in the United States was limited by physical conditions, and could not be extended; that Indian cotton, for reasons too long to explain, was not available; and that the amount which the United States could spare must be a constantly diminishing quantity. He saw that fresh and independent supplies must be found. He virtually started the British Cotton-growing Association, and helped it to raise large funds, amounting to some quarter of a million. Jones possessed the electric power of stimulating more sluggish temperaments. With Morris's aid, cotton-growing was successfully re-established in the West Indies. Jones pushed it for all he was worth in West Africa, and Northern Nigeria promises to be the greatest cotton-growing area in the world.

The importance of this achievement, however, shrinks before that which was perhaps the most remarkable of all. So far as I know, Jones had no scientific training; but he had a fixed belief in the value of scientific knowledge. There are plenty of business men who are ready, so to speak, to pluck the pear when it is ripe, careless who grew it. But Jones looked confidently to scientific method to help on the solution of unsolved problems. If commerce was to be carried on with tropical countries, it must be possible for Europeans to live in them. From his point of view it was not sufficient to treat the local diseases; it was necessary to trace them to causes which could be obviated. He therefore, in perfectly simple faith, founded and endowed the Liverpool School of Tropical Medicine, and sent out one scientific expedition after another to investigate on the spot. Cattle rearing in the West Indies is hampered by diseases which are transmitted by "ticks." Jones sent out Prof. Newstead to study their life-history; he saw that if you could control the tick you could master the disease. But you cannot control the tick until you know everything about it. I could give a striking illustration of a more futile procedure by our own Board of Agriculture.

Jones had, in fact, the true scientific instinct. He knew nothing about science, but he thoroughly believed in the validity of its methods. It is for this reason that he deserves commemoration in these pages. There are probably men like him in America; they are certainly rare in this country; Mond may have been one, but then he was not of English birth.

As I have said, I did not know Jones intimately, and I have therefore been able to write of what he did only as I saw it from outside. He lived a strenuous life, and was a man of few words. The *Times* speaks in terms which I can well believe of his private generosity. I wrote to him on behalf of an orphan boy of promise in the village from which I write. Jones would promise nothing; but the boy got the post he desired in the engine-room of one of his ships.

Jones was a Welshman, and therefore, I suppose, a Celt. Perhaps to this he owed the buoyant optimism and that quality of imagination which is the primary element of success in science as in business. The great enterprises which he started probably possess sufficient momentum to continue; but the resourceful directing spirit is extinguished, and it is a national loss. He was not without honours amongst his own people in Lancashire. In 1901 he was created K.C.M.G. for his colonial services. But the distinction he most deeply prized was his election, without academic standing, as an honorary fellow of Jesus College, Oxford, a recognition which scarcely honoured the electors less than the recipient.

W. T. THISELTON-DYER.

NOTES.

WE regret to announce the death, on December 18, at Weybridge, of Dr. Shelford Bidwell, F.R.S., in his second-second year.

THE council of the Linnean Society has decided to devote the next meeting, on January 20, to a discussion on the origin of vertebrates, in which it is expected that Dr. Gaskell, Dr. Gadow, Mr. Goodrich, Prof. Starling, Prof. MacBride, Dr. Smith Woodward, and Prof. Dendy will take part.

The University of Paris has been authorised, we learn from the *Revue scientifique*, to accept the gift made last June by M. Henry Deutsch. The gift, which amounts to 500,000 francs, and yields an income of 15,000 francs, is to be devoted to the inauguration of an aërotechnical institute for the encouragement of research, having for its object the perfecting of machines for aërial navigation. The institute is to be established at the St. Cyr School, and it is hoped that it will be opened in May next.

The inaugural meeting of the Nature Photographic Society was held at the Institute of Science, Art, and Literature, Leeds, on December 11, Mr. J. J. Ward presiding. The primary object of the society is to form a fellowship among nature photographers in all parts of the world. The president is Mr. Richard Kearton, and the vice-presidents are Messrs. J. J. Ward, F. Martin-Duncan, H. Irving, and O. G. Pike. The secretary is Mr. Carl Edwards, Woodlesford, Leeds, who will be glad to supply particulars to all who are interested in the work of the society.

We learn with regret that Dr. Enrico Hillyer Giglioli, professor of zoology and director of the Royal Zoological Museum in Florence, died on December 16 after a short illness. Dr. Giglioli was commendatore of the Order dei Santi Maurijis e Lazzaro and of the Corona d'Italia, commandeur of the Franz Joseph Order and of the Mérite agricole, officer of the Instruction publique de France and of the Brazilian Order of the Rose. He was born in London on June 13, 1845, and completed his studies in Pisa in the year 1864. The following year he made a voyage of exploration on the Royal ship *Magenta*. In 1869 he was called to the University of Florence, where he was made extraordinary professor in 1871, and ordinary professor three years later. In 1896 he founded the collection of the Italian vertebrates, and later he published his "Avifauna italica," which reached its second edition in the year 1906. On December 20 Prof. Giglioli would have celebrated his fortieth year of teaching; and his death a few days before this proposed celebration has deprived his colleagues, friends, and pupils of the anticipated pleasure of offering him their congratulations upon his work. By the death of Prof. Giglioli one of the leaders of zoology, ornithology, and anthropology in Italy has passed into silence.

Mr. Otto Beit has made a munificent gift of 215,000*l.* for the foundation and endowment of medical research scholarships as a memorial to his brother, the late Mr. Alfred Beit. It may be remembered that some time ago Mr. Alfred Beit provided by his will the sum of 50,000*l.* toward the establishment of an institute of medical sciences. Owing to various circumstances the proposed formation of this institute was abandoned, and the moneys subscribed were returned to the donors or their executors. Mr. Otto Beit has now increased the sum thus received by him as his brother's residuary legatee to 215,000*l.*, which will yield by investment in trustee stocks an annual income of about 7500*l.* In his letter to the Senate of the University of London announcing this generous gift, Mr. Beit asks that the fund shall be named "The Beit Memorial Fellowships for Medical Research," and shall be devoted entirely to the furthering of medical research work in all its branches; or, as the deed of foundation states, "to promote the advancement by means of research of medicine and the allied sciences in their relation to medicine." Each fellowship is to be of the value of 250*l.* a year for three years, and "any man or woman of European descent, graduate of any approved university within the British Empire," will be eligible for election. The fund will be administered by a board of trustees consisting of Viscount Milner, Lord Curzon, Mr. R. B. Haldane, the principal of the University of London (*ex officio*), Mr. Otto Beit, Dr. J. K. Fowler, and Mr. B. F. Hawksley. The advisory board must consist of not fewer than five or more than seven men, all of whom must be members of the medical profession. The first members of the board are Sir T. Clifford Allbutt, K.C.B., F.R.S., Prof. J. Rose Bradford, F.R.S., Dr. J. K. Fowler, Dr. C. J. Martin, F.R.S., Prof. W. Osler, F.R.S., and Prof. E. H. Starling, F.R.S. The first election to the fellowships will take place on or before March 1, 1910, and on or about January 1 of each subsequent year. Except in special cases, the fellows may undertake research only at recognised places in London, so that the work to be promoted by the benefaction will be mainly carried out in institutions connected with the University of London.

When Dr. F. A. Cook returned from north polar regions four months ago and announced that he reached the North Pole on April 21, 1908, we expressed the hope that the observations of position and narrative of the journey would be published at an early date, so that the value of the claim could be decided definitely. In the absence of documentary evidence of this kind, the explorer's statements had to be accepted provisionally, but judgment upon them was reserved. At last the material upon which the claim to have reached the North Pole is based has been submitted to a committee of Copenhagen University appointed to investigate the records of Dr. Cook's journey. The conclusion arrived at by the committee is that the documents are altogether insufficient to prove the attainment of the highest northern latitude. A Reuter message from Copenhagen on December 21 states that the papers submitted to the committee for investigation were:—(1) A type-written report by Mr. Lonsdale on Dr. Cook's Arctic voyage, consisting of sixty-one folios. (2) A type-written copy of sixteen folios, made by Mr. Lonsdale, comprising the note-books brought back by Dr. Cook from his journey, and covering the period from March 18 to June 13, 1908, stated to have been written on the way from Svartevaag to the Pole and back until a place west of Heibergsland was reached. The committee points out, as a result of its investigations, that the afore-mentioned report of the journey is essentially identical with that published some time ago in the *New York Herald*, and that the copy of the note-books did not contain astronomical records, but only results. In fact, the committee remarks that there are no elucidatory statements which might have rendered it probable that astronomical observations were really taken. Neither is the practical side, namely, the sledge journey, illuminated by details in such a way as to enable the committee to form an opinion. The committee therefore considers that from the material submitted no proof can be adduced that Dr. Cook reached the North Pole. The council of the University accordingly declares as a result of the committee's report that the documents submitted to Copenhagen University contain no observations or explanations to prove that Dr. Cook on his last polar journey reached the North Pole.

The December number of the *Entomologist's Monthly Magazine* contains announcements of several additions to the British insect-fauna, among the most interesting of which is the brachelytrous beetle *Proteinus crenulatus*, obtained by Dr. D. Sharp at Netley Bridge in 1906, and again in 1907. In Spry and Shuckard's "British Coleoptera" three of the five European species are recorded as British; Dr. Sharp has been enabled to include the whole five in our fauna.

ACCORDING to the report for 1908–9, the committee of the Leicester Museum and Art Gallery has sanctioned large and important additions to the buildings under its charge. The additions include a new entrance-hall, an extension of the main building, with the conversion of the greater portion of the ground-floor into a central hall, the replacement of the first floor by a gallery, and the construction of a new staircase. It is also proposed to erect and equip suitable work-rooms, to build a new wing on the west side of the present structure, and to devote the room now containing invertebrates to art purposes.

CIRCULAR No. 113 of the Entomological Bureau of the U.S. Department of Agriculture is devoted to the chinch-bug (*Blissus leucopterus*) and its ravages. No other insect indigenous to the western hemisphere has spread its devastating hordes over a wider tract than has this species, and were it not for the destruction of the larvæ by heavy rains, and, in a less degree, the diminution in its numbers by the attacks during the rainy season of a parasitic fungus, continuous corn-growing in many parts of the United States would have long since become impracticable owing to this insect. The present circular, after giving a detailed and illustrated account of the insect in its various developmental phases, summarises the history of its periods of greatest increase and its gradual spread, concluding with a description of the various methods which have been proposed to check and control its increase.

NOS. 1704 and 1705 of the Proceedings of the U.S. National Museum are devoted to molluscs, the first of these containing an account, by Mr. W. H. Dall, of a collection of marine shells from Peru, with a summary of the littoral marine mollusca of the Peruvian zoological province, while in the second Mr. P. Bartsch describes four new species of Philippine land-shells. In connection with the Peruvian province, Mr. Dall directs special attention to the unusual prevalence of black, blackish, or lurid colouring among the molluscs, this being particularly noticeable in the phytophagous group. It has been attempted to explain this phenomenon, which has long been known, by the suggestion that it is correlated with the presence of the vast beds of kelp so characteristic of the Peruvian coast; but it is pointed out that similar dark beds of kelp on the Californian coast give shelter to some of the most brilliant trochids and other molluscs, while green sea-weeds occur abundantly on the rocks below low-water mark on the coast of Peru. Evidently, therefore, some other explanation is required.

IN a paper published in a recent number of the *Journal of Physiology* (vol. xxxix.) Dr. H. M. Vernon suggests a hypothesis of tissue respiration founded on ferment action. Dakin has shown that, in accordance with the well-known Fenton reaction, hydrogen peroxide, in the presence of ferrous sulphate as activator, is able to oxidise various amino-acids and fatty acids completely to carbon dioxide and water. Aldehydes are formed as intermediate products. Similarly in living tissues it is thought that intra-molecular oxygen is taken up in the form of an organic peroxide and is transferred by the help of an intracellular peroxydase ferment to oxidisable substances. The presence of aldehyde groupings in animal tissues is strongly supported by the fact that poisons such as hydrocyanic acid, sodium fluoride and acid sodium sulphite, which are known to be capable of forming loose combinations with aldehydes, temporarily deprive the tissues of their respiratory power without necessarily doing them any permanent injury. Other poisons, such as formic aldehyde, temporarily prevent the tissues from forming carbon dioxide, though not from absorbing oxygen. It is suggested that they act by destroying peroxydase, so that the peroxide of the tissues, in the absence of activator, can only effect incomplete oxidations.

THE study of nuclear changes and qualities in the mutants and hybrids of Œnothera offers a promising field of investigation. Mr. R. R. Gates, who has already contributed some papers on the subject, furnishes in the *Botanical Gazette* (September) a further account of the chromosomes in the hybrid *O. lata*×*O. gigas*. There are normally twenty-one (rarely twenty) chromosomes in the somatic cells as compared with fourteen in *O. lata* and twenty-eight in *O. gigas*. At the reduction stage half the germ-cells receive ten and half receive eleven chromosomes, but there are occasional irregularities, as when the germ-cells receive nine and twelve respectively. The author argues that this segregation is not a pairing and separation of homologous chromosomes of maternal and paternal origin, but merely a division into numerically equal groups.

ALGOLOGY has formed the subject of several papers by Mr. F. S. Collins which have been published in *Rhodora* and other American publications. In his latest contribution, that appears as vol. ii., No. 3, of Tuft's College Studies, he undertakes the ambitious task of compiling a flora of the green algæ of North America. The bulk of the species are marine algæ collected on the shores of the United States, but the author recognises that Greenland, Canada, Mexico, and the West India islands fall within his province, and includes records of fresh-water algæ so far as they exist. The work contains short diagnoses of all the species, keys to the species, genera, and families, and a figure for each genus, thus providing a serviceable handbook for American algologists, and one that is likely to attract workers to the subject. The author distinguishes two main groups, the Heterokontæ, so-called because the motile cells have cilia of unequal length, and the Chlorophyceæ. The family of Desmidiaceæ is omitted, because it is too extensive.

WE have received from Prof. Hergesell a preliminary summary account of the participation of various countries in the international kite and balloon ascents during the quarter ended June last. In addition to many places in Europe and the United States, ascents were made at Samoa and by the Greenland Scientific Expedition. The greatest altitude reached by registering balloons was 27,100 metres, at Munich on May 7. Heights of 20,000 metres and above were attained by the ascents from Glossop (Manchester), Hamburg, Strassburg, Uccle (Brussels), and Zürich. The meteorological results will be published elsewhere.

IN addition to the elaborate monthly and seasonal meteorological charts of the Atlantic and Pacific Oceans issued by the U.S. Weather Bureau, to which we have already directed attention, we have received a copy of a handy "Marine Calendar," showing for each month the average weather conditions of the North and South Pacific, the storm and hurricane signal code, and the moon's changes for 120th meridian time (besides the usual almanac). Following the calendar are tables for the conversion of time of one country to that of another to the nearest second. The calendar will be found very convenient for the purposes intended, and will further popularise the useful marine work of the Weather Bureau.

AN appendix to the report of the International Conference on Electrical Units and Standards of 1908 has just been issued. It will be remembered that the specifications of the ohm, ampere, and normal cell in the original report were expressed in general terms so as to admit of modifications in details at the various national standardising laboratories. The appendix now issued contains details of the methods adopted at the National Bureau of Standards of America, at the Central Electrical Laboratory of Paris, at the Reichsanstalt at Berlin, and at the National Physical Laboratory at Teddington. References to the literature of the subject are also given, so that this appendix will prove of great use in electrical laboratories.

THE *Naturwissenschaftliche Wochenschrift*, the organ of the German Society for Popular Science of Berlin, devotes almost the whole of its issue of December 4 to the first of a series of three articles on the experimental foundations of the atomic theory, by Mr. Werner Mecklenburg. After a short historical introduction the author deals with the evidence for the existence of discrete particles in optically clear colloidal solutions, and then goes on to the kinetic theory of gases as one of the means of determining the size of the actual molecule of matter. Under this head simple proofs of Boyle's law, of the relation between mean free path and viscosity, of Van der Waals's equation, and of Loschmidt's method of calculating the radius of a molecule are given. As the method of treatment of the subject is not unlike that adopted in Meyer's kinetic theory of gases, readers of the above weekly must be interested in science to a greater extent than the public generally gets credit for being.

MESSRS. BURROUGHS, WELLCOME AND CO., of Snow Hill Buildings, E.C., have issued their exposure record and diary for 1910. This pocket-book is so well known among photographers that the chief object of this note is to inform them that the 1910 issue is now ready. It is important to point out that three editions are issued and bound in different tints, according as they are especially arranged for the northern or southern hemisphere or for the United States of America. The pocket-book itself is a mine of practical information set up, so to speak, in tabloid form, and the concentrated essence of the contents, together with the pages for entering exposure records and for a whole diary, is all enclosed in a very neatly got-up covering which will stand constant wear and tear. It must not be forgotten that a very important feature is the mechanical exposure calculator, practically the simplest efficient instrument, which is fastened inside the back cover. One turn of one scale tells the correct exposure for any subject, at any time of the day or year, in any part of the world. The writer of this note has used one of these books for several years, and finds, to his regret, that to be without his copy means a great uncertainty in giving correct exposures. Issued at a price of one shilling, it is an extremely good investment.

A NEW apparatus has recently been installed in the mechanical engineering department of the Northampton Institute for testing aëroplane models, and is described in an article, by Messrs. C. E. Larard and R. O. Boswall, in *Engineering* for December 10. The apparatus consists essentially of a carriage supported on four wheels running on a long straight track, and carrying the model aëroplane. The carriage is drawn along with increasing velocity by means of a horizontal cord, which is attached to the carriage at one end and to a large drum at the other end. The drum is rotated by falling weights, and the velocity of the carriage at any instant is obtained from a record traced on a moving strip of paper by a vibrator making five complete vibrations per second. When a sufficient velocity has been attained the model lifts, *i.e.* flight begins, and the instant at which this occurs is marked on the strip of paper electrically. The velocity at which flight begins can thus be determined easily. The authors prefer this form of apparatus to the whirling-table method, and hope to make a series of tests on planes of varying shapes and dimensions. Experiments are now being made to determine the velocities at different angles, and also to show the manner in which the centre of pressure alters as the angle of the plane is varied. It is also proposed to instal a considerably larger apparatus than the existing one, which has a track 60 feet long at present.

THE twenty-sixth annual issue of the "Year-book of the Scientific and Learned Societies of Great Britain and Ireland" has been published by Messrs. Charles Griffin and Co., Ltd. The book has been compiled from official sources, and is intended to be a record of the work done in science, literature, and art during the session 1908–9 by numerous societies and Government institutions. In some cases the lists of papers read before societies are a little belated. For instance, it should have been possible in December, 1909, to publish the titles of papers read at the Winnipeg meeting of the British Association last summer in the place of those read in Dublin in 1908. Exhaustive though the list of societies is, it is not yet complete. Certain local geographical societies are dealt with, but the Geographical Association, with its numerous branches, receives no mention—an omission we have pointed out on a previous occasion.

OUR ASTRONOMICAL COLUMN.

DANIEL'S COMET, 1909*e*.—Dr. Ebell's ephemeris for Daniel's comet, 1909*e*, is extended to January 2, 1910, in No. 4376 of the *Astronomische Nachrichten* (p. 127, December 14), and the following is an extract therefrom:—

Ephemeris 12h. M.T. Berlin.

1909	α (true) h. m.	δ (true) ° ′	log r	log Δ	Brightness
Dec. 21 ...	6 19·0 ...	+45 34·7 ...	0·2009 ...	0·8022 ...	0·92
,, 25 ...	6 19·2 ...	+48 15·8 ...	0·2032 ...	0·8128 ...	0·87
,, 29 ...	6 19·4 ...	+50 40·7 ...	0·2059 ...	0·8255 ...	0·81
1910					
Jan. 2 ...	6 19·6 ...	+52 47·8 ...	0·2092 ...	0·8404 ...	0·74

The elements given by Dr. Ebell show a likeness to those calculated by Dr. Becker for comet 1867 I. (Stephan), which are given for comparison; the "period" given in the latter is $40·1 \pm 2·0$ years. A number of observations are recorded in the same journal. On December 8 the comet was easily seen in the 8-cm. (3·2 inches) finder at the Uccle Observatory, and appeared to be of about magnitude 9·5; a nucleus of the twelfth magnitude and about 12″ in diameter was seen to be surrounded by a coma which was 3′ in diameter. Observers at Algiers and Arcetri on December 9 estimated the magnitude at 10·5 and 11·5 respectively.

HALLEY'S COMET.—Visual observations of Halley's comet with small instruments are now becoming common, and a number are recorded in No. 4376 of the *Astronomische Nachrichten*. Prof. Nijland reports that the comet was certainly visible in a 73-mm. finder on December 5, its magnitude being estimated as 11·0. Herr v. Buttlar, using a 3½-inch telescope on December 4, saw the comet as a nebulous mass of about 45″ diameter, having a magnitude of about 11·5.

SUBJECTIVE PHENOMENA ON MARS.—In No. 4358 of the *Astronomische Nachrichten* M. Antoniadi suggested, because it is not shown on photographs, that the dark band which surrounds the disappearing polar cap on Mars is probably a subjective phenomenon. In a later number (4363) of the same journal M. Jonckheere contested the subjectivity of a band which was irregular in form and might be obliterated from the photographs by the photographic "spreading" of the image of the brilliant polar cap.

To these suggestions M. Antoniadi replies, in No. 4376,

(1) that the irregularities are not in the band itself, but are due to a number of real, grey spots which are left isolated by the retreat of the disappearing cap; (2) that the distance of the dark band from the edge of the cap is too great to be covered by the "spreading" of the image of the latter. Further, he continues, if the phenomenon of the dark band is real, it should obey the ordinary laws of perspective, and should appear about two and a quarter times as broad at the extremities of the major axis of the projected cap as it does at the ends of the minor axis; but the majority of drawings show the band to be the same width all round, and M. Antoniadi therefore contends that it is a subjective effect produced by contrast.

TEMPERATURE CLASSIFICATION OF STARS.—In No. 4375 of the *Astronomische Nachrichten* Drs. Wilsing and Scheiner publish a list of 109 bright stars of which they have determined the effective temperatures by spectral photometric observations. The temperatures determined range from 2800° (absolute) for χ Serpentis, to 12,800° for λ Orionis, and, in a summary, the range from Vogel's type Ia1 to type III. is given as 9600°–3200°.

Dr. Nordmann, also, has recently published several notes, in the *Comptes rendus*, giving the results obtained by his method of photometric comparisons of various definite regions of the spectra. In No. 4 he gave a list of fifteen temperatures ranging from 2870° to >60,000° (absolute), and compared the order in which the stars were thus arranged with the order given, for the same stars, in Sir Norman Lockyer's temperature classification. The latter, of course, does not deal with actual temperatures, but in general the two arrangements were found to agree fairly well; Dr. Nordmann's value for the solar temperature also agrees well with the values determined by previous observers. In a later note confirmation of the temperature given for Algol was obtained by an independent method, whilst in the most recent publication (*Comptes rendus*, No. 23, December 26) Dr. Nordmann gives amended values of the temperatures primarily published. The only important alterations are found towards the upper temperature limit, and do not involve any re-arrangement of the sequence; the highest temperature (for λ Tauri) is now given as >40,000°.

A NEW VARIABLE STAR, OR A NOVA.—In No. 4375 of the *Astronomische Nachrichten* Prof. Ceraski announces that on a plate taken on March 23, at 10h. 6m. to 12h. 6m. (M.T. Moscow), Madame Ceraski discovered an image of a tenth-magnitude object which is absent from twenty-four earlier plates, showing 12·5 magnitude stars, of the same region. The approximate position of this object is 8h. 29m. 26s., +53° 50′ (1900), and the shape of the image shows it to be a star; the suggested explanations that it might be a planet or an end-on meteor are thought to be improbable, and Prof. Ceraski suggests that all observers having plates of this region should examine them for traces of what may be either a nova or a new variable star.

THE "COMPANION TO THE OBSERVATORY."—Edited by Messrs. T. Lewis and H. P. Hollis, and published, at 1s. 6d., by Messrs. Taylor and Francis, this annual is the most generally useful, to the practical, general astronomer, of all the British annual publications. The issue for 1910 differs but little in form from its immediate predecessors, the usual contributions having been obtained from Mr. Denning, Dr. Maw, Mr. Crommelin, and M. Baillaud.

THE RELATION OF SCIENCE TO HUMAN LIFE.[1]

IN casting about for a suitable introduction for my address this afternoon, I came across some words written by a great Englishman, which with your permission I will read to you.

"Remember the wise; for they have laboured, and you are entering into their labours. Every lesson which you learnt in school, all knowledge which raises you above the savage and the profligate—who is but a savage dressed in civilised garments—has been made possible to you by the wise. Every doctrine of theology, every maxim of morals, every rule of grammar, every process of mathematics, every law of physical science, every fact of history or of geography, which you are taught, is a voice from beyond the tomb. Either the knowledge itself, or other knowledge which led to it, is an heirloom to you from men whose bodies are now mouldering in the dust, but whose spirits live for ever and whose works follow them, going on, generation after generation, upon the path which they trod while they were upon earth, the path of usefulness, as lights to the steps of youth and ignorance.

"They are the salt of the earth, which keeps the world of man from decaying back into barbarism. They are the children of light. They are the aristocracy of God, into which not many noble, not many rich, not many mighty, are called. Most of them were poor; many all but unknown in their own time; many died and saw no fruit of their labours; some were persecuted, some were slain, as heretics, innovators and corruptors of youth. Of some the very names are forgotten. But though their names be dead, their works live, and grow and spread over ever fresh generations of youth, showing them fresh steps towards that temple of wisdom which is the knowledge of things as they are; the knowledge of those eternal laws by which God governs the heavens and the earth, things temporal and eternal, physical and spiritual, seen and unseen, from the rise and fall of mighty nations to the growth and death of moss on yonder moors."

So spake Charles Kingsley, and his words I make use of as an introduction which strikes the key-note of what I have to say to you to-day.

The subject which I have chosen for my address—the relation of pure science, and especially of biological science, to human life, and inferentially the relation which ought to exist between pure and applied science in a college of science—is naturally of great interest to us in the Imperial College, which is a college of science and technology, and the purposes of which are, in the words of the charter, "to give the highest specialised instruction and to provide the fullest equipment for the most advanced training and research in various branches of science, especially in relation to industry." Particularly do I desire to set forth as clearly as I can the justification for including in a college which deals, not only with science, but with science in relation to industry, those branches of science which deal with organisms.

As industry forms the principal occupation of human life, and as the phenomena of organisms constitute the science of life, it may seem absurd to set out solemnly to justify the inclusion of the biological sciences in a college which deals with science especially in its relation to human life. Nevertheless, having regard to the fact that I have heard some doubt expressed as to whether the cult of the biological sciences properly falls within the scope of the Imperial College, it may not be out of place to bear the matter in mind on this, the second, occasion of the prize-giving of our new college.

What is the meaning of the word *science*? As in the case of so many words, its meaning has become confused by its partial application, *i.e.* by its application to a part only of its contents, and this has often led to a misapprehension of the relation of science and of the scientific man to life. Science simply means knowledge, and to speak of scientific knowledge, as opposed to ordinary knowledge, is to use a redundant phrase, always supposing that we are using the word knowledge in its strict sense. Huxley defined science as organised common sense, by which, I take it, he meant knowledge of things as they are—knowledge the reality of which can at any time be checked by observation and experiment; for common sense, if it is anything, is the faculty by which we are made aware of reality. Science is sometimes spoken of as exact knowledge, but I am bound to say that I do not like the phrase exact knowledge; it seems to imply an insult to the word knowledge. Its use reminds me of a friend of mine who, when he was offered one morning at breakfast a fresh egg, mildly asked, "In preference to what other kind of egg?" It recalls those regrettable phrases one so often hears, I *honestly* believe, or I *honestly* think; one wonders how the people who make use of them usually believe and think.

It must, I think, be admitted that science simply means

[1] Address delivered at the Imperial College of Science and Technology on December 16 by Prof. A. Sedgwick, F.R.S.

knowledge, and that there is nothing peculiar about the knowledge of scientific men by which it differs from other knowledge.

Scientific men are not a class apart and distinct from ordinary mortals. We are all scientific men in our various degrees. If this is so, how comes it that the distinction is so often made between scientific men and non-scientific men, between scientific knowledge and non-scientific knowledge? The truth appears to lie here: though it is true that all men possess knowledge, *i.e.* science, yet there are some men who make it their main business to concern themselves with some kind of knowledge, and especially with its increase, and to these men the term scientific has been technically applied. Now the distinctive feature of these men, in virtue of which the term scientific is applied to them, is that they not only possess knowledge, but that they make it their business to add to knowledge, and it is this part of their business, if any, which justifies their being placed in a class apart from other possessors of knowledge.

The men who make it their main business to add to knowledge may be divided into two classes, according to the motive which spurs them on. (1) There are those whose immediate object is to ameliorate the conditions of human life and to add to its pleasures; their motive is utility, and their immediate goal is within sight. Such are the great host of inventors, the pioneers in agriculture, in hygiene, preventive medicine, in social reform and in sound legislation which leads to social reform, and many other subjects. (2) There are those who pursue knowledge for its own sake without reference to its practical application. They are urged on by the desire to know, by what has been called a divine curiosity. These men are the real pioneers of knowledge. It is their work which prepares the way for the practical man who watches and follows them. Without their apparently useless investigations, progress beyond the limits of the immediately useful would be impossible. We should have had no applied electricity, no spectrum analysis, no aseptic surgery, no preventive medicine, no anæsthetics, no navigation of the pathless ocean. Sometimes the results of the seeker after knowledge for its own sake are so unique and astounding that the whole of mankind stands spellbound before them, and renders them the same homage that the child does the tale of wonderful adventure; such is the case with the work on radium and radio-activity, which is at present fixing the attention of the whole civilised world. Sometimes the work is of a humbler kind, dealing apparently with trivial objects, and appealing in no way to the imagination or sense of the wonderful; such was the work which led to and formed the basis of that great generalisation which has transformed man's outlook on nature—the theory of organic evolution; such was the work which produced aseptic surgery and the great doctrines of immunity and phagocytosis which have had such tremendous results in diminishing human pain. The temper of such men is a curious one; no material reward can be theirs, and, as a rule, but little fame. Yet mankind owes them a debt which can never be repaid. It is to these men that the word scientific has been specially applied, and with this justification—they have no other profession save that of pursuing knowledge for its own sake, or, if they have a profession, it is that of the teacher, which, indeed, they can hardly avoid. Ought such men, working with such objects, to find a place in the Imperial College?

It is a curious thing, but it has only comparatively recently been realised, that a sound and exact knowledge of phenomena was necessary for man. The realisation of this fact, in the modern world at any rate, occurred at the end of the Middle Ages; it was one of the intellectual products of the Renaissance, and in this country Francis Bacon was its first exponent. In his "Advancement of Learning" he explained the methods by which the increase of knowledge was possible, and advocated the promotion of knowledge to a new and influential position in the organisation of human society. In Italy the same idea was taught by the great philosopher Giordano Bruno, who held that the whole universe was a vast mechanism of which man, and the earth on which man dwells, was a portion, and that the working of this mechanism, though not the full comprehension of it, was open to the investigation of man. For promulgating this impious view both he and his book were burnt at Rome in 1600. You will find the same idea cropping up continually in the written records of that time; Copernicus gave it practical recognition when he demonstrated the real relation of the earth to the sun, and it was thoroughly grasped by our own Shakespeare, who gave it expression in the dialogue between Perdita and Polixines in the *Winter's Tale*:—

Perdita. The fairest flowers o' the season
Are our carnations and streaked gillyvors,
Which some call Nature's bastards: of that kind
Our rustic garden's barren; and I care not
To get slips of them.
Polixines. Wherefore, gentle maiden, do you neglect them?
Perdita. For I have heard it said
There is an art which, in their piedness, shares
With great creating nature.
Polixines. Say there be;
Yet nature is made better by no mean,
But nature makes that mean: so, o'er that art
Which you say adds to nature, is an art
That nature makes. You see, sweet maid, we marry
A gentle scion to the wildest stock and make conceive a bark of baser kind
By bud of nobler race: this is an art
Which does mend nature,—change it rather; but
The art itself is nature.

It is not difficult for us, though it may be difficult to our descendants, to understand how hard it was for man to attune himself to this new, this mighty conception, and the intellectual history of the last three hundred years is a record of the struggles to make it prevail.

Trained through long ages to believe that the heavens were the abode of the gods, who constantly interfered in the daily affairs of life and in the smallest operation of nature, it seemed to men impious to maintain that the earth was in the heavens, and to peer into the mysteries which surrounded them, and the endeavour to do so has been stoutly resisted; but the conflict, in so far as it has been a conflict with prejudice, is now over. It vanished in the triumph of the modern views on the origin of man which will be for ever associated with the names of Lamarck, Spencer, and Darwin.

The triumph of these views does not mean that they are correct or that we know anything more about the great mystery of life than we did before. He would be a bold and a prejudiced man who made that assertion. What it means is this, that man is grown up, that he has cast off the intellectual tutelage under which he has hitherto existed, that he has attained complete intellectual freedom, and that all things in heaven and earth are legitimate subjects of investigation. But it means even more than this; it means that the conviction is rapidly growing upon him that the only way in which he can hope to improve his condition is by understanding the laws, physical as well as spiritual, under which he exists, and this he is determined to try to do by the only method open to him—that of minute and arduous research.

And is it, I ask, an unworthy ambition for man to set before himself to understand those eternal laws upon which his happiness, his prosperity, his very existence depend? Is he to be blamed and anathematised for endeavouring to fulfil the divine injunction, *Fear God and keep His Commandments, for that is the whole duty of man?* Before he can keep them, surely he must first ascertain what they are!

We hear a great deal nowadays about the humanities and the humane studies—the study of "ancient elegance and historic wisdom"—and I should be the last to minimise in any degree the value and intense interest which is attached to the study of the writings and utterances of the mighty dead. They will always retain undimmed their attraction and inspiration for man, and man will always think with gratitude and affection of their authors; but it is possible to overdo a thing, and this talk of the humanities and humane studies has been overdone. After all, a live dog is better than a dead lion—but in this case we are dealing with a living lion.

It is ridiculous to say nowadays that the study of the humanities consists solely of the study of the writings and philosophy of the ancients; to take that view is to take the view of the schoolmen, the death-blow to which was given by Bacon and Bruno.

We have got beyond that; we claim that the true study of the humanities is a far wider thing—it is the study of the stupendous mechanism of the universe of which man forms a part, and the understanding of which is necessary for his happiness. That is the true humanity of which the other forms only a small portion. The time is coming when the principal preoccupation of man shall be the gradual disclosure of this mechanism and his principal delight the contemplation of its beauty. For remember what Plato himself said: the whole of nature, so far as it really exists, is a revelation of God.

In spite of the work and writings of such men as Bacon and Bruno in the end of the sixteenth century, the progress of science was at first but slow and the workers few. We have, of course, the immortal achievements of Newton and Harvey, and the foundation of the Royal Society, and the tremendous outburst of scholarship as typified in this country by Bentley and his co-workers; but the eighteenth century was, on the whole, characterised by intellectual quiescence both in scientific output and in literary creation. The quiescence was apparent rather than real. To borrow a metaphor from the garden, though there was little growth above ground, active root formation was going on. Linnæus (1707–78) was at work in Sweden creating the framework which rendered future work in botany and zoology possible; Buffon in France was cautiously feeling his way towards a theory of organic evolution; Henry Cavendish (1731–1810), Joseph Priestley (1733–1804), and Antoine Lavoisier (1743–94) were laying the foundations of modern chemistry; Albrecht von Haller (1707–77), Kaspar Friederick Wolff (1733–94), and John Hunter (1728–93), those of anatomy and physiology. The spade-work of these men, together with the improvement of the microscope, was necessary for the great outburst of scientific investigation which characterised the nineteenth century. Ushered in by the work of Cuvier (1769–1832), Lamarck (1744–1829), St. Hilaire (1772–1844), in biology, Thomas Young (1773–1829), Laplace (1749–1827), Volta (1745–1827), Carnot (1758–1823), in physics, it was adorned in its middle and latter period by the names of Davy, Faraday, Dalton, Arago, Richard Owen, Darwin, Lyell, Joh. Müller, Agassiz, Helmholtz, Stokes, Kelvin, and Pasteur.

The advance of knowledge is yearly becoming more rapid; if its steps were slow and hesitating in the seventeenth and eighteenth centuries, and if it quickened to a rapid walk in the nineteenth, we now hear the sound of a trot, which at the end of the century will be a gallop, and as the centuries succeed one another its pace will become even faster. Where will it lead us, and what will be the upshot for man?

But it is no part of my purpose to-day to give you an historical summary of scientific progress. The point I wish to illustrate is the vast increase in the scientific army and in the results achieved by them.

My thesis is that pure research into the sequence of natural phenomena is in itself of the greatest importance to the progress and welfare of humanity, and that a great statesman can have no higher aim than to solve the problem of how it may best be fostered. To what extent can such a thesis be justified by experience?

I might begin by examining the origin and progress of our knowledge of what is called current electricity, to which modern life, from a material point of view, owes so much. In illustration of what we owe to workers in electrical science I need only mention land telegraphy, ocean telegraphy, wireless telegraphy, telephones, electric light, electric traction, and our knowledge of radio-activity. The history of this science forms, perhaps, the best example of the importance to man of pure, apparently useless, scientific research, for at every stage of it, from Galvani's original observation through the discoveries of the Swede Oersted and of the Frenchman Ampère to those of our own Faraday and to the theoretical adumbrations of Clerk Maxwell and to the researches of Crookes on the passage of electricity through vacuum tubes, we meet with the investigation of phenomena which were apparently perfectly useless, and which to most practical men must at the time they were made have appeared as little more than scientific toys provided by nature for the harmless amusement of the queer people who meet in the rooms of the Royal Society and suchlike places where unpractical oddities resort. And yet I ask you to reflect upon the astounding results which have arisen from Galvani's observations made to discover the cause of the twitching of the frog's legs, and of Faraday's discovery of induction, and to indulge your imaginations in an endeavour to predict what may issue for man from Crookes's investigations of the glow without heat of the vacuum tubes.

But I have neither the knowledge nor the time to dwell upon the physical side of science. As in private duty bound, I must devote the short time at my disposal to examples culled from the biological sciences.

The great Frenchman Pasteur, in making a thorough examination of the process by which alcohol was obtained from sugar, discovered the part played by the organism known as yeast, and established the idea of organised ferment bodies. He extended his observations to other micro-organisms, and, in conjunction with his co-workers, among whom must be included those who were looking into the question of the spontaneous generation of living matter, definitely gave us the idea that putrefaction was caused by micro-organisms acting upon organic matter, that these micro-organisms are capable of resisting drought, and when dried float freely in the air and are distributed everywhere. When they fall upon a suitable material their vital activity is resumed, and they increase with incredible rapidity and set up putrefaction. It was reserved for our distinguished countryman Lister, then a surgeon in Edinburgh, to recognise the importance of these discoveries for surgery. Knowing of the researches of Pasteur and his fellow-workers, he conceived the idea that suppuration was due to putrefaction in the organic matter of the wounds caused by micro-organisms. Acting on this, he introduced his method of antiseptic surgery, by which his name has been rendered immortal. I think we may say that no single application of the results of pure research has done more to preserve human life and to diminish human suffering than this linking up by Lister of the putrefaction of suppuration with the work of his predecessors on the effects of the actions of micro-organisms upon organic matter. It is well to notice, in passing, that this discovery of Lord Lister's is a good illustration of the difficulty which the human mind has of conceiving even the simplest new idea. To us, now, how simple seems the step which Lister made; yet there were thousands of surgeons in the world who failed to make it, though they were continually dealing with suppurating wounds and wondering why they suppurated, and when it was made it was stoutly discredited by many quite able men.

I must now turn to another subject which is closely connected with the preceding, and well illustrates my thesis that pure scientific research, without reference to practical utility, is of the highest importance to mankind.

It will doubtless have occurred to many of you to ask the question, How is it, if the air contains floating in it the dried spores of multitudinous micro-organisms which only need a suitable medium for their development and increase, how is it that they do not obtain a lodgment in the healthy animal body, which one would think offers all the conditions necessary to their growth? It can easily be shown that the air we breathe, the water we drink, the food we eat, everything that we touch, swarms with these microscopic creatures; that they enter our lungs, that they germinate in our skin, that they occur in countless numbers in our alimentary canals, in short, that they are found everywhere on our body surfaces. How is it that they do not increase and turn our organs into a seething mass of putrefying corruption? One would expect that even if the skin and the membrane bounding the internal organs to which they obtain entrance incurred the slightest lesion, even a pin-prick, that they would have been able to enter. We know that after death they at once obtain complete dominion, and we therefore infer that in life there must be some protective mechanism in the body capable of dealing with them.

The discovery that there is such a mechanism was made in the early 'eighties by the distinguished Russian zoologist Elias Metschnikoff, though the need of its existence was not recognised by biologists in general until later. The result of this was that his remarkable discoveries were at first pooh-poohed and discredited by many, but ultimately they gained acceptance, and their further development in his own hand and that of others has wrought a revolution in the art of preventive medicine.

The mechanism consists of the small amœboid cells found in the blood, lymph, and body fluids generally, and called leucocytes, or white blood corpuscles. Though long known to exist, very little had been ascertained as to their function until Metschnikoff, working at such remote subjects as the embryology of sponges, the structure and digestion of polyps, the blood of water-fleas, realised that these small amœba-like cells, which exist in all organisms, actually swallow, digest, and so destroy small foreign bodies which have invaded the organisms. He called them the phagocytes, and all his subsequent work has been directed to the elucidation of their mode of action.

It is to Metschnikoff's work, prompted solely by the scientific spirit, that we owe our knowledge of phagocytosis and the great theory of immunity which has proceeded from it. It is impossible at the present moment to estimate fully the value to man of Metschnikoff's discoveries. Suffice it to say that they have already led to important practical results, and have revolutionised treatment.

I must now turn for a moment to another subject of the greatest importance to mankind, and one which has been brought into notice by the researches, perfectly useless so far as our material welfare is concerned, which were undertaken with the view of elucidating the great question of organic evolution. I refer to the study of genetics, which deals with the question mainly of the transmission of the properties of the organism; but it deals with even a larger subject than that. It looks into and tries to determine the laws which govern the origin of the characters of individuals, whether plants or animals, whether those characters have been acquired by inheritance or in some other way. The subject is of the utmost interest and practical importance to man from three points of view. It has a bearing on philosophy of a most important and far-reaching kind through the theory of organic evolution. That theory largely depends for its proof upon the science of genetics. Secondly, it has a most important bearing upon practical questions affecting breeders of animals and raisers of plants, and also upon man himself in connection with practical legislation. This brings me to the third point, in which this subject specially appeals to us, and that is what I may call its bearing upon ethics. This is, of course, closely connected with the last.

We are constantly confronted with questions in which we have to think, not only of the advantage and happiness of those alive at the present moment, but also of those not yet born who will succeed us on the earth. The decision of these questions is one of the most important and burning subjects which can be put before us. They often crop up in legislation, and yet we are quite unable to answer them because of the very little knowledge we possess of the laws which govern the transmission of characters from generation to generation.

The interests of future generations often appear to be in conflict with the immediate pleasure and happiness of the living, and we are confronted with the question whether we ought to give way to our own humane and benevolent feelings or whether we ought to set our teeth and deal ruthlessly with a number of people who must appeal to our pity, lest by saving them from elimination we should bring about an increase in the number of people who are unable to hold their own, and so weaken the nation and increase for the next generation the difficulties which we set out to cure. I do not pronounce any judgment on these questions; I merely wish to emphasise the immense, the transcendent importance, from the human point of view, of the investigations which the study of the question of evolution has caused biologists to carry out into that most difficult of all subjects, heredity, and of obtaining clear ideas upon the subject. These, I admit, are elementary examples, and probably familiar to most of you—and they might be largely added to from other branches of zoology, such as entomology, marine fauna, and physiology—of the great practical achievements which have followed from the recognition of the fact, possibly appreciated in some ancient civilisations,[1] but in modern times first understood by Bacon and his compeers, that natural phenomena are in themselves, and without reference to immediate utility, proper subjects of man's inquiry, and that all progress must be based on their thorough and accurate investigation.

The genesis of a new idea is so difficult, and the amount of work necessary for its complete elucidation and development so vast and detailed, that many eminent men, taking only a short period of time and not realising the minute steps by which the advance of knowledge takes place, have been led to doubt the value of scientific investigation in the higher realms of pure knowledge, even to the extent of speaking of the bankruptcy of science. Others, again, perceiving the apparent aimlessness of many investigations and undervaluing the motive which urges them on, have come to look with a certain contempt upon the man of pure science and his slow and plodding progress. What is the good of all this work at unimportant details? What do you get out of it, and what pleasure do you find in it? they ask, and when they are told that the humble worker usually gets nothing out of his work except the pleasure of doing it, and that his motive is nothing more elevated than the satisfaction of his curiosity, there does appear to be, it must be admitted, some justification for the contemptuous indifference with which the poor researcher is regarded by a considerable section of the population, as is shown by the almost entire absence of support of pure scientific research on the part of the Government. With the exception of an annual grant of 4000*l.* a year given to the Royal Society, I think I am correct in stating that the Government affords hardly any support to science save to such as is concerned with teaching or with some practical problem; and when one remembers the composition of Governments and the manner in which, and the reasons for which, they are chosen, one cannot unreservedly blame them for this attitude. The best method of fostering research is a difficult problem, and I can well understand that a modern democratic Government, depending as it does upon popular support with its attendant popular mandates, should shrink from dealing with it. To do so would bring them no popularity and no votes, and too often they are not really aware of its immense importance to human progress, and when they are they have great difficulties to face.

For it is impossible to organise research on a commercial basis. "All attempts," says Prof. Nichols, of Cornell, "at a machine-made science are doomed to failure. No autocratic organisation is favourable to the development of the Scientific Spirit. No institution after the commercial models of to-day is likely to be generously fertile. You can contract for a bridge according to specifications. No one, however, can draw up specifications for a scientific discovery. No one can contract to deliver it on a specific day for a specified price, and no employee can be hired to produce it for wages received."

This it is impossible to get the public to understand even when it has undergone the process which we call education. You may establish paid posts for scientific research, but you cannot be sure that you will get research, for science is like the wind that bloweth where it listeth, and that is what our educated public do not like. They want something for their cash, and they will not wait.

Even those who are aware of the immense value of pure research forget the fact that the aptitude for scientific investigation is as rare as the gift of poetry, to which in many respects it is allied, for both are creative gifts, rare and precious. They forget that it is impossible to ascertain without trial whether a man possesses it or not, and that this trial can only be made when he has passed his student days and looks to support himself by his own

[1] There are, as is well known, indications that research into natural phenomena was practised and esteemed in some ancient civilisations which have been destroyed by the inroad of barbarians or by other causes. One of the most striking of these indications is the record in one of the sacred books of the Hindus which cannot be less than 1400 years old, and is probably much older, that malarial fevers are directly caused by the bite of mosquitoes. Attention was first diected to this record by Sir H. A. Blake, G.C.M.G., in 1905, while he was Governor of Ceylon (*vide* Journal of the Ceylon Branch of the British Medical Association, vol. ii., part i., 1905).

exertions. To provide for this support money is needed, and studentships must be established in considerable numbers, from the holders of which those who show that they possess the gift of research can be selected and promoted to higher posts in which their gift can find full opportunity; but we want more than this—we want compensation for those whom we have encouraged to make the trial and who have failed to show that they possess the gift, and an outlet by which they can emerge and find work in practical life.

This has been and is a difficulty in all schools of science, for many are called but few are chosen. The situation is this: it is desirable that a large body of able young men should be encouraged to take up scientific research, but as experience has shown that only a small proportion of them will possess the qualities by which success in research can be attained, and as it is undesirable to encumber the progress and the literature of science by a host of workers who have no real capacity for research, it results that a time will arrive when a great proportion of those whom we have encouraged to give some of the best years of their life to this unremunerative work should be invited to find other occupations. What is to be done? We cannot throw them into the street. Some compensation must be given. There are two ways in which this can be done. One is the system of prize fellowships, which has for long been in vogue at the old universities, and which it has of late been the custom of those who have not really studied the matter to decry. Nevertheless, it is a good system, for it provides an income by which those who have given some of the best years of their life to this trial of their capacity can support themselves while they qualify for taking part in a practical profession.

A prize fellowship system, or something like it, is a necessary accompaniment of a university which induces a large number of young men to follow for a time the intellectual life; it acts both as an inducement and a compensation, and it would be a mistake and an injustice, in my opinion, to abolish it; but there is another way in which the difficulty can be met, and that is the way which has been adopted by the wise and far-seeing founders of the Imperial College, namely, by the combination of a school of science with a school of technology. If you have incorporated in your school of science a school of applied science, and if you at the same time take care that none but able men are allowed to enter the research grade, and if you establish, as you must do if you honestly work your school, a connection with the great industrial interest of the country, you have all that is necessary for the disposal of those men who, for whatever reason, find themselves unable to follow a life of pure science. As is well known, the faculty for pure, apparently useless, research in science is often possessed by men without any aptitude for practical application of science or desire of practical success and the wealth which practical success brings, while, on the contrary, many minds of the highest order cannot work at all without the stimulus of the thought of the practical outcome of their labour.

In our college there is room both for those with the highest gifts for pure scientific research and for those with the inventive faculty so important in the arts, or with the knowledge and ability for controlling and organising great industrial enterprises; and, what is more, the combination of the two types of mind in the same school cannot but be of the greatest advantage to both, not only on account of the atmosphere which will be created, so favourable to intellectual effort, but also because good must result from the contact in one school of minds whose ultimate aim is to probe the mysteries of nature and to acquire control over her forces.

As Prof. Nichols has well said in pointing out the dependence of technology on science:—"The History of Technology shows that the essential condition under which useful applications are likely to originate is Scientific productiveness. A country that has many investigators will have many inventors also. . . . Where science is, there will its by-product technology be also. Communities having the most thorough fundamental knowledge of pure science will show the greatest output of really practical inventions. Peoples who get their knowledge at second hand must be content to follow. Where sound scientific conceptions are the common property of a nation, the wasteful efforts of the half-informed will be least prevalent." These are sound conclusions, and experience has shown that if the terms are interchanged the same remarks may be made with equal truth of the good influence which results to a school of science from its association with a school of technology.

Before concluding, it may be well to say a word as to the origin of the great imperial institution in the interests of which we are met here to-day. It may justly be described as the natural and necessary outcome of the scheme for scientific instruction which was originated by that great Prince whose memorial stands near the end of Exhibition Road, and to whom science and art in England owe so much. He dreamed a dream which his untimely death alone prevented him from realising. Had he lived, who can set a bound to what he would have achieved for science and education in England? It is a most happy circumstance that the final stages of the realisation of that dream should have been entered upon in the reign, and have received the sympathy, patronage, and active support of his great son, our most gracious King, who is working in so many directions for the welfare and happiness of our race.

There is one further point I must touch upon. In the few remarks which I have had the honour to make to you, I have endeavoured, however imperfectly, to embody in words certain thoughts which bear upon a great subject. I thank you for the patience with which you have heard me. Whether I have produced the effect I desire I know not, but I know this, that even if I had the tongue of men and angels, no words of mine could have been so apt, so expressive as the magnificent deed of Mr. Otto Beit recorded in to-day's newspapers. It is impossible for me to pass this over in silence, so closely is it connected with the subject of my address. There are two ways of manifesting thought, by word and by action. Mr. Beit has chosen the latter and far more effective way. We can only express our respectful admiration and gratitude for his generosity, and our thankfulness that a man should exist among us with the power, the insight, and the true humanity to do such a splendid deed.

THE NEW DEPARTMENT OF BOTANY AT UNIVERSITY COLLEGE, LONDON.

ON Friday, December 17, the new botanical laboratories at University College, London, were formally opened by Dr. D. H. Scott, F.R.S., the Vice-Chancellor of the University of London (Prof. M. J. M. Hill, F.R.S.) presiding. Dr. Scott, in the course of a very interesting address, said that botany has been more fortunate in that college than in many others of more modern origin, for the subject has always been recognised from the foundation of the college as an independent science co-equal with her sisters. In the long period from 1828 to the present time there have only been three appointments to the chair, viz. Profs. Lindley and Daniel Oliver, and the present occupant, Prof. F. W. Oliver. After giving an outline of the history of the department and of his own connection with it, Dr. Scott spoke of the various branches comprised in the subject. Systematic botany is the oldest branch, but it never can become old-fashioned. It is not needed less now than a century ago. At one time there was a tendency to neglect it somewhat in favour of the study of the structure and functions of some few plants which have been favoured with selection as types. Now the pendulum has swung the other way, and its importance is fairly recognised in teaching. It would be disastrous if systematic botany fell into neglect, and it would be peculiarly discreditable to English people, because systematic botany is specially a glory of this country.

Referring to the Hookers, Bentham, C. B. Clarke, and Daniel Oliver, Dr. Scott said it would appear to be a characteristic that the ablest minds have been attracted towards systematic botany. Comparative anatomy, he said, is now pressed into the same service as systematic botany. Comparative anatomy is particularly a study of the modern English school. These two branches are now subservient to questions of evolution, the search for relationships having become identified with the attempt to trace descent. It is from this point of view that the English school of anatomy has been directed, and this has led to a close union with fossil botany, the direct investigation of the historical documents of the rocks, so often best recorded in anatomical characters. In this way the modern study of fossil botany, based chiefly on structure rather than on the often deceptive external appearances of the fossils, has been active in an advantageous way in recent times, and has given it a more truly comparative and evolutionary character than it ever had before. After referring to physiology, ecology, and cytology, Dr. Scott expressed the view that genetics, the study of variation and heredity, is probably the leading subject of all at the present day. It is the subject by which this age will be remembered, though the study is only actively beginning now. The impetus given by Darwin, already felt in many other directions, is only beginning to be felt in this particular direction.

A vote of thanks was moved by Lord Reay (chairman of the college committee) and seconded by Prof. F. W. Oliver, who, on behalf of the members of the department of botany, presented to Mrs. D. H. Scott a piece of jewellery as a souvenir of the occasion.

The opening ceremony was attended by a numerous company of botanists, members of the University Senate, college committee, and professorial board. The exhibits shown in the rooms of the new department included portraits of former members of the staff, a selection of records connected with the ecological work of the department at the Erquy station, fossil plants from the groups of the Pteridospermeæ and Cycadophyta, and other work connected with the work of the department.

The following is a description of the new department, which takes the place of a series of inconvenient and indifferently lighted laboratories in the central building.

The suite of rooms now allotted for the accommodation of the department of botany has become available through the transfer of the department of physiology to new quarters in the south quadrangle. Built in 1878, under the supervision of the late Sir J. Burdon Sanderson, for purposes closely similar to those to which they are now being put, it has not been found necessary to make any structural alterations of moment.

In all, fifteen rooms are included in the department; they are situated on either side of a corridor which runs the whole length of the top floor of the north wing of the college. The rooms have been allocated as follows:—

On the north side, following the lecture-room, is the professor's laboratory, and adjoining this the elementary and advanced laboratories. These two rooms have been thoroughly overhauled, and staging has been erected so that the working tables get the full benefit of the excellent lighting. The benches are arranged in four tiers, and are fitted with water, gas, and electric lamps. Each of these laboratories has seating capacity for forty students. Beyond these rooms is a large room set apart for original investigations, especially in anatomical and microscopic work. The available space is increased by the existence of a gallery along the south side with separate windows. Communicating with the research room is the chemical physiology room, with benches equipped for twenty-four workers. As in the research room, there is a gallery lighted from the south, and suitable for special investigations.

On the south side of the corridor the rooms are all top-lighted in order to conform with the style of architecture in which the façade of the college has been built. The first room on this side has been fitted up as a departmental library, in which the collection of pamphlets, numbering about 4000, has just been classified, and is now about to be catalogued.

Next the library comes the large apse room, which will be used as a herbarium and ecology room. Here are being arranged the ecological collections and photographs, vegetation charts, &c., connected with the field work of the department at Erquy and elsewhere, together with biological specimens generally. The overhead lighting of this room makes it very suitable for the examination and exhibition of specimens, and for mapping and similar purposes. The concave apsidal end of this room has been fitted with a continuous, semi-circular desk for demonstrations and temporary exhibits—a purpose for which it is well suited.

Next to the ecology room, the old animal room has been converted into a central store for preserved material of all sorts. On one side of this store potting benches have been erected for the service of a small conservatory which lies beyond. This greenhouse will be used as an adjunct to physiological work and for raising plants for class purposes.

INDIAN GUILD OF SCIENCE AND TECHNOLOGY.

ON Saturday, December 18, a large number of Indian students assembled at the University of Leeds to inaugurate an Indian Guild of Science and Technology. This movement is the outcome of the noteworthy migration of Indian students during the past three or four years to countries where they seek to equip themselves with scientific and technical knowledge to aid in the development of Indian industries. The object of the Guild is to promote intercourse between these students and to assist them in every possible way to attain their common aim. The members hope, by associating themselves in this way, to assist other incoming students, and to cooperate, when they return, in promoting science and its applications to industry and sanitation. They hope also to stimulate an organised movement in India with these objects.

The meetings on December 18 were attended by students from a considerable number of centres of higher education, and the proceedings were marked by unanimity and enthusiasm. At a preliminary meeting the general constitution of the Guild was drawn up. In the afternoon the inaugural meeting was held, when Prof. A. Smithells, F.R.S., was elected president for the year, and delivered an address. Prof. Smithells outlined the work which he thought the Guild might accomplish, and enlarged upon the importance of science in relation to the development of the resources of India and the improvement of the condition of the people. He insisted upon the importance of not allowing an educational system to arise which should lead intelligent Indians mainly to the destiny of lawyers and clerks, and he maintained that India could not at this day develop its industries without a much greater application of science than there had been in the early days, or was even at the present time in Great Britain. Though there were many signs of scientific activity in India, and much excellent work was being done by the Government, he thought that a national effort among the younger men of the country might do much towards aiding the existing agencies.

Lord Airedale, as a representative of the iron and steel industries, who for more than half a century had been associated with a large manufacturing concern, made an interesting speech, in which he recalled examples of the benefits conferred by science upon industry. He urged his hearers not to let their poetic imaginations run away with them, but to apply themselves practically and industrially to the attainment of scientific knowledge, and then to concentrate on one or two definite objects.

Among speeches made by the students was an eloquent plea, by Mr. R. N. Sen, for regaining the lost glory of India by the assimilation of all that is best in western scientific and technological knowledge.

In the evening the members of the Guild assembled at an inaugural dinner. Many encouraging messages had been received from men of science, including the presidents of the Royal Society, the British Association, the Institute of Chemistry, Sir Henry Roscoe, Prof. Witt, of Charlottenburg, Prof. P. C. Rây, of Calcutta, Sir Alex. Pedler, Prof. Meldola, Prof. Dunstan, and others. Lord Airedale, Sir Henry Roscoe, Sir W. Ramsay, K.C.B., and Prof. O. N. Witt were elected patrons, and the following were elected sectional hon. presidents:—Prof. Schäfer, F.R.S. (Edinburgh), Prof. Barr (Glasgow), Prof. Procter (Leeds), Prof. Cadman (Birmingham), Prof. Knecht (Manchester).

The subscription to the Guild is 10*s*. entrance fee and 10*s*. annual subscription. The secretary is Mr. M. A. R. Paniker, The University, Leeds.

THE PHYSICAL SOCIETY'S EXHIBITION.

THE fifth annual exhibition, which was held by the Physical Society of London at the Imperial College of Science and Technology last week, was marked by some pleasing innovations. Hitherto the exhibition has been limited to the evening only, but on this occasion it was open also in the afternoon, and this extension of time was evidently appreciated. Experimental lectures were also introduced. Thus many visitors must have welcomed the opportunity of seeing once again the beautiful and well-known experiments on soap bubbles by Prof. C. V. Boys, F.R.S., as they have not been seen during the last ten or fifteen years. In the evening Prof. S. P. Thompson, F.R.S., showed the remarkable effects obtained by combining mica and selenite viewed under polarised light.

Turning to the exhibits themselves, we may remark that there were about forty exhibitors, and for this reason it is impossible to do more than give a brief reference to some of the more interesting and novel exhibits in the space at our disposal. In the subject of mechanics, in its broadest sense, Mr. W. V. Gilbert's anticlastic levers, shown by Messrs. Strange and Graham, received the most attention. The device is known by the trade name of "Vilcars," and enables a movement in a given plane to produce a movement in a plane at right angles, although no joints or complicated links are used for producing this change in the direction of motion.

Among other mechanical devices we may mention the Wimperis accelerometer, shown by Messrs. Elliott Bros. (see NATURE, December 2, p. 139). The acceleration is indicated by a pointer, which moves on a scale suitably graduated. The indication is effected by an eccentrically placed copper disc which is controlled by a hairspring and is magnetically damped. By a special gear and balance weight the disc is compensated so that the instrument is affected only by acceleration in one direction, which is indicated by an arrow on the dial. A simpler type of instrument is that due to Mr. A. P. Trotter, and shown by Messrs. Everett, Edgcumbe and Co. This consists simply of a curved glass tube nearly filled with liquid, and is best described as a spirit-level of extravagant curvature. When subjected to acceleration along its length the position of the bubble varies according to the acceleration. Obviously it may be used equally for measuring gradients.

The principle of the diffusion of gases is brought into practical use in the gas-leakage indicator shown by the Cambridge Scientific Instrument Co. An elastic metal chamber is closed by a porous tile, so that the pressure within it increases when the instrument is brought into an atmosphere containing light gas, such as coal gas. The pressure is shown by a pointer, the motion of which is an indication of the presence of gas.

There was a good display of optical apparatus, including microscopes, cameras, and photometers. Among the latter may be mentioned the daylight illumination photometer due to Mr. A. P. Trotter, and exhibited by Messrs. Everett, Edgcumbe and Co. In testing the illumination of a room by daylight, an absolute figure in, say, candle-feet is not of value by itself, because it depends upon the brightness of the day on which the measurement is made. This difficulty is overcome by using a vertical tube placed over the screen which receives the illumination to be measured. The instrument is first placed where a clear view of the zenith is obtained, and a stop is inserted in the tube so as to cut down the illumination to a convenient figure. A measurement is then made in the room where desired, the tube having been removed. The stops are so proportioned that the true ratio of the illumination in the room to that in the open is readily obtained. As examples of such measurements the makers mention that the ratio over the Speaker's chair in the House of Commons is 0·0009, and that in the British Museum reading room 0·007.

Electrical exhibits were by far the most numerous, and among these perhaps the most interesting was the application of Abraham's rheograph (shown by the Cambridge Scientific Instrument Co.) to throw on the screen a hysteresis loop. It will be remembered that in the rheograph a light aluminium frame is suspended in a permanent magnetic field, and forms the secondary of a small transformer. The controlling and damping forces are made relatively unimportant, so that the deflection becomes proportional to the current or potential difference under observation. On the present occasion two vibrators were arranged at right angles, one to give a deflection proportional to **B** and the other to **H**. A beam of light being reflected first from one and then from the other therefore gave a hysteresis loop, which appeared quite steady upon the screen.

The same firm showed Dr. C. V. Drysdale's slip meter, which, although it has been in use for some years at the Northampton Institute, has not, so far, been generally available. A circular card, on which certain geometric figures are printed, is fixed to the shaft of the machine under test, and is observed through a stroboscopic disc. The latter is driven frictionally by a conical roller, which in turn is driven by a small synchronous motor. By moving the disc along the roller its speed is varied, and when the geometric figures on the card appear stationary the speed can be read off on the graduated leading screw which controls the position of the disc. This part of the apparatus is quite small and compact. Depending on the arrangements used, speed, frequency or slip can be determined.

Messrs. Snell and Tinsley showed one of Dr. C. V. Drysdale's potentiometers for alternating currents, the difficulty of phase difference being eliminated by a "phase shifter," by which the phase of the current in the potentiometer wire is made to coincide with that of the pressure to be measured. A rotary field is produced in the phase shifter by splitting up a single-phase current into two in quadrature.

Duddell's vibration galvanometer, which is a modified oscillograph, was shown by Messrs. Nalder Bros. and Co. Messrs. J. J. Griffin and Sons exhibited Mr. Tucker's high-potential primary battery; it is compact in form, and appears to give its 1000 volts with a minimum of trouble. Mr. F. Harrison Glew showed a radium collector for atmospheric electricity. This consists of a metal spiral coated with insoluble radium salts; it is suspended in an elevated position from a weather-proof insulator, and as the radium ionises the air around it the wire acquires the potential of the atmosphere, and gives an indication on an electroscope.

Visitors also had an opportunity of seeing one of the latest methods of transmitting photographs electrically, as exemplified in the apparatus of Mr. T. Thorne Baker, shown by the *Daily Mirror*. Prof. Korn's method, with selenium cells, has reached a stage of some perfection, but the smallness of the currents available in such a method introduces difficulties. There is thus a tendency to use rather more mechanical methods. In Mr. Baker's apparatus, photographs are printed on fish-glue upon lead foil, and lines are drawn across this so as to expose the lead. The style comes into contact more or less with the lead, depending upon the density of the image, and thus allows current to flow into the line. At the receiver the picture appears on suitably prepared paper by electrolytic action, and the results seem to be very satisfactory.

The exhibits we have enumerated by no means exhaust all that was of interest, but want of space renders a complete survey impossible.

EXPERIMENTS ON COMPOUND STRESS.

TWO papers dealing with experiments on compound stress were read at the Institution of Mechanical Engineers on Friday, December 17. The first of these, by Mr. William Mason, of the University of Liverpool, gave the results of tests made by the author on mild steel tubes, and included tests made in simple compression, in simultaneous compression and hoop tension, in simple axial tension, simultaneous axial and hoop tension, simple axial compression, and simultaneous axial and hoop compression. Two sizes of tubes were used, viz. 3 inches bore and 2·75 inches bore, of thickness about 0·08 and 0·128 inch respectively. The larger tubes were cold-drawn, and the others were hot-drawn. Some of the tests were made on the tubes unannealed, in others the tubes were annealed. Extensometers of the Ewing type were used in measuring the strains. The testing machine employed was the 100-ton Buckton machine in the Walker Engineering Laboratory. Hoop tension and compression were obtained by applying hydraulic pressure to the inside and outside of the tubes respectively; in the latter case a special jacket surrounded the tube under test. The experiments show an approximate agreement between the maximum shear stress at the yield point in compression and the yield-point stress in pure shear, the mean difference in the tests of annealed specimens being about 3 per cent. It appears, then, that mild steel in compression yields by shearing; and, to a first approximation, the value of this shear stress is independent of any normal compressive stress on the planes of the slide.

The second paper was contributed by Mr. C. A. M. Smith, of the East London College, University of London. Solid mild steel test specimens were used under combined tension and torsion, and also under combined compression and torsion. The 50-ton machine at the college was used, and the strains were measured by means of the author's sphingometer, by means of which readings are obtained on three planes at 120 degrees. The results obtained give further confirmation of Guest's law for mild steel. The author's remarks regarding the difficulty of obtaining axial application of the load, both with pull and push, were of special interest. Ordinary wedge grips are of little use in securing this; even spherical seatings are bad. Sphingometer readings with the latter show great divergence from regularity in the strains on three planes, although the means are perfectly regular. Often in a test the ball joints slip into new bearing positions, thus producing a new eccentricity of the load. These facts emphasise the necessity of employing an instrument of the sphingometer type in tests of a scientific character for loads within the yield point.

THE PARASITES OF THE GROUSE.

SOME valuable results of the work of the Grouse Disease Inquiry Commission are published by Dr. A. E. Shipley, F.R.S., in a series of papers on the parasites of the red grouse (Proc. Zool. Soc. Lond., 1909, pp. 309–368, plates xxxv.–lx.), in which the ectoparasites, the thread-worms, and the tape-worms are successively described and illustrated.

Ninety per cent. of the birds examined were infested with two species of Mallophaga (*Goniodes tetraonis* and *Nirmus cameratus*) which feed on the barbules of the feathers. "The number on each bird is to some extent an inverse measure of their health." Though not a parasite, the larva of the common dung-fly (*Scatophaga stercoraria*) is described and excellently figured—a noteworthy contribution to the scanty literature on larval Diptera—because it was hoped that these maggots, which are found in numbers among the droppings of the grouse, might prove to be intermediate hosts for the grouse tapeworms; the results, however, were entirely negative. With the same object in view, the crops of many grouse were examined, and although gamekeepers and sportsmen believe that these birds eat no insects, their animal food was, in fact, found to be "fairly abundant and very varied," comprising caterpillars of moths and saw-flies, froghoppers and Diptera, spiders and slugs. Although no bladder-worms were found by these investigations, Dr. Shipley has incidentally thrown light on the feeding habits of the grouse, and has shown that mere external observation in such questions is often to be distrusted.

The grouse tape-worms, the cysticercus stages of which are thus still unknown, comprise a larger species (*Davainea urogalli*) and a smaller one (*Hymenolepis microps*). This latter, "so transparent when alive as almost to be invisible," is nevertheless very abundant in the duodenum, where its presence appears to be often fatal to the birds, so that it is a far more serious pest than its larger companion.

Of the Nematoda that infest the grouse, *Trichosoma longicolle* and *Trichostrongylus pergracilis* are the most important, and the latter of these, at least, requires no intermediate host for its development. By soaking heather and then centrifuging the drawn-off water, Dr. Shipley showed that "heather is, so to speak, crawling with thread-worms"; the means by which the nematode larvæ, hatched from eggs passed out of the birds' intestines, enter the food canal of new hosts is thus plain. Another fact of interest is the presence of larval thread-worms in the lungs and liver; these are believed to be derived from eggs hatched while still in the intestine of their parents' host-bird, and to wander through the latter's body. Readers who have followed Dr. Shipley's recent suggestions as to the importance of parasitic worms in certain human diseases will be prepared for his belief that these wandering larval nematodes may be responsible for pathological conditions in the organs of the grouse.

G. H. C.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The general board of studies has appointed Mr. L. A. Borradaile to be university lecturer in zoology from January 1, 1910, to September 30, 1914.

It is proposed, in accordance with the recommendation of the special board for moral science, to appoint a syndicate to make arrangements for the building of a laboratory of experimental psychology.

DR. J. L. SIMONSEN, assistant lecturer and demonstrator in chemistry in the University of Manchester, has been appointed professor of chemistry in the University of Madras, and Dr. A. Holt has succeeded him at Manchester.

A LECTURE by some man eminent in letters, science, or art, to be delivered annually in the Lent term, has been established at Queen's College, London. Her Majesty the Queen, patron of the college, has allowed it to be called the Queen's lecture.

UNDER the Irish Universities Act, 1908, graduates of the Royal University of Ireland may be registered as graduates of the National University of Ireland. We are asked to announce that as the first meeting of Convocation must take place within six months from the date of the dissolution of the Royal University of Ireland, it is very advisable that application for registration as graduates should be made without delay. All information may be obtained from Dr. Joseph McGrath, registrar of the University, the National University of Ireland, Dublin.

COURSES of afternoon lectures on aëronautics will be held after Christmas at the Imperial College of Science and Technology. Sir George Greenhill, F.R.S., will lecture on the dynamics of an aëroplane; Mr. H. R. A. Mallock, F.R.S., on fluid resistance; and Colonel H. C. L. Holden, F.R.S., on light petrol motors for aërial work. The courses will begin respectively about the middle of January, the early part of February, and after Easter. Research scholarships will be awarded by the college to advanced students desirous of undertaking research work in scientific problems connected with aëronautics. The scholarships are to be tenable for one year at the Imperial College, and provision may be made for part of the work to be undertaken at the National Physical Laboratory. Scholars will be entitled to free admission to the college and to a maintenance allowance.

THE next annual conference of teachers arranged by the London County Council will be held on January 6–8 inclusive at Birkbeck College, Chancery Lane, London. Among the subjects for discussion, we notice that during the afternoon of the first day the training of engineers will be dealt with. Sir William White, K.C.B., will preside, and addresses will be delivered by Prof. D. S. Capper on the training of engineers, by Dr. R. M. Walmsley on the sandwich system as applied to day engineering students, and by Mr. R. Bunting on higher elementary education and the preliminary training of engineers. The next afternoon Sir Lauder Brunton will preside, and the teaching of domestic economy will be discussed. Mr. John Wilson will deliver an address on the correlation between the teaching of domestic economy and experimental science. Other subjects of discussion will be:—the organisation of higher schools; the teaching of number; methods of teaching in schools for the mentally defective, and educational experiments in schools. No charge is made for admission, and tickets may be obtained from the Chief Inspector, Education Department of the London County Council.

La Ligue du l'Éducation Familiale was founded in 1899, with the cooperation of the Belgian Government, to secure closer association between parents and teachers in the study and practice of educational methods. An international congress was held at Liége in 1905 to discuss the relationship of home life to education in school and college. A second similar congress was held in Milan in 1906. At the request of the Belgian Government a committee has been organised to bring to the attention of the British public the third International Congress, to be held in connection with the Brussels Exhibition, August 21–25, 1910. The Marquess of Londonderry has accepted the presidency of the committee, and Mr. Walter Runciman, President of the Board of Education, and Mr. Charles Trevelyan, Parliamentary Secretary to the Board, have been appointed vice-presidents. The necessity for intimate association of home and school influences if we are to obtain efficiency in education is becoming increasingly recognised, and the committee desires that parents and teachers will take full advantage of such an interchange of opinion as is offered by this congress.

The prize distribution at the Imperial College of Science and Technology, South Kensington, on Thursday, December 16, was chiefly noteworthy for the interesting address by Prof. Sedgwick, F.R.S., on scientific research, reprinted in another part of this issue. Lord Crewe, the chairman of the governing body, presided, this being the first occasion on which he has attended this annual function. In his opening remarks the chairman referred to the resignations of the rector (Dr. Bovey), Sir William Tilden and Prof. Gowland. The proceedings were enlivened by numerous interruptions from students of the Royal School of Mines, who, by shouting the name of the school, demonstrated that the individuality of the school has not been lost by the establishment of the Imperial College, of which it forms an "integral part." The vote of thanks to Lord Crewe for presiding was proposed by Sir Julius Wernher and seconded by Mr. Arthur Acland, who stated that the governing body has set aside the sum of 12,000*l*. for the establishment of a students' club. Lord Crewe, in responding, appealed for a double loyalty among the students—for their respective colleges on the one hand, and for the Imperial College on the other, the relation of which to the component colleges he compared to that of his own University of Cambridge to the Cambridge colleges. The associateship of the Royal College of Science was granted to forty-four students, and the associateship of the Royal School of Mines to thirty-four students.

The Mathematical Association and the Association of Public School Science Masters will hold their annual meetings next January in common, to a large extent. The meetings of both associations are to be held at Westminster School. On January 12, 1910, the Mathematical Association will hold its own meeting in the morning, when, after the business part of the agenda has been completed, addresses will be delivered by Mr. C. Godfrey on different methods in algebra teaching for different classes of students, by Prof. P. J. Harding on elliptic Trammels and Fagnano points, and by Mr. W. J. Dobbs on a patent inexpensive balance. During the afternoon of the same day a joint meeting will be held of both associations for the consideration of the report of the committee on the correlation of mathematical and science teaching. On January 13 the science masters will hold their annual meeting. The president for the year, Prof. H. E. Armstrong, F.R.S., will deliver his address, taking for his subject "The Future of Science in Our Schools." Afterwards Mr. Eccles, of Gresham's School, Holt, will read a paper dealing with the confusion existing in the symbols used in text-books on physics, and urging that some uniform system be introduced. In the afternoon Mr. L. Cumming, of Rugby School, will read a paper on the desirability of teaching all boys geology or biology during some portion of their school life; Mr. Cross, of King's School, Peterborough, will deal with laboratory equipment and design, and Mr. Oldham, of Dulwich College, on teaching oxidation and reduction. The usual exhibition of books and apparatus will be held.

The annual prize distribution of the Sir John Cass Technical Institute was held on December 16, when the awards were distributed by Dr. H. A. Miers, F.R.S., principal of the University of London. In the course of his address, Dr. Miers pointed out that success in competition is to be regarded as a special gift, because it is not everyone who is born to succeed in competing with his fellow men and women, and, moreover, success is not to be measured by the faculty of excelling others. No pleasure can surpass that of success in one's own work, and the problem in modern life is how to combine this conscious spirit of pleasure and pride in work with the totally different conditions in which it is carried out now as compared to those which existed in the old days of the guilds and apprenticeship in the City of London. The aim of technical institutions should be to make the students less of specialists and to give them more versatility and adaptability so as to enable them to find out new ways of pursuing their own work. It is true that in order to effect this many subsidiary subjects of study are necessary, but such subjects should be regarded as only representing the different principles of the more special subject of study, and should be worked out with enthusiasm and keenness from the point of view of their bearing upon the specific science or industry in question. New methods of work which may have a bearing in many directions of science are not made as accessible as they should be, owing to the extreme difficulty of reading research papers outside one's own special subject, a difficulty due to the fact that those who are pursuing scientific research and are studying scientific methods do not devote sufficient attention to expressing themselves in simple English. The student who goes out into the world with a keen interest, not only in his special work, but also in the other subjects which he had to learn as a student, and with some knowledge of the general principles underlying them all, will never feel helpless when he finds himself in new conditions and confronted by new problems. In conclusion, Dr. Miers pointed out that no educational work could be quite successful unless it is inspired by the spirit of research, and he welcomed the encouragement of research in the Sir John Cass Technical Institute, referring especially to the prizes awarded by the Goldsmiths' Company in metallurgy, and to the award by the Institution of Mining and Metallurgy of the "Consolidated Goldfields of South Africa premium of forty guineas" jointly to Mr. C. O. Bannister, the head of the metallurgy department, and to Mr. W. N. Stanley, a student in the department.

SOCIETIES AND ACADEMIES.

London.

Royal Society, December 9.—Sir Archibald Geikie, K.C.B., president, in the chair.—W. J. **Young**: The hexosephosphate formed by yeast-juice from hexose and phosphate.—L. S. **Dudgeon** and H. A. F. **Wilson**: On the presence of hæm-agglutinins, hæm-opsonins, and hæmolysins in the blood obtained from infectious and non-infectious diseases in man (third report). These results are based upon some hundreds of experimental observations which have been made upon normal and pathological blood, and are as follows:—(1) Auto-agglutination of the red blood cells, as tested for by the methods which we have employed, may be shown to occur with specimens of pathological blood only occasionally, but never with normal blood; and auto-hæmolysis has not been met with. (2) Iso-agglutination is often met with in specimens of blood obtained from patients suffering from the same disease. (3) Hæm-agglutination is largely a specific phenomenon, both in normal and pathological blood, and the specific effect can be shown to persist even if the red cells have been subjected to high degrees of temperature or to complete drying. (4) Hæm-agglutination and bacterial agglutination are distinct phenomena. (5) Well-marked isohæmolysis in specimens of normal and pathological blood is not common, although some degree of hæmolysis can frequently be demonstrated. (6) Concerning phagocytosis: It would appear necessary to avoid mixing specimens of normal or pathological blood, because just as samples of sera are known to vary in value, so do the leucocytes, although to a less extent, whether they are obtained from specimens of normal or pathological blood. Still further, by mixing samples of normal or pathological blood a hæmolytic action may be induced which in itself has been found capable of exciting abnormal results in phagocytosis. (7) It appears to be incorrect to regard a specimen of blood as normal until it has been subjected to a detailed examination by the methods referred to in this and the two previous communications, quite irrespective of its actual source. —L. **Doncaster**: Gametogenesis of the gallfly *Neuroterus lenticularis* (*Spathegaster baccarum*), part i. The cynipid *Neuroterus lenticularis* has two generations in the year, hatching in April and June. The April generation consists of females only, which lay parthenogenetic eggs. Evidence is given that some of these flies lay only eggs destined to become males, other flies only eggs which become females. The June generation thus consists of males and females; the eggs are fertilised and give rise to the generation which appears in April. In the spermatogenesis 10 chromosomes are found in the spermatogonial mitoses. In the spermatocytes, the first maturation division is abortive, only a small piece of cytoplasm with the centrosome being separated. In the second spermatocyte division 10 chromosomes appear and divide equally into the spermatids. The two spermatids are similar, except that one receives a small extra-nuclear body absent in the other. Somatic mitoses in the male show 20 chromosomes, except in the nerve-cells, which appear to contain 10 only. The eggs of the June generation undergo a double but irregular maturation division, apparently leaving 10 chromosomes in the pronucleus. Segmentation divisions in these eggs and body-cells in females of both generations show 20 chromosomes. The study of the maturation of the eggs of the spring (parthenogenetic) generation is not yet complete, but suggests that the eggs of some females undergo maturation and chromosome-reduction; those of others undergo no reduction. It is suggested that the former eggs yield males, the latter females. These observations, combined with (1) those of the author on the relation between sex and a somatic character in the moth Abraxas, (2) with the inheritance of such cases as colour-blindness, and (3) with the sex-relations of "heterochromosomes" in insects, lead to a hypothesis as to the nature of sex. It is suggested that there are male and female sex-determinants (symbols ♂, ♀) which behave as Mendelian characters, each being allelomorphic with its absence (symbol ⊙). Females have constitution ♀ ♂, and produce ♀ eggs and ♂ eggs; males have constitution ♂ ⊙, and produce ♂ and ⊙ spermatozoa. ♀ eggs are fertilised by ♂ spermatozoa, yielding females; ♂ eggs by ⊙ spermatozoa, yielding males.—Dr. E. **Schuster**: Preliminary note upon the cell lamination of the cerebral cortex of echidna, with an enumeration of the fibres in the cranial nerves.—Dr. F. W. **Mott**, Dr. E. **Schuster**, and Prof. W. D. **Halliburton**: cortical lamination and localisation in the brain of the marmoset. This research is one which has been carried out on lines similar to that previously published by two of the authors in relation to the brain of the lemur. A series of sections of the cerebral cortex has been examined in order to map out the extent and boundaries of the types of cell lamination observed. It is now well known that these differences are correlated with differences in function, and this method of histological localisation of function (as it may be termed) has been controlled by the physiological method of stimulation.—R. H. **Whitehouse**: The caudal fin of fishes (preliminary paper). The paper communicated is a summary of a fuller work on the caudal fin of fishes in general, but principally the Teleostei. It aims at a revision of the definitions of terms in general use, in order to disperse the vagueness surrounding these terms. Diphycercy is shown to be very vague, inasmuch as it does not specify the primary or secondary nature of the symmetry, and thus it may be dispensed with in favour of protocercy and gephyrocercy, the former of which implies primary, and the latter secondary, symmetry. Concerning heterocercy, the essential features of this condition are considered to be (1) an enlarged lower lobe, and (2) the retention of individual centra, when formed, to the end of the axis. The term "hypural" is introduced into this form, since there is evidence of these structures being formed by the union of radials and hæmal arches. Under homocercy, three varieties of fin-structure are discussed for the purpose of showing (1) the breadth of the term, (2) features which determine the degree of specialisation, and (3) the taxonomic value of the caudal. Evidences of caudal abbreviation are reviewed, and a re-defining of the term "epural" is given, by which this structure is considered the dorsal homologue of the ventral hypural. The presence of radials dorsally and ventrally is directed attention to, and also the composite nature of hypurals and epurals. Finally, evidence is given in support of the theory that the permanent homocercal caudal is a shifted anal, and, moreover, support is forthcoming among the Elasmobranchs.—H. E. **Arbuckle**: Some experiments with the venom of *Causus rhombeatus*.—Dr. V. H. **Veley** and Dr. A. D. **Waller**: The comparative action of stovaine and cocaine as measured by their direct effects upon the contractivity of isolated muscle. As tested by an independent method, these two drugs are found to be of approximately equal physiological action in correspondence with their affinity values.—Sir David **Bruce**, Captains A. E. **Hamerton**, H. R. **Bateman**, and F. P. **Mackie**: *Glossina palpalis* as a carrier of *Trypanosoma vivax* in Uganda.—Prof. W. M. **Hicks**: A critical study of spectral series, part i., the alkalies, H and He.—G. W. C. **Kaye**: The distribution of the Röntgen rays from a focus bulb. A Röntgen bulb was constructed with an antikathode the inclination of which to the beam of kathode rays could be varied at will. The bulb as a whole was also capable of rotation, and thus by the use of a stationary ionisation chamber, intensity distribution curves could be obtained for the X-rays. The hardness and intensity of the Röntgen rays were found to be almost independent of the obliquity of the antikathode. Some possible improvements in the modern focus bulb are suggested in the paper.—R. D. **Kleeman**: The direction of motion of the electrons ejected by the α particle. When an α particle collides with a molecule, we should expect that the direction of motion of the ejected electron depends on that of the α particle. If the whole or a part of the energy of ionisations is derived from the α particle, the electron should have a component of motion in the same direction as the direction of motion of the α particle. Some experiments to test this showed that when α particles are shot through thin metal foil more electrons are given off from the side of the foil where the α particles emerge than where they enter. This shows that the motion of the liberated electrons is on the whole in the same direction as that of the ionising α particle.—F. **Soddy** and A. J. **Berry**: Conduction of heat through rarefied gases. By the aid of the calcium absorption process of producing high vacua, the conductivity of twelve gases for heat has been determined at pressures so low that the actual path of the molecule is comparable with its mean free path (*cf.* Sir W. Crookes, Proc. Roy. Soc., 1880, 31, 239). By an electrical method the heat dissipated from a platinum strip, maintained at 61° in the gas, has been measured at various pressures down to a thermally perfect vacuum. As indicated by the kinetic theory, the heat dissipated at low pressure is proportional to the pressure, whereas at higher pressures it is independent of pressure. It was found that the conductivity in the first case bore no relation to that in the second. At all ordinary pressures hydrogen and helium are easily the best conductors, while of the gases examined carbon dioxide was the worst. At low pressure the conductivity of acetylene, methane, and cyanogen somewhat exceeded that of hydrogen, while helium was but slightly better than carbon dioxide. At low pressures the conductivity will be defined in terms of the calories ($x\ 10^{-8}$) dissipated per second, per 0·01 mm. of pressure, per sq. cm. of surface, per 1° difference of temperature between the surface and the wall of the containing vessel. The symbols K and Q will be used to express respectively the experimental and calculated values of the conductivity so defined. On the assumption that the heat interchange between the molecule and the surface it impinges upon is perfect, Q is the product of the number of impacts of the molecules per second per sq. cm. and the specific heat of the molecule. By the aid of the kinetic theory, Q may readily be approximately calculated from the mean molecular velocity and the molecular heat at constant volume. In the table the gases have been arranged in ascending order of K. In the second column, which gives the relative conductivity of the gas at ordinary pressures, the figures refer to the watts dissipated by the gas in the apparatus at pressures such that conductivity was independent of pressure. In the last three columns the values of K, Q, and of the ratio of K to Q, are given.

	Watts.	K.	Q.	K/Q.
Argon	1.07	1.30	1.20	1.09
Neon	2.35	1.76	1.70	1.04
Carbon dioxide ...	0.95	1.89	2.64	0.72
Oxygen	1.55	1.91	2.23	0.86
Helium	7.30	1.94	3.80	0.51
Carbon monoxide ...	1.37	1.96	2.38	0.82
Nitrous oxide ...	0.97	2.11	2.75	0.77
Nitrogen	1.44	2.21	2.35	0.94
Hydrogen	8.75	2.29	8.95	0.25
Cyanogen	0.97	2.35	—	—
Methane	2.81	2.70	3.95	0.68
Acetylene	1.24	2.75	3.82	0.72

For argon and neon the agreement between the observed and calculated conductivity is as good as can be expected, whereas for all the other gases the ratio is less than unity, and in the case of hydrogen and helium the divergence is especially marked. The results appear to afford the means of obtaining information concerning the nature of the single impact of the gas molecule with a surface. Whereas for the denser monatomic gases the interchange of energy appears perfect, for the more rapidly moving molecules of helium and hydrogen this is not the case. The results are preliminary, and the conclusions now tentatively suggested are being tested further with improved apparatus.—T. **Wright**: Harmonic tidal constants for certain Chinese and New Zealand ports.—S. **Kinoshita**: The photographic action of the α particles emitted from radio-active substances. The photographic action of α rays is quite distinct from that of light. There is no diminution in the action when the rays are screened by an absorbing substance, so long as they are capable of passing through the photographic film. In the case of light, the action varies with the intensity of the light, which decreases on passage through an absorbing screen. The photographic action of α rays is thus independent of the velocity of the rays and depends on the number of α particles, N, which passes through the film and can be expressed, when measured by the density, D, as

$$D = D_{max}\left(1 - e^{-CN}\right), \text{ where C is a constant.}$$

This formula can be theoretically deduced on the assumption that each halide grain is rendered capable of development when struck by a certain number of α particles. By counting the number of silver grains in the film exposed to a known number of α particles, it was found that each halide grain was rendered capable of development when struck by a single α particle. The mass of silver per unit area of a developed film, calculated from the number of grains and their average size (deduced from the constant, C, in the above equation) by a consideration of the theory of probability, agrees well with the value determined from the density and the photometric constant. The sensitiveness of a photographic film to α rays cannot be characterised by its inertia. A rapid plate is more sensitive to α rays than a slow plate, if density be taken as a criterion. The reverse holds, however, when the number of grains is considered, provided that the total amount of silver halide per unit area is the same in both cases. The authors have now this new method of counting single α particles, in addition to the electrical and scintillation methods. The photographic method should prove very valuable for counting very small numbers of α particles, since it is applicable to very weak sources by using very long exposures, and also to α particles having a very short range.—Hon. R. J. **Strutt**: The accumulation of helium in geological time, III. The present experiments refer to the amount of helium in zircon. This mineral is found in igneous rocks of all ages, and the experiments show clearly that the quantity of helium generated closely follows the geological age. This must not be taken to prove that they retain the whole of the helium generated within them by radio-active change, but rather that, as they all crystallise from fusion, they are all of similar structure, and retain a not very different fraction of the full quantity of gas in each case. The following table summarises the results. The last column shows the ratio of helium to radio-active matter (c.c. per gram of uranium oxide), thoria being reckoned as equivalent, in helium production, to 0.203 times its weight of U_3O_8:—

Locality.	Geological Age.	Per Gram of Zircon.			Helium Ratio.
		Helium cc. × 10 − 4	U_3O_8 Grams × 10 − 8.	ThO_2 Grams × 10 − 4.	
Vesuvius	Tertiary ...	<0.4	38.0	—	<0.01
Campbell I., New Zealand	Tertiary ...	0.807	3.17	8	0.223
Mayen, Eifel	Tertiary ...	1.14	12.7	0	0.090
Expailly, Auvergne ...	Tertiary ...	2.12	3.72	0	0.570
N.E. Tasmania	?	4.34	1.14	0	3.88
Brevig, Norway	Post Devonian	98.8	13.3	32.7	4.94
Cheyenne Cañon, Colorado	Palæozoic ...	193	12.8	11.4	12.8
Green River, Henderson Co., N. Carolina	Palæozoic ...	255	12.9	30.1	13.4
Ural Mts.	Palæozoic ...	300	6.34	46.5	19.0
Kimberley Diamond Mines	Palæozoic ...	323	10.8	1.32	29.2
Ceylon	Ancient ...	210	6.57	19.8	19.8
Ceylon	Ancient ...	283	10.1	4.0	26.0
Ceylon	Ancient ...	575	75.3	28.5	7.1
Sebastopol, Renfrew Co., Ontario, Canada	Archæan ...	114	1.83	0.92	56.6

Royal Anthropological Institute, December 14.—Mr. H. Balfour, past-president, in the chair.—E. **Torday**: Results of a recent ethnographical expedition to the Congo Free State. The expedition left England in October, 1907, and travelled by the Kasai and the Sankuru to the Ba-Songe country. The Ba-Songe are a tribe of the Ba-Luba people, whose affinities lie rather to the south. The next tribe visited was the Ba-Tetela, a cannibal people who occupy a large extent of country between the second and fifth degrees of southern latitude. These people seem to have been extending, gradually but steadily, south and west from the Lower Lomami. Their culture is interesting as exhibiting a transition between that of the forest and of the plains. Other tribes visited were the Bu-Shongo, the Akela, and the cannibal Ba-Nkutu, who seem to have cultural affinities with the northern Ba-Tetela. The Ba-Songo Meno, a term given to a large number of tribes on both banks of the Kasai between the Sankuru and the Mfini, were also visited. These tribes have never been investigated, and show great hostility to the white man. The western Bu-Shongo tribes were also visited. These people, originally migrants from the north, gained most of their culture from the tribes to the west, and it was with these people that the paper chiefly dealt, including the Ba-Kongo and the Bashi Lele, who represent the first waves of Bu-Shongo immigration into the country. With regard to history, it is a remarkable fact that the Bu-Shongo people have preserved their records. The name means people of the Shongo, the shongo being a weapon, now obsolete, which was the principal arm of offence in the early days. The chief drew a picture of this weapon in the sand, and it was unmistakably a throwing knife. Now the throwing knife as a weapon does not occur south of the great bend of the Congo. The argument, therefore, that the people originally came from the north is strengthened by this fact, as the north was the original home of the weapon. From evidence of language, tribal history, and culture, the original home of the people seems to have been the west central Sudan. The remainder of the paper dealt with the institutions, government, and religion of the people. The tribal organisation is extremely elaborate. At the head is the chief, but in certain points his mother appears to take precedence. There are also six great officers and a host of other officials. Although nominally absolute, the chief has little real power. The right to the throne descends in the female line, but a woman can only come to the throne if the male stock fails.

This is the theory. In practice the chief has the power practically of nominating his successor, as he can disinherit any likely claimant. In religion the Bu-Shongo believe in an all-powerful creator, but they pay no worship to him. Magic is largely practised. The spiritual nature of man is considered to consist of three elements, soul, double, and shadow. The soul only leaves the body at death, the double at both death and sleep, and the shadow only at death, the belief that a corpse cannot cast a shadow being current among the people. The nearest approach to true totemism as yet discovered in Africa was found among the western Bu-Shongo, where each person inherits from his father an Ikina, a plant or animal which he may not eat. This Ikina has no connection with tribal names, and the division into Ikina cuts across the division into tribes and villages. Persons possessing the same Ikina may not marry.

Royal Meteorological Society, December 15.—Mr. H. Mellish, president, in the chair.—Dr. W. N. **Shaw,** F.R.S.: The variations of currents of air indicated by simultaneous records of the direction and velocity of the wind. In order to form a mental picture of the changes which are taking place in the amount of air flowing past an anemometer, we need to take into account the changes of direction as well as the changes in velocity. The author had endeavoured to combine these in what he called a "vector diagram," and he pointed out some interesting results which he had obtained from such diagrams.—W. G. **Reed,** jun.: A critical examination of South American rainfall types. The object was to make a simple yet accurate map showing the seasonal distribution of rainfall in South America.—W. G. **Reed,** jun.: The study of phenomenal climatology. The suggestion has several times been made that treatment of weather elements by days and months is arbitrary and unnatural for places not within the tropics. The author points out that in latitudes subject to cyclones the distribution of weather elements depends largely upon the relation of cyclones and anticyclones, and he therefore suggests that the cyclone is a more rational unit than the day or the month.

EDINBURGH.

Royal Society, December 6.—Prof. Cossar Ewart, F.R.S., vice-president, in the chair.—Dr. D. C. L. **Fitzwilliams**: The short muscles of the hand of the agile gibbon (*Hylobates agilis*), with comments on the morphological position and function of the short muscles of the hand of man. The material was supplied by the late Prof. Cunningham. The extraordinary length of the upper limb of the agile gibbon, and the manner in which it uses the hook-like hand as it swings itself from tree to tree, have an influence upon the anatomy which can be clearly recognised, especially in regard to the muscles. Thus in the gibbon the muscles of the hand tend to wander down the phalanges. This is evidently a mechanical gain, and is a response to the demands of function. The paper contained an elaborate comparison of the layers of muscles in the hand of the gibbon with the arrangements in the human hand, the discussion being based upon the distribution of the three primitive layers which, according to Cunningham, characterise the typical mammalian manus.—G. **Green**: Waves in a dispersive medium resulting from a limited initial disturbance. Following up a former paper on group velocity, the author investigates the effect of the same initial disturbance in all media in which the velocity of an infinite train of regular waves is proportional to the wave-length. The results obtained are similar to those given by Prof. Burnside for water waves in his paper on deep-water waves resulting from a limited original disturbance, of which the paper is an extension. It is shown that in all the media considered the greatest disturbance at each point is inversely as the square root of the distance of the point from the place of the original disturbance, and the wave-length of the disturbance when greatest is the same for every point, being determined entirely by the form of the initial disturbance.—Dr. W. A. **Caspari**: The composition and character of oceanic Red Clay. The chemistry of this deposit, though it has received attention from several investigators, still presents uncertainties. At Sir John Murray's suggestion a re-investigation of the whole subject from the chemical standpoint was undertaken. Moreover, Sir John Murray's unique collection of deep-sea deposits afforded the opportunity of choosing a highly representative series of red clays from all parts of the world. The methods and the results of analysis are given in detail. Regarding the general question of the molecular constitution of submarine clays, the author concludes that these hydrous silicates are not so much definite chemical compounds or mixtures of such as agglutinates of colloidal silica, alumina, &c., in inconstant proportions. What the affinity is which binds the constituents together we do not know, but it is certainly not exclusively chemical. In the Red Clay areas we have a temperature of 1° C. to 3° C., pressures of 400 to 600 atmospheres, and a uniform medium (sea-water), conditions which give to deep-sea weathering features which sharply contrast with subaërial weathering. The degradation product has much the same composition all over the globe, and it is a more acid silicate than the corresponding continental material. Clearly silica can escape into the hydrosphere just as well as alkalies and alkaline earths. On the whole, there seems to be something approximating to a genuine equilibrium between Red Clay and sea-water. When the colloidal nature of Red Clay is realised, the invariable presence of calcium, magnesium, and alkalies causes no surprise. This retention of highly soluble matter may be ascribed to capillary action at the enormous surfaces presented by the fine grains of clay and their internal framework, but the possibility that chemical affinities are also exerted is not to be disregarded. Potassium, calcium, magnesium, and sodium are withdrawn, in approximately constant proportions, out of the sea-water. The order given is the order of their adsorbability, and is just the reverse of their abundance in sea-water.

PARIS.

Academy of Sciences, December 13.—M. Bouchard in the chair.—H. **Deslandres**: Arrangement of the large telescope at Meudon for the photography of comets. Application to the Halley comet. Details are given of the addition of a finder to the large telescope and its mode of use for keeping the image of the comet on a fixed point of the photographic plate.—H. **Deslandres** and A. **Bernard**: Preliminary note on the spectrum of the Halley comet. At the Lick Observatory W. Wright found this comet to give an absolutely continuous spectrum; the results obtained by the authors, on the contrary, show clear discontinuities in the spectrum. There is a possibility that two condensations noted in the ultra-violet are near the bands λ 388 and λ 391·45 found in the Morehouse comet. Further measurements are required, but it seems proved that the comet shines by its own light, part of which is due to incandescent gases.—H. **Poincaré**: A generalisation of the method of Jacobi.—M. **Coggia**: Observations of comets made at the Observatory of Marseilles with the Eichens 26-cm. equatorial. Data are given for Daniel's comet on December 9 and 10, and Halley's comet on December 2, 3, 4, 5, 8, 9, and 10.—Eugène **Bloch**: The Hertz photoelectric effect. The classification of metals in the order of their photoelectric effect is modified by the wave-length of the light employed.—G. A. **Hemsalech** and C. **de Watteville**: The line spectrum of calcium given by the oxy-acetylene blow-pipe. The spectrum approaches that of the arc in the number and intensity of the lines. The relation between the number of lines and the nature of the flame is discussed.—A. **Lafay**: An arrangement for the determination of very small differences of pressure. A silvered collodion film is displaced by the pressure to be measured and brought back to its original position electrostatically, an interference method being used to measure the displacement.—E. **Caudrelier**: The discharge of inductors. The influence of the primary condenser on the length of the spark.—Louis **Dunoyer**: The variation in the conductivity of glass with temperature.—P. A. **Guye** and N. **Zachariadès**: The reduction of weighings to a vacuum applied to the determination of atomic weights. A revision of the figures given in an earlier paper, in which the errors caused by the presence of occluded air in the salts weighed are determined. This occlusion of air results in the density assumed in the corrections to the weight in a vacuum being taken too low.—L. **Bruninghaus**: A relation between absorption and phosphorescence.—J. **Taffanel**: Experiments relating to the propagation of coal-dust explosions in mine workings. The inflammation of the coal-dust was started in these experiments either by exploding a small charge of dynamite or some cubic metres of a mixture of methane and air. Measurements of the velocity of propagation of the wave at varying distances from the firing point were made, and the effect of obstructions and changes in the direction of the gallery studied.—E. **Goutal**: The estimation of carbon monoxide in steel. In a previous paper the author has shown that during the solution of iron or steel in cupric chloride a small amount of carbon monoxide is given off, corresponding to about 0·006 per cent. of the carbon in the steel. The first experiments were carried out with iodine pentoxide as the oxidising agent; it is now shown that identical results are obtained when blood is used as the reagent. An amount of carbon monoxide of 0·0142 per cent. by weight represents the limit of saturation for solid steel.—Emm. **Pozzi-Escot**: The separation of vanadium, molybdenum, chromium, and nickel in special steels.—G. **Chesneau**: The analysis of niobites and tantalites. The proposed process is described in detail, and as an example of its application the complete analysis of a tantalite is given.—P. **Freundler**: Some *c*-oxyindazylic derivatives.—Marcel **Godchot**: Some derivatives of dicyclohexylphenylmethane.—M. **Chevalier**: The scientific expedition to eastern Africa, September and October, 1909.—L. **Trabut**: Some facts relating to the hybridation of Citrus and on the origin of *Citrus aurantium*.—E. **Coquidé**: The plurality of the types of vegetation in the peaty soils of the north of France.—A. **Prunet**: The resistance of the Japanese chestnut to disease (*maladie de l'encre*). The chestnut has been destroyed in various parts by a cryptogamic disease of the roots, and experiments have been made during the last six years on the possibility of replacing the French trees by an American or Japanese variety. The American tree did not resist the disease, but so far the Japanese tree appears to be immune. The latter grows well, and its introduction may have important economic consequences.—Paul **Becquerel**: The variations of *Zinnia elegans* under the action of traumatisms.—Émile **Gautrelet**: The partial transformation of fatty food materials by pepsic and pancreatic digestion *in vitro*. It is shown that mannites are the result of this partial digestion.—H. **Guillemard**, R. **Moog**, and G. **Regnier**: The dehydration of the organism by the pulmonary and cutaneous channels and its variation with altitude.—Maurice **Holderer**: The influence of the reaction of the medium on the filtration of the diastases. Sucrase from *Aspergillus niger* was chosen as the diastase for these experiments. In media neutral to phenolphthalein, this sucrase passes entirely through porcelain filters; in media neutral to methyl orange, the sucrase is completely retained by the filter.—R. **Anthony**: The elevation of *Zeugopterus punctatus* at the maritime laboratory of Saint-Vaast-la-Hougue.—L. **de Launay**: The characteristic features of hydrothermal springs.—Paul **Lemoine**: The magnitude of the shrinking produced by the folds of the Paris basin.—G. **Delépine**: The succession of fauna and the distribution of the facies of the Carboniferous limestone of Belgium.—René **Gambier** and Armand **Renier**: Observations on Pinakodendron.—E. A. **Martel**: The subterranean hydrology of the *massif* of Penè-Blanque or Arbas, Haute-Garonne.—Charles **Moureu** and A. **Lepape**: The gases from thermal springs: the presence of krypton and xenon. The gases from twenty-six springs were freed from gases other than the rare gases in the usual way. The residual rare gases were fractionated, firstly, by wood charcoal at the temperature of liquid air, thus separating the helium and neon, and the remainder further treated with charcoal at −23° C. The xenon and krypton were then obtained from the charcoal. These two gases were identified in every one of the waters examined. Blank experiments were also carried out to guard against the possibility of a leakage of air into the apparatus during the analyses, with negative results.

Calcutta.

Asiatic Society of Bengal, December 1.—W. A. **Inglis**: Rivers of Bengal. The author refers to Captain Hirst's article on the Kosi River, and discusses the general question of the construction of marginal embankments, which have for their object the prevention of the overflow of floods.—D. **Hooper**: The secretion of *Phromnia marginella*. In north-east India the larvæ of these insects secrete in the dry weather a saccharine substance, which gives to the plants they affect a snow-white appearance. The chief constituent of this deposit is dulcitol (dulcite). The Phromnias are frequently found upon Celastrus, Elæodenoton, and other species of Celastrinea, and it is interesting to know that chemists have isolated dulcitol from several plants of this natural order.—Hem Chandra **Das-Gupta**: A probable identity between *Clypeaster complanatus*, Duncan and Sladen, and *Clypeaster Duncanensis*, Noetling. The author gives reasons for thinking that *Clypeaster Duncanensis*, Noetl., was founded on large specimens of *Clypeaster complanatus*, Duncan and Sladen.

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