THURSDAY, JANUARY 23, 1908.

MANX ARCHÆOLOGY.

Manx Crosses; or the Inscribed and Sculptured Monuments of the Isle of Man from about the end of the Fifth to the beginning of the Thirteenth Century. By P. M. C. Kermode. Pp. xxii+221. (London: Bemrose and Sons, Ltd., 1907.) Price 63s. net.

THIS handsome volume contains notes and illustrations of the inscribed and sculptured stones of the Isle of Man from the time of its conversion to the end of the Scandinavian rule, that is to say, from the close of the fifth (?) to the beginning of the thirteenth century A.D. The individual descriptions are preceded by some ninety pages on the early history of the island and the leading features of the monuments as a whole. These are of great value for the study of Celtic art in general, and many readers—all, indeed, who are unable to study the crosses on the spot—will give them more attention than the remainder of the book. In view of this fact and the somewhat recondite nature of the subject, it may not be out of place if we touch on the more important of their contents before proceeding to speak of particular instances.

The earliest monuments in the island are, without question, the rude boulders inscribed with Oghams. In language, formula, and characters these do not differ from those of the fifth century in Pagan Munster, but if we are to judge from the frequency with which the names of Irish ecclesiastics occur in the appellations of the Manx keeils or chapels, and the dedications of the parish-churches, it seems reasonable to suppose that the Irish came to Man to christianise it, and that the Ogham writing was introduced by, and the stones erected to the memory of, Christians. The date of the conversion of the Celtic Manx is uncertain, but we know that it was in the sixth century that the Irish missionaries began to wander over Europe, and it would have been strange indeed if they had neglected a people so near at hand. The advance among them of the new creed, though never actually checked, was fated to be disturbed some three centuries later by the raids of the Vikings. They appeared in the Irish Sea in 798, and harried the island at intervals during a considerable period. At the end of the ninth or the beginning of the tenth century, it began to be definitely occupied by the Scandinavian invaders, and for the next hundred years it was ruled by the successors of Olaf the White, King of Dublin.

The Northmen, as we have said, did not attempt to stamp out Christianity among their Manx subjects; on the contrary, our author thinks it not unlikely that the Celtic church revived, and that the later Celtic pieces carved in relief and highly decorated were erected during this period. The conversion of the settlers themselves he shows ground for assigning to the first quarter of the eleventh century, and it is significant that after 1050 we hear of a Norwegian bishop, "Hroolwer or Hrolfr," who, according to the chronicle, was succeeded by another, William, before Godred Crovan began to reign in 1075. The year of Hroolwer's coming or death is unknown, but this mention of him enables us to fix approximately the date of our first Scandinavian monuments, which cannot be earlier than 1025 or 1030, and as in one of his inscriptions (Kirk Michael 74) Gaut claims to have made all the crosses in Man, we must suppose enough time to have elapsed for the late Celtic pieces to have been overlooked. Yet neither from this nor from the appearance of the Norwegian ecclesiastics should we be justified in assuming a break in the continuity of the Celtic Church; that there was no such thing is shown by the fact that the later Scandinavian pieces preserve the Celtic type, and are found on ancient sites dedicated to Celtic saints. But if its ascendency was undisputed by the Northmen it was fated to pass away before another power; the year 1170 saw the foundation of the Abbey of Rushen, and this resulted in the virtual subjection of the Manx hierarchy to the great English house of Furness. Under these new conditions the native school of art ceased to develop, the foreigners being opposed to anything savouring of paganism, such as the Runic inscriptions, or likely to interfere with the spread of Catholicism. The Gothic coffin-lid at Rushen may well have belonged to one of the last of the Scandinavian rulers. In any case it is unlikely that the specimens of Celtic art in the island are, any of them, later than the beginning of the thirteenth century.

From the circumstances of their production our author passes on to speak of their distribution and artistic features. As most of us are aware, they form part of the monumental system of the early British Church, which was an extension westward of that of Christian Rome in the period succeeding the death of Constantine. They will be found, however, to show distinct local peculiarities. Of the 116 pieces discussed in the book forty-five are classed as Scandinavian, seventy-one as of earlier date. Maughold has by far the greater number, thirty-seven; Michael comes next with ten, Braddan with nine. Both groups alike are of local rock, usually clay-slate, derived from the immediate neighbourhood. Almost all are sepulchral, and though described as crosses, they are, strictly speaking, cross-slabs, upright, rectangular blocks, varying from 2 feet 6 inches to 6 feet in height, by about fifteen to twenty-four inches wide, and from two to four inches thick. A few are wheel-headed or rounded; only in two late instances is the stone itself cruciform.

We are not surprised to find that the pre-Scandinavian monuments are more numerous in the old parishes Maughold, Braddan, Conchan, Rushen, Lonan and German. After the Ogham-stones already mentioned come a certain number with crosses incised, linear or in outline, all of them plain except for three with hexafoil and one with triquetra. A further stage is reached by those with the figure sculptured in relief. Of the stones of this group, seven show practically no decorative treatment, thirteen are plain or have decorations only of the simplest, crosslets, pellets, bosses, &c., while the remaining eighteen have geometrical designs, zoomorphic interlacings, and figure subjects. These latter are hard to date exactly, but they clearly reached down to the period of the Scandinavian occupation if they did not overlap it. We must not forget to mention, midway between the incised and decorated pieces, six monuments with sunk background or design.

These pre-Scandinavian crosses vary greatly in shape, particularly those of the earlier groups. Among those incised in outline we find some pure Latin, some equal-limbed, some with expanded arms, one crux ansata, &c. At first, at any rate, we are not confined to the type with recessed limbs and joined ends, which it is customary to associate with Celtic art, and which came to predominate here as in other Celtic countries. The art motives remind us, if anything, of those of the Irish school, but it would be a mistake to suppose that the Manx artists were slavish imitators of foreign models, Irish or otherwise. Some well-known designs, viz. the step, the key-fret, and the spiral, are feebly represented or altogether missing. Nor do we meet with the lacertine and bird-like figures with interlaced top-knots, tongues, tails and legs, which are regarded as Irish *par excellence,* the nearest approach being the dragon-plait on the fragment from Cardle (Maughold 60). On the other hand, these monuments boast a certain number of patterns, *e.g.* the double twist with diamond ring and the various developments of loop-plait, which cannot be matched elsewhere, and show originality of conception as well as technical skill.

Except at Maughold and Braddan, the Scandinavian monuments are most numerous where there are few or no Celtic, as at Andreas, Michael, and Jurby. A few pieces are unadorned—these are late, strange to say—the remainder are handsomely decorated on both fronts, sometimes even on the edges. As we have pointed out, this series is to all intents and purposes a continuation of the earlier one. The crosses are Celtic in form; the decorative treatment and the designs are of Celtic origin. For one feature, indeed, it is not indebted to any Celtic, or indeed any Christian, model; we allude, needless to say, to its inscriptions in Runes. These occur on twenty-six out of the total of forty-five stones, eighteen in the northern and eight in the southern district. All are Scandinavian, in the Norwegian tongue excepting, perhaps, that on Maughold 104, which Prof. Bugge believes to be in Swedish. The one Anglo-Saxon example occurs on a stone of the Celtic group.

A good deal of space is devoted to this subject, not only to the Runes of Man, but to runes in general, and we do not doubt that this section will prove of great value to the student. Though the designs on these monuments are based on Celtic types, it would be a mistake to imagine that the men who made them drew their inspiration from pieces already in the island. On the contrary, several of their patterns, the step, the divergent spiral, and the chevron, are entirely absent from the Celtic pieces. The tendril and the forms of link-twist introduced by Gaut, Mr. Kermode believes to have been suggested by the carved stones of Scotland and the north of England; the other designs on these later pieces he derives from the Celtic MSS., basing his view on the frequent use of the triquetra and other local peculiarities. The origin of the figure-drawing is harder to determine. It is true that some of the stones have zoomorphic patterns of Norse type, and scenes from Norse mythology. Yet for all that, these latter have no more in common with the drawings of Scandinavia proper, which are inferior and rare, or the Viking-pieces of the lake-district, than with the rude efforts of the Welsh or the later Irish work. They have some affinities with the drawings on the stones of East Scotland, but what we find on them for the most part are original representations taken direct from nature. Generally speaking, these Scandinavian monuments show less regard for accuracy, a bolder treatment, and greater freedom than the earlier pieces.

It remains to say something as to individual crosses, no easy task when the space is so limited, and there is so much to detain the artist and antiquarian. We must be content to touch very briefly on a few of those most worthy of attention. Of the stones of the Celtic group a great number are interesting mainly for the light they shed on the development of the figure or the design; the most striking in itself, far more striking than the more highly decorated pieces, is the stone found in the Calf of Man (50) with a unique example of the Byzantine treatment of the Crucifixion. We have alluded more than once to the Ogham stones of the fifth century Irish type. To these must be added two monuments, not Celtic, by the way, but Scandinavian, inscribed with scholastic or Pictish Oghams. On one of these, the beautiful Mal Lumkun Cross (Michael 104), along with Runic legends we find one of the earliest instances of the Ogham alphabet. Of the Latin inscriptions, that on Maughold 48 is perhaps the most interesting, the Guriat to whom it refers being connected in all probability with Cynan, King of Gwynedd, whose daughter Etthil he may be supposed to have married. The Anglian Runes on Braddan 25 form the word "Blagkimon," a known Anglo-Saxon personal name.

Among the Scandinavian monuments the most remarkable beyond a doubt, though not always the best preserved, are those with Norse mythological scenes (Jurby 93, Malew 94, Andreas 95, Bride 97, &c.). The representations of Sigurd slaying the dragon Fafni, or Heimdal blowing his horn, of Vidar spearing the Wolf, show great vigour and originality.

We have endeavoured to give an idea, however imperfect, of the contents of this long and interesting volume. We have but little to offer by way of criticism. One thing strikes us, and that is that the author is not of those antiquarians who are for ever wresting facts to support a theory. If anything, he is afraid of being thought dogmatic. In expressing his own opinions he is careful not to shut out possible alternatives. He agrees, for instance, with Mr. Romilly Allen in deriving the Celtic cross from the monogram of Constantine's dream; he points out, none the less, that it might well have been developed from a form similar to that of the lost cross at Braddan, with equal limbs and circles between them. So, too, in the chapter on runes already mentioned, he places at the disposal of the reader a complete *résumé* of all the views on the subject. Except for many repetitions the arrangement of the work is admirable, and the style, all things considered, unusually lucid. The erudition displayed in it is considerable, and the standard of accuracy a high one. Mr. Kermode may fairly claim to have bestowed on the student a lasting possession, and to have done for the Isle of Man what Dr. Anderson and the late Mr. Romilly Allen did for Scotland.

A word must be said in conclusion as to the plates, which greatly enhance the value of the work. They are taken, not from photographs, but from reduced copies, made with the greatest care, of full-sized drawings, founded on rubbings of the stones.

CHEMICAL AND PHYSICAL TABLES.

Van Nostrand's Chemical Annual, 1907. Edited by Dr. J. C. Olsen. Pp. x+496. (London: A. Constable and Co., Ltd., 1907.) Price 12*s*. 6*d*. net.

CHEMICAL and physical tables required by various kinds of chemists have been collected in this annual. Among the ninety-three tables it contains are five-figure logarithms, constants of the elements, some very complete tables of factors and their logarithms for the calculation of gas, volumetric and gravimetric analyses, constants of fats, oils and waxes, the more important constants (molecular weight, specific gravity, melting point, boiling point, solubility, crystalline form and colour) of some 4000 inorganic and 5000 organic compounds, specific gravities of solutions, vapour pressure, conversion, and heat of combustion tables. The remainder of the book is taken up with classified lists of the chemical papers and books published since the beginning of 1905, and an index.

This matter forms a volume which has been much needed, and will be most useful to all chemists. No pains have been spared to make many of the tables accurate and comprehensive, as, for example, the above-mentioned data for some 9000 compounds. The classified list of chemical papers, on account of its conciseness, should, if kept complete, be quite useful even to those who have the fuller abstracts of the Chemical and American Chemical Societies; the list of books will be even more valuable.

Unfortunately, references have been given only in a few cases to the original observers of the data used in the annual. In future editions such references should be made more complete. The following quantities are not defined:—electrical conductivities, specific heat of gases (whether C_p or C_v), and the various "constants" and "values" for oils, fats and waxes. To give Reichert-Meissl values without definition when two sets of values are current is confusing. The table of gas densities is quoted, unfortunately, from Landolt-Börnstein-Meyerhoffer Tabellen, where the densities are calculated on certain assumptions (clearly wrong in the light of the work of D. Berthelot, P. Guye, Lord Rayleigh and others) instead of being the observed densities; further, the values found by E. Morley for hydrogen and oxygen in his classic work are not given.

While laborious determinations are being made to improve the second decimal place of atomic weights, there are scarcely any other physico-chemical constants known to anything like the accuracy which atomic weights now have. The energies of many of the workers on atomic weights might now with great advantage be turned to improving the accuracy of many other constants. Boiling points are an example of this; scarcely any are known to $0^\circ{\cdot}1$, and many current values for the same substance differ by whole degrees. The boiling points of organic substances in this book are from Beilstein, yet for five out of the six esters we have tried, the very careful determinations of Young and Thomas are not given.

We have detected few misprints; the logarithm of 2011 is incorrect. The value of the inch in millimetres is given to eight places, or to 10^{-9} cm.; this is less than the accepted value for the diameter of an atom, and the minimum length visible. The boiling point of helium is given as -267°; we were not aware that it had been liquefied; Olszewski failed to do so by cooling it to a calculated temperature of -270°.

We know of no other tables of this kind in English which are so complete and so up to date as this annual. It is convenient in size, and clearly printed on good paper. The five-figure logarithms are the best arranged we have seen. T. H. L.

A NEW TEXT-BOOK OF PSYCHOLOGY.

Elements of Psychology. By Dr. S. H. Mellone and Margaret Drummond. Pp. xvi+483. (Edinburgh and London: W. Blackwood and Sons, 1907.) Price 5*s*. net.

THIS book is the joint work of two authors who are evidently well acquainted with the needs of the examinee, as well as those of the more genuine student of the science of psychology. It is therefore not surprising to find in the preface the statement that the book is intended as "a contribution to the *teaching* of psychology." Every stone of offence is carefully removed from the learner's path. Even the usual order of treatment is altered for his benefit. After a few introductory chapters on the method and subject-matter of the science, the student is brought face to face with the most essential characteristic of consciousness, viz. mental activity, and in its most pronounced form—volition. Not until the emotions and pleasure-pain have been treated with like fulness and concreteness do the authors descend to the conventional sequence of sensation, perception, &c. This order is determined by relative difficulty of introspection, the prominent complexes of mental life being taken before their more abstract elements.

It will thus be seen that the introspection standpoint is avowedly adopted as the fundamental one. Although the objective conditions of consciousness are by no means neglected, no attempt is made to develop that objective and functional view of mental life which is so popular in certain quarters at the present day, and, to the present writer's mind at least, seems so full of promise. The standard authorities—Ward, James, Stout, &c.—are closely followed, and to such good purpose that the book forms an excellent introduction to the study of these authorities themselves. A notable feature is the list of detailed references inserted at the end of each section.

Altogether, the book will be found admirably suited for its purpose, viz. to serve as a general text-book for pass examinations in the subject at a university, and will probably earn a well-deserved popularity. One is tempted, however, to look for something more in a text-book on such a science as psychology. The science is a comparatively new one, with an ever-broadening outlook, and a text-book such as we have before us might well be expected to extend or at least define this outlook by discussion of the most recent experimental results attained by psychologists, where they appear to involve important modification of theory. Yet we look in vain for any reference to the important experiments of Drs. Head and Rivers on cutaneous sensibility, or, again, to those of Prof. Sherrington on the relation between the two eyes in their response to intermittent light stimulations. A treatment of the latter would probably have reminded the authors likewise to discuss the general problem of psychical fusion, over which they preserve a disappointing silence. These are two instances out of several that might be quoted.

Objection might also be made to the method of treatment of the general psychophysical relation in the chapter headed "Mind and Brain." A more concrete and detailed discussion would have given greater relevance to the suspense of judgment therein advocated, or might even have opened up the prospect of a reconciliation of interactionism and parallelism on metaphysical lines. Not even a beginner is likely to be satisfied with a crude "either—or" in this case.

The book should be valuable alike to teachers and students, as being a compact, sound, and thorough statement of current views in psychology. W. B.

OUR BOOK SHELF.

Die Physik Roger Bacos. By Sebastian Vogl. Pp. 106. (Erlangen: Junge und Sohn, 1906.)

IN this dissertation, Dr. Vogl has collected a large number of interesting facts relating (i) to Roger Baco's, or, as we commonly say, Bacon's, biography, his education and his friends and colleagues; (ii) the literature of the Greeks, Romans, and Arabs, from which he derived his physical ideas; and (iii) his physical works. As the result of this study, Dr. Vogl has given us a typical insight into the state of science in the thirteenth century. Baco was born about the time that the Dominican and Franciscan orders were founded, and in these circumstances the position of a man who was far in advance of his times is not difficult to understand, especially in such an atmosphere as that of Oxford, where he remained until 1240.

As usually happens, Baco's claims to fame can hardly be said to be well understood even at the present time. Dr. Vogl considers that no great importance can be attached to his predictions of steam engines, flying machines, and other modern inventions, all of which only reproduce ideas current in Arabic and other writings. On the other hand, Dr. Vogl considers Baco has claims to be regarded as the founder of mathematical physics, and the large portion of the *opus majus* devoted to the uses of mathematics in science doubtless constitutes one of the most important advances with which Baco was associated. His physical writings dealt mainly with optical problems, and this is scarcely to be wondered at, for geometrical optics is the simplest and at the same time the most perfect branch of applied mathematics. When we remember the great hostility and apathy which exist at the present time against mathematicians in England (as exemplified by a remark on p. 49 of NATURE, November 21, 1907, if this is to be taken seriously), we cannot wonder that in an age of religious superstition and ignorance Baco fared badly. Although seven hundred years have elapsed, the world has not yet realised the great extent to which ignorance of mathematics is responsible for human crime, poverty, and misery.

The Preservation of Infant Life. A Guide for Health Visitors. By Emilia Kanthack. Pp. iv+92. (London: H. K. Lewis, 136 Gower Street, W.C.) Price 1s. net.

THIS small book consists of six lectures which were delivered by Miss Kanthack to voluntary health visitors in St. Pancras. In the words of Dr. J. F. J. Sykes, the medical officer of health of that borough, who has written a short preface, it "may be strongly recommended to those who intend to undertake health visiting amongst the poor."

It would be difficult to conceive of the subject of the preservation of infant life being better presented to the class of audience to which Miss Kanthack had to address herself, and the lectures furnish evidence of a considerable study of her subject, together with a sound practical acquaintance with it. They will well serve as models for those who may have to address similarly constituted audiences, and they may be read with pleasure and profit alike, not only by every woman health visitor, but by every educated woman. The information is so happily expressed and tellingly presented that one lays down the book with the sincere wish that Miss Kanthack may give us more.

In her opinion, personal influence is the keynote of success in dealing with infantile mortality. She emphasises the fact that the baby is an entity long before it is born; therefore, to give it a good start the mother must be looked after during pregnancy. Speaking of the dangers of the artificial feeding of infants, she makes the following stricture:—"If one of the brute creation refused to suckle its young it would be thought a monstrous violation of nature, and yet a woman may evade this natural function and it arouses no comments."

Sanitation in Daily Life. By Ellen H. Richards. Pp. ix+82. (Boston: Whitcomb and Barrows, 1907.) Price 60 cents net.

IT is now generally agreed that in every efficient school the pupils should receive instruction in the simple laws of personal hygiene and of public health. The short, bright chapters which this book contains on subjects like "the clean city," "the clean house," and "habits of cleanliness" should be of value to teachers, especially those in elementary schools, as indicating the possibility of explaining vitally important truths in a manner which can be understood by children. The illustrative experiments at the end of each section should be studied by teachers who give lessons on health.

Der neue Leitfaden. By L. M. de la Motte Tischbrock Pp. x+126. (London: John Murray, 1907.) Price 2s. 6d.

A SATISFACTORY course for students—juvenile or adult—commencing the study of the German language is provided in this book. In addition to being grammatically and educationally sound, and of good literary quality, the volume contains many extracts on scientific subjects as exercises for reading and translation.

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 Stresses in Masonry Dams.

IF Prof. E. Brown will refer again to my letter published in NATURE of January 2, he will see that I specifically stated that I did not question that in so far as the dam acted as a horizontal beam, the stresses $\widehat{xx}$ and $\widehat{zz}$ will be different in an actual dam and a slab dam. The real point is that Prof. Karl Pearson has said that, apart from any action of this kind, the stresses $\widehat{xx}$ and $\widehat{zz}$ in a slab dam and in an actual dam are widely different. Thus, on p. 11 of Pearson and Pollard's paper, he says Messrs. Wilson and Gore put the stress $\widehat{yy}$ zero, and "hence the vertical and horizontal pressures they calculated have no direct application to real dams." He has since explained in *Engineering*, September 20, 1907, that he did not here refer to any action of the kind mentioned by Prof. Brown and by myself in my original letter to you, but that, apart from any action of this kind, the stresses $\widehat{xx}$ and $\widehat{zz}$ are entirely different in a slab dam and a long dam. Messrs. Wilson and Gore deduced the stresses for their slab by the equations

$$\widehat{xx}=\frac{E}{\left(1-\frac{1}{m^2}\right)}\left(e_1+\frac{e_2}{m}\right)$$

$$\widehat{zz}=\frac{E}{\left(1-\frac{1}{m^2}\right)}\left(e_2+\frac{e_1}{m}\right),$$

where E is Young's modulus, e_1 and e_2 the measured strains, and m Poisson's ratio. So far as I can see, these equations give correctly the stresses $\widehat{xx}$ and $\widehat{zz}$ for the slab, and if my reasoning in my previous letter to you is correct, these stresses will be unaltered when the slab forms part of a complete dam and is then exposed to stresses $\widehat{yy}$ at right angles to the plane of the other two.

H. M. MARTIN.

83 St. James's Road, Croydon, January 10.

MAY I ask whether the interesting experiments on gelatin models of masonry dams, recorded in your issue for January 2, p. 209, do not ignore one factor on which the stability of actual dams is calculated largely to depend, namely, the weight of its materials?

This factor does not seem to be reproduced in the model, and I conceive that it may account for the rupture depicted on p. 210, which is hardly of a kind that one would expect to have to guard against in a real dam.

OLIVER LODGE.

MR. MARTIN in his letter to NATURE of January 2 cites the body stress-equations of elasticity

$$\left.\begin{aligned}\frac{d\widehat{xx}}{dx}+\frac{d\widehat{xz}}{dz}&=0\\ \frac{d\widehat{xz}}{dx}+\frac{d\widehat{zz}}{dz}+\rho g&=0\end{aligned}\right\}\quad\ldots\quad\text{(i)}$$

and appears entirely to overlook the fact that two equations will not suffice to determine the *three* stresses $\widehat{xx}$, $\widehat{zz}$, and $\widehat{xz}$. There is another relation between the stresses, and this relation depends on the relation between the strains, which is purely geometrical, namely,

$$\frac{d^2\sigma_{xz}}{dxdz}=\frac{d^2s_x}{dz^2}+\frac{d^2s_z}{dx^2}\quad\ldots\ldots\quad\text{(ii)}$$

In substituting for these strains in terms of the stresses the resulting third equation differs for the cases of the dam and of the slab.

For the case of the dam abutting at its terminals against rigid supports:—

$$4\frac{d^2\widehat{xz}}{dxdz}=2\eta\left(\frac{d^2}{dx^2}+\frac{d^2}{dz^2}\right)\left(\widehat{xx}+\widehat{zz}\right)+\left(\frac{d^2}{dz^2}-\frac{d^2}{dx^2}\right)\left(\widehat{xx}-\widehat{zz}\right)\ \text{(iii)}$$

For the slab with free faces:—

$$4\frac{d^2\widehat{xz}}{dxdz}=\frac{1+2\eta}{3-2\eta}\left(\frac{d^2}{dx^2}+\frac{d^2}{dz^2}\right)\left(\widehat{xx}+\widehat{zz}\right)+\left(\frac{d^2}{dz^2}-\frac{d^2}{dx^2}\right)\left(\widehat{xx}-\widehat{zz}\right)\quad\ldots\ \text{(iv)}$$

where η is Poisson's ratio.

Messrs. Wilson and Gore have determined their $\widehat{xx}$, $\widehat{zz}$, and $\widehat{xz}$ from measuring σ_{xz}, s_x, and s_z on an india-rubber slab with, I presume, $\eta=\frac{1}{2}$. Their values for these stresses therefore ought to satisfy (i) and (iv); it is difficult to understand how Mr. Martin can believe them to satisfy (i) and (iii) with $\eta=\frac{1}{4}$, which is needful in the case of the masonry dam.

To Sir Oliver Lodge I can only reply:—"Read our memoir and you will find that the influence of the weight of the dam is fully discussed, and experimentally determined. You will also find that the actual *tearing* was only reached by 'excessive water pressure.'"

With regard to Prof. Brown's views on the effect of the terminals, the following words are used to limit the actual theory applied:—"Let us suppose an indefinitely long dam, or if it be of finite length that its terminals abut against rigid supports." The words *abut against* were purposely used instead of *are built-in* to mark what conditions were being assumed. It is quite another point how far my theoretical dam may be considered an approximation to a real dam. Prof. Brown, emphasising the variability of conditions in any practical case, says that engineers "have used a simple but approximate method of estimating stresses in a dam, based on the flexure of beams." My criticism is that this is not an approximation at all, and that if it were they have neglected to apply their own conditions to the vertical sections, in which case they would have found any existing dam so lacking in stability that they would have promptly dropped a theory which, if carried to its logical conclusion, condemns all existing dams! Now, when an engineer treats a dam as a beam, he forgets two points:—(1) That the length of a beam must be large compared to the linear dimensions of the cross-section. In the case of the dam, its base, the built-in cross-section, is of the same dimension as to depth as the length of the beam, *i.e.* the height of the dam. The ordinary formulæ of flexure are thus absolutely inapplicable, as anyone who knows de Saint-Venant's classical memoir on flexure will at once realise. (2) That the faces of the beam must be free to expand in order that the theory may apply. In applying his theory of flexure, therefore, the engineer, so far from building-in his terminals, does not even suppose them to abut! I contend that if Prof. Brown's balcony were 100 feet broad, but *half a mile or a mile long*, he would find little difference in the stresses except relatively close to the abutments, whether he supposed the terminals abutted or were built-in. In any case, I am convinced on both theoretical and experimental grounds that for the bulk of the dam far better results will be obtained by applying the uniplanar equations of stress than by any attempt to deal with a solid practically as broad as it is long by a theory of flexure.

That the terminal conditions produce effects goes without saying; I agree with Prof. Brown that we should, if possible, consider them, but their order of importance is that of two terminal supports to a balcony, say 1 foot broad, 1 foot deep at the built-in edge, uniformly loaded, and perhaps 50 feet long. Such effects are purely secondary, and it will be time enough to consider them when we have reached some agreement as to the main stresses; these stresses can be fairly reached by taking, as I have done, an indefinitely long straight dam *abutting* against rigid terminals.

With most of Prof. Brown's statements in his appreciative criticism I am in complete harmony. No theory will replace local knowledge—that of the geologist as well as that of the engineer—no theory will perhaps be of equal value with past experience, but it can be helpful and even suggestive. Mr. Pollard and I did not smooth our observations, as has been done in some other cases, because it was desirable to show how much variability is due to local conditions, how much to observational error. Much of what Prof. Brown would attribute to want of homogeneity in our material I know to be due to the changes in external contour, and this is one of the urgent problems of dam construction. Our experimental work shows that very large changes are made by modification of the contour. Is it not possible to reach experimentally better forms for the flank of a dam than are at present in use?

The cost of experimental work on a suitable scale is prohibitive to the individual experimenter, but it appears to me that something on a really big scale ought to be done by the Institution of Civil Engineers. The problem is a very important one, and I do not believe, notwithstanding what I have read to the contrary, that the keen mathematician feels anything but intense awe in the presence of the creative engineer, who has succeeded, notwithstanding the weak-kneed theory provided by men of science, in producing such monumental works as the Assuan and Vyrnwy dams by the force of mechanical appreciation alone. KARL PEARSON.

The Nature of γ and X-Rays.

IN a letter to NATURE of October 31, 1907 (vol. lxxvi., p. 661), a copy of which arrived here recently, Mr. Barkla criticises a paper of mine which was published in the *Philosophical Magazine* for October. In that paper I tried to show how closely the properties of γ and X-rays were in agreement with the hypothesis that they consisted mainly at least of neutral pairs, and I pointed out that even the peculiar polarisation effects which Mr. Barkla had shown to exist might be explained, not unreasonably, as a consequence of the rotatory motion which such pairs would probably possess. I suggested that a pair might be more likely to become entangled with and deflected by an atom revolving in the same plane as itself.

Mr. Barkla describes an experiment in which he has measured the amount of scattering of X-rays in different directions, and compares his results with those which he expects to obtain as the result of calculations based on each of the two hypotheses in turn, that of the neutral pair and that of the ether pulse. He states the results to be against the former theory.

But for the result from his calculations in the case of the neutral pair, he makes the assumption that the probable direction of motion of a neutral pair on emergence from an atom with which it has been entangled is independent of its original direction of motion.

There is no justification for this assumption. It does not even appear to be probable. Consequently, the experiment has no value as a critical test. Yet I fully agree with Mr. Barkla that the dependence of the amount of secondary radiation upon the angle which its line of motion makes with that of the primary ray is a very proper subject of study; it might be expected to furnish much-wanted information.

For this reason I also have been investigating one aspect of this question. With the assistance of Mr. J. P. V. Madsen, of this University, I have been comparing the secondary radiations issuing from the two sides of a plate through which γ rays are passing. On the ether pulse theory there should be complete symmetry, provided that the rays have not been appreciably absorbed on their way through. Secondary radiation, whether material or not, originated in an atom by a passing pulse, is just as likely to go forwards as backwards. This is, indeed, always assumed by writers on the ether pulse theory, *e.g.* by Mr. Barkla himself in the letter already referred to.

On the other hand, if the γ rays are material, it is quite possible, though not necessary, that the secondary radiations on the two sides of the plate should be different.

As a matter of fact, there is the most remarkable want of symmetry, and this is fatal to the ether pulse theory of the γ rays. Moreover, all our experiments so far show that, on the whole, the kathode radiations from a given stratum of matter traversed by γ rays possess momentum in the original direction of motion of the rays, and this shows that the rays are material.

The experiments are very simple, and are not wholly new. The secondary kathode radiations due to a stream of rays impinging on a plate have been studied by many observers, who all concur in the statement that they increase with the atomic weight of the material of the radiating plate. For example, the figures for Pb, Al, and C are about as 100 to 30 to 15. In fact, they follow almost the same law as in the case of β particles. The reason for this will appear presently. The secondary kathode radiations that appear where γ rays *emerge* from a plate have been less studied, but Eve has shown that they consist largely of kathode particles, and Dawes (*Phys. Rev.*, xx., p. 182) that they do not appear to follow the same law as what may be called the "incidence" radiations. Further, Wigger has made the very important observation ("Jahrbuch der Radioaktivität," Bd. ii., pp. 428–430) that in certain circumstances the γ rays issuing from a plate of Al which they have traversed make *more* secondary rays than when they issue from Pb.

All these facts may be conveniently studied together. Let an ionisation chamber be made of cylindrical form with plane ends, and let a pencil of γ rays be directed along the axis. Let the rays first pass through a cm. or so of lead. Let them then pass through a pair of plates which can be inverted; a convenient pair may be made of a lead plate 1 mm. and a carbon plate 1 cm. thick; these are to form one end of the chamber. It will then be found that there is more current through the chamber when the C plate is next to it, and the "emergence" secondary rays are produced in the carbon, than when the Pb plate is next the chamber. But if the plate closing the other end of the chamber be at one time Pb, at another time C, the reverse effect occurs. At this plate "incidence" secondary rays are produced by the same pencil of γ rays, and these are greater when the plate which is struck is Pb than when it is C. The differences are of the order of 10 per cent., 20 per cent., up to 60 per cent., depending on the circumstances of the experiment. The materials and the form of chamber may be largely varied, but the same want of symmetry is always there.

It appears that the "emergence" radiations from the plate through which the γ rays have entered are more important than the "incidence" radiations from the other plate. The latter serves mainly as a reflector or scatterer of the rays from the former, and this is the reason why there is less current when it is formed of a material of smaller atomic weight, following the usual rule for β rays. This effect is a general one, and it serves to explain why all observers have found less kathode radiation due to γ rays from Al or C than from Pb, when actually the rays produce more from the former than the latter when they have been first sifted by a cm. or so of lead. A stream of γ rays contains β particles derived from the γ rays by the influence of the last substance traversed. It is the scattered portion of these which constitutes the main portion of the secondary radiations due to γ rays, and the reason why the incidence radiations run parallel to those of β rays is obvious. Nevertheless, there are small variations due to secondary rays formed in the material of the plate itself, the quantity of which is influenced by the nature, not only of this material, but of the screens through which the rays have previously passed. This is because the γ rays are heterogeneous, as first shown by Kleeman. It is when the rays have passed through some thickness of lead that they are acted on with greater effect by Al or C than by lead. The quantity of kathode radiation set free in the radiator itself depends on the quality of the rays as well as on the radiating material. The particles at first move mainly, perhaps entirely, in the original direction of motion of the γ rays, but are subsequently scattered, and contribute to some extent to the "incidence" secondary radiation. But the principal portion of the incidence radiation is due to β particles which were in the stream of γ rays before it struck the plate.

It would make this letter too long if I were to discuss these results with any fulness, or to show their relations to results already obtained. I hope to publish a fuller account in a short time. Meanwhile, I will point out that the experimental proof of the material nature of the γ rays carries with it, almost surely, a corresponding proof as regards the X-rays. The points of similarity are too numerous for it to be otherwise. Only, as I have said in the paper already quoted, there should, of course, be ether pulses in the X-ray stream, and the γ stream also for that matter, and it may possibly be these which have been the subject of experiment by Marx, and which show Mr. Barkla's polarisation effects. But I think it is certain that at least the γ rays are material, and those X-rays which give rise to a secondary kathode radiation of a speed due to a few thousand volts. W. H. BRAGG.

The University of Adelaide, South Australia,
December 12, 1907.

Drifted Ice-crystals.

THE accompanying photographs, showing the incipient freezing of the sea during severe frost on January 4 at

FIG. 1 – Bank of drifted Ice-crystals.

Littlehampton, may be of interest to readers of NATURE. They were taken about high water, at 11 a.m. A high

FIG. 2.—Layer of drifted Ice-crystals.

N.E. wind and the flowing tide had drifted ice-crystals formed on the surface of the sea into the slack water in the angle between the east side of the small pier and the shore, until they were collected in a viscous layer covering the whole angle. The layer seemed to be more than an inch thick.

The photographs show the border of ice-crystals thrown up on the beach, with a vertical front towards the sea about 18 inches high.

The effect disappeared rapidly when the tide began to fall. The timbers of the pier were thickly coated with ice at high-water mark, and as far above as the splashing reached, but remained perfectly clear below this line.

WALTER LEAF.

The Interpretation of Mendelian Phenomena.

DR. G. ARCHDALL REID has recently suggested (1) that Mendelian phenomena occur only under artificial conditions, and (2) that they are to be explained in terms, not of segregation, but of "latency" and "patency." As regards the latter contention, it appears to me that it would be justified if, in the case of experiments conducted under stringent conditions, dominant characteristics were, even occasionally, to appear in recessive generations or *vice versâ*; but if this is not the case it seems an abuse of language to describe a thing as "latent" which never gives any manifestation of its existence. Further, Dr. Reid's theory does not explain—as the Mendelian theory does—why these characteristics not only appear and disappear, but play this game of hide-and-seek in accordance with strict numerical rules.

As to the other point, that Mendelian phenomena are confined to cultivated varieties, it is extremely difficult to prove or disprove, because to ascertain the phenomena you must experiment, and to experiment is to place under artificial conditions. But the well-ascertained facts of conjugation and cell-mitosis, which Mr. R. H. Lock regards as affording considerable support to the doctrine of gametic purity, are certainly not confined to cultivated varieties. That all inheritance may be particulate was long ago suspected by Galton, who speaks of skin colour as possibly "a fine mosaic too minute for its elements to be distinguished in a general view" ("Natural Inheritance," p. 12).

May I suggest one line of inquiry that may possibly prove fruitful in competent hands? Is there any connection between the variability of a plant or animal and the number or size of its chromosomes? Man, for example, has a large number of chromosomes, and is extremely variable. The correspondence would no doubt be far from exact if we suppose with Mr. Lock that the biological units are not the chromosomes themselves, but the chromomeres or some even minuter subdivisions. But it might be assumed, at any rate as a first approximation, that the ultimate units were roughly proportional to the number and size of the chromosomes, and in that case species possessing many and large chromosomes would be likely to have a larger stock of the raw material of variation than their fellows. H. H. O'FARRELL.

East India United Service Club,
St. James's Square, S.W.,
December 30, 1907.

Musical Sands.

IN reply to Prof. Poynting's letter (NATURE, January 16), may I say that the article which appeared in NATURE (August 6, 1901) was only intended to supplement my paper of 1888, by recording the results of further investigations up to date, and to show that I claimed, both by analytical and synthetical methods, to have proved the theory previously dealt with in detail?

In that paper (1888) I rejected the conception that the notes emitted from musical sands were due to the vibration of the individual grains as separate particles, because the contact of one grain with another would prevent such vibrations, and suggested that the only other explanation possible was that certain grains, in *rubbing* one against another, might produce the required vibrations through surface friction.

The music from sands is a cumulative effect, and only possible under the prevalence of numerous favourable conditions, and I found that if I eliminated one apparently insignificant factor from the conditions upon which my theory was based, the production of musical sands artificially became impossible.

Until an artificial musical sand can be produced exclusively under the conditions suggested by Profs. Poynting and Thomson in "Sound," I submit that my explanation may be retained. CECIL CARUS-WILSON.

Filtration of Rain Water.

I WISH to ask the opinion of someone in regard to the filtration of rain water, and the removal of any sediment, before it finds its way into large underground cisterns holding fully 15,000 gallons.

It will not be difficult or costly to collect the water and pump it up for use in a large laundry. A pump can be worked by the engine close by.

The point is how to prevent a lot of smuts, &c., finding their way into the cisterns, which would necessitate the frequent removal of this stuff, an operation that would be both difficult and expensive.

Is there any way by which filtration can be carried out above ground?

I shall be glad to know of any way to meet the difficulty.

January 13. ENQUIRER.

THE HIGHLAND OVERTHRUSTS.[1]

THE controversy regarding the structure of the north-western Highlands was a disturbing factor in the progress of geology from 1819, when the problem was first raised by Macculloch, until it was closed in 1884 by Sir Archibald Geikie's announcement in NATURE (vol. xxxi., p. 29) that the generally accepted view could no longer be maintained. The NATURE article—perhaps the most sensational announcement in geological literature—was followed in 1888 by a report from six members of the Scottish Geological Survey (Messrs. Peach, Horne, Gunn, Clough, Hinxman, and Cadell), giving a summary of the evidence which they had collected as to the structure of the north-western Highlands; and it has taken another twenty years to complete the survey of the whole overthrust region and prepare the detailed observations for publication. The full results are now issued in an elaborate monograph, the most important and the cheapest publication ever issued by the British Geological Survey. It includes 700 crowded pages, 52 artistic and instructive plates, and a beautiful colour-printed geological map of the whole area on the scale of four miles to the inch. The price of the book is 10*s*. 6*d*. The Survey is to be congratulated on having secured for this memoir a style of production far superior to the usual standard, and on its issue at a price which should ensure for it a wide circulation.

The book no doubt suffers from the inevitable compromise between conflicting requirements. Many readers will never have the opportunity of visiting north-western Scotland, and they will seek in this volume for a clear statement of the general results; their needs are satisfied by the fine photographic plates of the scenery, which show the overthrust structures more clearly than they are often visible through the persistent mists of the west Highland hills, and by the masterly introductory statements by Dr. Horne in chapters i., iii., xxxii., and xl. (of the last of which Dr. Teall is joint author), and the corresponding chapters by Hinxman on the Torridonian, and by Horne and Peach on the Cambrian. The memoir has also to serve as a field handbook to those who can visit the district. Accordingly it has to give precise information, which cannot be too detailed, as to localities and sections. The bulk of the book consists of detailed local descriptions, written by Messrs. Peach, Horne, Clough, Hinxman, and the late W. Gunn, with notes by Cadell, Greenly, and Harker. A third group of geologists will turn to the volume for help in the investigation of other regions of crystalline schists, for nowhere has so large and comprehensive an area of these rocks been subjected to such a searching investigation. The conclusions of this work and the most important evidence are given in a detailed account by Dr. Teall of the gneisses, and altered sedimentary rocks associated with them. The appendix includes a list of fossils and fossiliferous localities, a chemical study of the Durness Dolomites by Dr. Pollard, and a full bibliography by Mr. D. Tait.

The book therefore combines chapters which can be read with advantage by any geological student and others which have to be judged as a collection of materials for reference by specialists. The memoir is appropriately edited by Sir Archibald Geikie, who started the work in 1883, and carefully supervised its progress for eighteen years, until his retirement from the Survey in 1901. It is doubtless due to his literary skill and sense of proportion that the book enjoys a greater uniformity in style and treatment than would be expected in a work extending over so many years, and written by so many men.

The history of the north-west Highlands controversy is summarised in a chapter by Dr. Horne, who lucidly states the results of all previously published geological work on the district. The geological interest of the area dates from the announcement by Macculloch, in 1819, of his discovery of fossiliferous rocks lying above gneisses, and covered by the gneisses and schists that form the great bulk of the Scottish Highlands. Murchison, with his keen scent for a good clue, visited the area, and he re-examined it after the discovery by C. Peach, in 1854, of the better fossils (now known to be Cambrian) in the Durness limestones. Murchison was convinced that the fossiliferous rocks were covered by the eastern gneisses, and, in accordance with the law of superposition, accepted the eastern gneisses as younger than the rocks beneath them. He regarded the fossils as Lower Silurian, and therefore did not shrink from the apparently inevitable corollary that most of the crystalline rocks of the Scottish Highlands are post-Lower Silurian in age. This conclusion had a world-wide influence. Similar crystalline schists form vast regions in all the continents, and they were at first regarded as all pre-Palæozoic; but if the Scottish schists are altered Palæozoic sediments, then the similar rocks elsewhere may include rocks of any geological age. To this day vast regions of schists and gneisses are mapped as altered Silurian, in consequence of Murchison's work on the north-west Highlands.

Murchison's views were at once opposed. The common-sense judgment of James Nicol showed him the improbability of Murchison's conclusions, and his keen and careful field-work revealed that the superimposing of schists over sediments was not an original arrangement, but was due to subsequent earth movements. The first controversy was short. Nicol's inter-

[1] Memoirs of the Geological Survey of Great Britain. The Geological Structure of the North-west Highlands of Scotland. By B. N. Peach, John Horne, the late W. Gunn, C. T. Clough and L. Hinxman, with Petrological Chapters and Notes by J. J. H. Teall. Edited by Sir A. Geikie. Pp. xviii+668; plates lii., map. (Glasgow: H.M. Stationery Office, 1907.) Price 10*s*. 6*d*.

pretation of the evidence had not the fascinating simplicity of the other theory, and it was not wholly right. The eastern and western gneisses are not simply repetitions of the same series, and Murchison was apparently right in his view that the upper gneisses and schists are an independent and younger series than the Lewisian gneisses, which underlie the Cambrian band to the west. Moreover, Nicol failed to realise that the apparent bedding planes in the eastern gneisses were not original, but secondary structures due to earth movements.

Murchison, with a theory attractive by its charming simplicity and far-reaching results, and right in his recognition of the essential differences between the eastern and western gneisses, swept his critic from the field. Nicol, disheartened by the fate of views which he knew to be essentially correct, practically gave up geological research, and went to his grave, his geology despised and his conclusions rejected—by all except his wife. In 1878, the year before Nicol's death, the controversy was re-opened by that geological knight-errant, Dr. Hicks, who ran a tilt against the Murchisonian theory. It survived his onslaught, but two years later it received an almost fatal blow from Prof. Bonney, who, by work near Loch Maree, demonstrated that some of the rocks of the eastern series were the old Lewisian gneiss brought up by faults. The establishment of this fact, which is described in the memoir as "the first important advance towards the solution of the problem of the succession in the north-west Highlands since the publication of Nicol's researches" (p. 23), was not enough, although it was supported by the work of Callaway and Hudleston. In 1882–3 Prof. Lapworth mapped in detail the classic sections on the shores of Loch Eriboll; he proved that the apparent sequence was deceptive, and that the eastern gneisses were older than the fossiliferous rocks, and had been placed above them by earth movements; and it was his crowning glory to recognise that many of the fine-grained, shale-like rocks, which look like comparatively unaltered sediments, are the most intensely altered rocks of the area; they consist, like ordinary shales, of fragments of primary rocks, but instead of having been formed by the usual agents of denudation and deposition, they are due to crushing along planes of earth movement.

Unconformability of Cambrian quartzites on Torridon sandstone. Loch Coire Mhic Fhearchair, Beinn Eighe, Ross-shire. Reproduced with the authority of the Controller of H. M. Stationery Office.

The close of the controversy was now near at hand. In 1883 Sir Archibald Geikie arranged for the detailed mapping of the Loch Eriboll district by the Geological Survey. The work was soon found to be far more complex than had been expected; it was attacked with invincible patience and thoroughness by the surveyors under Peach and Horne; the essential conclusions of Nicol and Lapworth were confirmed, and it was promptly announced in NATURE that the Murchisonian theory must be abandoned. In 1888 a preliminary report on the Survey's investigations was published by the Geological Society, but it has taken another nineteen years to extend the survey along the whole of the overthrust line, and to prepare the materials for publication.

The work is of the highest geological importance, and in spite of its necessary descriptive details, every page contains observations of interest. The account of the Torridonian series, for example, describes the oldest considerable land surface known, and some traces of fossils in these pre-Cambrian rocks. The part of most interest is the account of the movements by which the eastern gneisses have been overthrust on to the younger rocks. The movements have taken place along a line more than 100 miles in length, and have carried the rocks in places for ten miles westward. The thrusting forward of these hard rock slices has produced a most intricate system of faults, and extreme changes in the rocks, some of the fresh structures, as in the pseudo-rhyolites, simulating those of igneous rocks. The extent of the metamorphism is one of the secondary questions of most interest. Its range appears to be very variable; in places the alteration is confined within very narrow limits; elsewhere it may extend to a mile from the plane of movement; but it never appears to be regional, and evidence is given that some of the schists had their present structures before the great disturbances. The problems connected with the eastern schists are handled with reserve, as there seem to be marked differences of opinion as to their age and origin; but on the main question, the relation of the schists to the fossiliferous rocks, the memoir, with its convincing combination of fulness of detail and clearness of exposition, leaves no room for doubt.

J. W. GREGORY.

THE TOTAL SOLAR ECLIPSE OF JANUARY 3, 1908.

THE first cablegram, containing news relating to the eclipse of January 3, observed by the parties stationed on Flint Island in the South Pacific, reached this country on Saturday last. The cable was from Mr. F. K. McClean, and was dispatched immediately on his arrival at Auckland, New Zealand. It read as follows:—"Partial success, fine morning, heavy rain several minutes until totality; first minute cloudy, remainder clear. Four corona results; none spectrum; bad plates; other observers not developed. Campbell reports success."

The above news is really very satisfactory, because it was anticipated by those at home that the weather conditions which generally prevailed at that time of the year would most probably prevent any observations at all being made. There is, however, no doubt that the parties were very fortunate, since, according to the above account, the clouds only just cleared from the neighbourhood of the sun in time.

Those who have been on like expeditions will be able to picture to themselves the anxiety which must have prevailed among the observers as totality was approaching. The heavy rain must have necessitated the covering up of all the instruments, more especially the silvered mirrors and object glasses. The clearing up, after totality had begun, must have created a condition of affairs which was probably not legislated for in the "rehearsals" which had no doubt been daily gone through.

The fact that the length of totality was of four minutes' duration gave probably sufficient time for all the instruments to be brought into use. It is hoped, therefore, that a very complete record has been obtained of the latter portion of totality, and, if this be so, then the term "partial success" may be changed to complete success.

With regard to actual results obtained little is known at present. The reason of this is that the development of the negatives secured was not completed on the island. Mr. McClean provided himself with a dark room on board the steamer he had chartered, so he may have developed his corona negatives on his way back to Auckland. According to his cable four of the plates he exposed were successful, but the words "bad plates" seem to suggest that the results he obtained were not so good as they might have been.

Reuter reports that the observations of the different parties at Flint Island and Samoa were, generally speaking, fairly successful, and mentions specially that the bolometric measurements of the heat of the corona made at Samoa were successfully made.

WILLIAM J. S. LOCKYER.

THE BRITISH SCIENCE GUILD.

THE second annual meeting of the British Science Guild was held on January 15 at the Mansion House, the Lord Mayor being in the chair. The large assembly of fellows and members, and the presence of distinguished representatives of many departments of intellectual activity and national interest, show that the Guild is strengthening and extending its influence over a wide field.

The report, which was adopted, referred to the missionary work of the Guild in educating the public in the following terms:—

> The executive committee believes that in this direction the labours of the Guild are becoming more effective each year, and there is a gradually increasing volume of opinion chronicled or expressed in the daily and weekly Press in harmony with the main objects of the Guild.
>
> For this result a large debt of gratitude is due to the president, Mr. Haldane, who has taken many opportunities of expressing and emphasising the views of the Guild before large audiences in connection with various educational institutions.
>
> It is in the direction of primary education that the most rapid advance in public opinion has taken place, and on this the nation is to be congratulated, for it is on the proper education of the children that all future progress must ultimately depend. At the inaugural meeting of the Guild in 1905, the chairman of committees, in referring to the subject of education, pointed out that a complete education must be based upon things and thinking as well as words and memory, and that we want "one kind of education for everybody—the Best." Further, that no one should be stopped on his upward course save by his own incapacity; and that all impediments should be removed. These views are now being acted on in many places.
>
> The Guild is not alone in pointing out that our great commercial competitors are those lands where there is the greatest number of complete and State-aided universities, and in which as a consequence "all the national activities are carried on in the full light of modern science by men who have received a complete training both in science and the humanities, in close touch with the Governments."

Some of the City livery companies have shown great interest in the work of the Guild. The Clothworkers' Company has made a donation of 100*l.* to the funds, and the Drapers' Company one of 105*l.* This evidence of the interest taken in the movement is very gratifying, and it is hoped that other City companies will similarly assist in furthering the objects of the Guild.

Numerous subjects have occupied the attention of the executive committee during the year, and several deputations to various Ministers of State have been arranged. Among questions thus dealt with may be mentioned the amendment of patent laws, the anthropometric survey of school children and adults, and the prevention of pollution of rivers. Deputations had also been planned to the Colonial Premiers and in connection with vivisection licences, but subsequent circumstances made these unnecessary.

In addition to this work of the executive committee, committees have been appointed by the Guild to deal with education, inexpensive apparatus in science teaching, agriculture, chemical industries, the Franco-British Exhibition, postal reform, and biological subjects.

The question of university endowments has received the earnest attention of the Guild; and the following considerations relating to it are stated in the report:—

The necessity for increased endowment has been, to a large extent, conceded, especially by the last Chancellor of the Exchequer, Mr. Austen Chamberlain. In 1904 the then endowment was increased, and a still greater increase was promised. But it was pointed out that, until the universities themselves had considered to what extent they were willing to come under inspection, it was difficult to deal with the question of still higher endowments.

The existence of large college endowments at Oxford and Cambridge places these universities in a different position from the rest, although the small endowments of the universities themselves are felt as strongly as in the other universities.

The Scotch universities, like Oxford and Cambridge, receive no Government assistance. The University Act of 1889 gave to the Scotch universities, not as a boon or gratuity, but as an absolute right, 42,000*l.* a year. This represented obligations which the Government had taken upon itself when it assumed possession of property which belonged to the universities, and which, had it remained to them, would have brought in a larger revenue. In 1892, 30,000*l.* a year was added; it was not a special grant from Government, but came entirely from the Scottish Local Taxation Fund, in which no other part of the kingdom had any concern. England might, had it pleased, have assigned a share of the English Local Taxation Fund to the universities, but she did not do so.

Whether or no it is desirable that a large proportion of the college funds at Oxford and Cambridge be applied to various branches of real university teaching and of post-graduate research is a matter on which members of the Guild might have much to say.

It is also hoped that in time the new universities will be provided with funds for the establishment of hostels, such as the Oxford and Cambridge colleges are to a large extent. This provision, however, may fairly be made in the case of the newer, as of the older foundations, by private munificence, and not by Government aid.

The ultimate aim should be State, municipal, and private endowment for all universities.

Universities supported entirely by municipalities are impracticable, as the influence of a university must extend over a large area, which will increase as its specialisation is proceeded with; this renders the application of local rates, and therefore local control alone, unfair and undesirable.

It is possible that the old English universities themselves would be among the first to welcome an inquiry which might consider the best way of placing matters on a more satisfactory footing.

In July the question of a Royal Commission on the older universities was brought forward in the House of Lords by the Bishop of Birmingham. Lord Crewe, in communicating to the House the decision of the Government, stated, "it is important for us, before arriving at a final conclusion, to know what the most thoughtful and the most competent opinion at both universities really demands, and we also must either inform ourselves or be informed exactly what the universities cannot do of their own motion, and for what purposes legislation would be required."

In consequence of this decision no further action has so far been taken by the executive committee.

After the meeting had been opened, Mr. Haldane, Secretary of State for War, and president of the Guild, gave an address to the members. For the subjoined report of his remarks, and of those made by Dr. T. H. Warren, vice-chancellor of the University of Oxford, we are indebted to the *Times* of January 16:—

Mr. Haldane said that the Guild was a body of people who had come together for the purpose of organising interest in science, an interest which had not been, as they thought, sufficiently great. It also aimed at assisting those who had scientific objects to accomplish to find the means of accomplishing them. They endeavoured to stimulate successive Governments. Governments were very apt not to be quite as scientific as everybody might desire, and the most perfect embodiment of the work of the Guild was when they got the two functions combined. For instance, the War Minister in this country was apt to take an easy-going view of organisation, but if the president of the Guild was always at his elbow to remind him that what he was doing was unworthy of one who was acquainted with the principles of the Guild, then something was gained, and if the two happened to be rolled up into one person physically who could divide himself spiritually into two, then they had an ideal combination. It was encouraging to see signs of progress everywhere in this country. Only that morning he had seen the announcement that Mr. Wills had offered the University College of Bristol 100,000*l.* if it was incorporated into a University of Bristol. This enterprise would come within the range of the criticisms of those who complained of small universities, but the matter had been threshed out before the Privy Council when the question of the granting of a charter to the University of Liverpool came before it. The special committee of the Privy Council selected to give a judicial opinion on that question pronounced in favour of an increase in the number of universities in England. That policy had been carried out with the utmost success. An extraordinary development was going on just now in the direction of the application of science to industry. At Armstrong College, Newcastle, which was a part of the University of Durham, he found the other day a change which he could hardly have credited had he not witnessed it. In certain buildings there were organised the scientific foundations of the shipbuilding industry in a fashion which was beyond praise. The professors of mathematics, of engineering, of physics, of applied mechanics, of designing were all working with one purpose, which was to provide a school of the university type, for, among other people, those who were to be engaged in the practical business of shipbuilding. On the other hand, the shipbuilders on the Tyneside were sending up their young men in order that they might acquire knowledge of the principles of the construction of compound engines, and how to solve the thousand and one problems constantly coming up in the construction of a great liner. The effect of that was immense, not only in stimulating the interest in university work, but upon the great industries in the neighbourhood. He saw the same thing at Sheffield. Part of the university looked very much like a steelworks. There were places with great crucibles and all the apparatus for the purpose of casting steel. There were brawny workmen there, obviously come from the works, and students of the university were working with them and mastering that most important work of metallurgy. He did not suggest that they should bring down the university to the simple function of applying science to industry—far from it—but they would gladly see in our provincial centres, which the Universities of Oxford and Cambridge could not reach, facilities given which existed in other countries, but did not exist in our own country. He wished God-speed to the new enterprise, and he knew that his colleague in the Government, Mr. Birrell, who sat for the city of Bristol, was deeply interested, like himself, in the success of the movement. This year, moreover, the Government had in its programme the giving of teaching of a university type in an enlarged and extended degree to Ireland. Ireland had one great university, the University of Dublin, consisting of Trinity College, but they felt that, valuable as was the work and greatly to be reverenced which the University of Dublin had done, it could not provide for the needs of the Irish people, who suffered much from there being no outlook, no career for the talent of their young men, and particularly of the Catholic and middle classes. The Government had to provide education, not of a sectarian kind, but in an atmosphere which would not offend sectarian prejudices. The negative was a very different thing from the affirmative in that matter, and if that was attained he did not see why education could not be given to Belfast and Dublin, to the Presbyterians and Catholics of Ireland alike, an education of a university type which would not run athwart those feelings and considerations which obtained to so high a degree among the Irish people. That was a step in the direction of solving a very difficult problem which had embarrassed Governments before now and which might embarrass this one, but they hoped to try, and it was a sign of the times that they should try. In Scotland a step forward in the spirit of that guild had been taken very recently. They had brought the teachers into close relation with the Scottish universities. The training of those teachers used to be undertaken by the churches. It was no want of reverence or respect for the churches which led him, speaking from that platform, to say that in Scotland they preferred that the universities should train their teachers rather than that they should be trained in any denominational atmosphere, however excellent. He was not touching in the least on the question of denominational colleges. The university, after all, ought to be at the head of education, and to permeate downwards, and could not do that unless it trained the teachers for the work. It was not only in the direction of university teaching that the signs of the permeation of the new spirit were to be seen, and in the departments of the Government numerous little things had happened lately to show how progress was being made. In these days science was becoming more and more of moment in the race between nations. No industrial community could retain its place unless it had got the highest science at its disposal. If he were to adopt a motto for that guild, it would be the motto of a German trade association, which ran :—" Science is the golden guiding star of practice; without science there can be only a blind groping about in the region of undefined possibilities." The change that had come over things in the last fifty or sixty years was immense. Without science no one could organise his business; without science no nation could keep its place in the van. Therefore he said that one of the great responsibilities of a nation was not only to keep her knowledge in the minds of a few individuals abreast of the age, not only to produce her Kelvins and her Darwins, but to see that her science was disseminated, and that it had entered the minds and actuated the endeavours of her captains of industry generally. That was the creed of that guild, and that was the lesson which they had come together to endeavour to teach.

In moving the adoption of the report, the Vice-Chancellor of Oxford said that in the report they would find some remarks and some criticism, implied rather than developed, upon the older universities. Speaking for Oxford, he did not deprecate that criticism. He desired measures and large measures of reform in Oxford and her colleges. He did not agree with his friend the Bishop of Birmingham in invoking as a first step the interference of the State. He would like to see Oxford reform herself. But he fully recognised that when the Government had given her, as it had, this opportunity of doing so, if she failed to use that opportunity this Government, or any other Government, would have strong justification for stepping in and reforming her from outside. He wished to see reform both in her constitution and her curriculum, both in the colleges and the university. On what lines should that reform proceed? He would say on the lines indicated by the British Science Guild. They would find in the report a suggestion that college funds might be more largely used to aid the university. He believed they might, and he believed they ought to be more largely used in this way. But they would find also a recommendation that the new universities should be provided with funds to establish hostels such as the colleges at Oxford and Cambridge very largely were. He took it that the British Science Guild did not want to abolish the colleges. He certainly thought that would be a pity. Hostels they were, but they were something more than hostels. Some would say they were only glorified hostels. He would say they were glorious hostels. Trinity College and King's College at Cambridge and Christ Church and New College and Magdalen at Oxford—he thought all who knew them would agree that they merited that description, and that their glory was part of the educating influence and the attracting spell of the older universities, that they were an academic, aye! and a national asset which it would be folly to throw away or destroy. In the appendix to the report there were some remarks about the tardy and sluggish response on behalf of the private benefactor to the appeal of the University of Cambridge, to the unattractiveness of the universities generally to the benefactor. To bring that appendix up to date mention should be made of a new fact. The president had brought the report up to date by referring to the splendid gift that was announced in the *Times* of that morning, the gift that one of the heads of a great and generous family in the ancient city of Bristol had made to its college. Might he, as an old Bristolian, ask them to send their thanks to that generous family which had already done so much for that city, and had now come forward with this benefaction? He remembered the famous motto in which Bob Lowe suggested that money might be made out of matches—*ex luce lucellum*. He thought the Wills family had taken a better motto. Theirs seemed to be *ex fumo dare lucem*. They had all read, a few weeks ago, of the magnificent bequest left by Sir W. Pearce to the Royal and religious foundation of Trinity College, Cambridge—money made, by the way, in applied science; it was enough to make, and he believed made, mouths water, not only in the University of Cambridge, but in the other colleges of Cambridge, and in some colleges in Oxford too. For his part he welcomed that bequest. He congratulated his old friends of Trinity College. It was a great example. If Trinity used it well, and he believed the college of Newton and Clerk Maxwell, and Macaulay and Tennyson, would use it well for the public benefit of the university, not for any self-aggrandisement, it would be a greater example still, and might well prove contagious. He thought that college funds should be used much more largely for the university, and that the college should be brought into closer and more responsible relation with the university. He thought, too, that the university needed reform in its curriculum. If there was anything about which he had been persistently keen all through his academic course it had been the desire to introduce science into the regular and compulsory curriculum of Oxford, to ensure that everyone who took the ordinary degree should at least know what science and the scientific attitude of mind were like. But he did not want literature excluded. The ideal was, he thought, that all literary men should be scientific and scientific men literary. The highest ideal, to his mind, would be that Oxford scientific men should know Greek, for Greek literature was the most educating literature, and the Greek language the finest language that an Englishman could study. But he was afraid that was not practicable, and if they were not to know Greek, they should know our own splendid literature, the next in fertility and force to that of Greece. They should know, too, the lucidity of French and the philosophy of German. If they could not study Sophocles and Plato, let them at least study Bacon and Pascal, Goethe and Tennyson.

Sir A. Geikie, K.C.B., Sec.R.S., in seconding the motion, remarked that one great function of the Guild is to lose no opportunity of saying a word in season and out of season to educate the Government and the people to realise that, unless we have a scientific spirit and method, we cannot compete with nations which are working in that spirit and by that method.

After the adoption of the report, the following vice-presidents were appointed upon the proposal of Sir William Bousfield, seconded by Sir John Rhys :—Lord Curzon, the Rev. the Hon. E. Lyttelton, Lord Iveagh, and the Prime Ministers of Australia, Cape Colony, New Zealand, and Natal.

Sir E. Busk moved, and Mr. F. Verney, M.P., seconded, a resolution, which was carried, approving of the members of the executive committee. Prof. R. Meldola, F.R.S., then moved a vote of thanks to the

Lord Mayor, and in the course of his remarks referred to the attitude of science toward the public and of the public toward science; he pointed out that although there are branches of science which cannot be popularised, the practical results can be described.

The vote of thanks was heartily accorded, and the Lord Mayor having briefly acknowledged it, the meeting dispersed. The following telegram was dispatched to the Lord Mayor of Bristol:—

"Lord Mayor of London, on behalf of British Science Guild at annual meeting, sends warm congratulations to Lord Mayor and city of Bristol on generous munificence of Mr. Wills to Bristol University College, and hopes soon to welcome University of Bristol."

The following reply was subsequently received from the Lord Mayor of Bristol:—

"On behalf of my fellow-citizens and myself I beg to thank your lordship and the British Science Guild for your warm congratulations on the munificent promise towards the endowment of a Bristol University by our fellow-citizen, Mr. Harry Overton Wills."

J. MACFARLANE GRAY.

WE regret to announce the death of Mr. John Macfarlane Gray on January 14, at his residence in Edinburgh, in his seventy-sixth year. Mr. Gray had a varied experience as an engineer, and was for many years chief examiner for marine engineers at the Board of Trade. The work which first brought him into prominence was his invention in 1866 of the steam steering gear which was first applied to the *Great Eastern*. The results led eventually to the general adoption of the system. Mr. Gray contributed numerous important papers to the various institutions to which he belonged, and frequently took part in discussions at the meetings, his contributions being characterised by pawky humour and sound knowledge of the subject. His contributions to scientific knowledge were for a time curtailed by the action of the Board of Trade, who, on the ground that the individual opinion of any of their engineering officers must not be made public, refused him permission to discuss the report of a research committee of the Institution of Mechanical Engineers. Fortunately he had previously been able to publish the results of his important investigation of the Theta-Phi diagram.

The most valuable of Mr. Gray's papers were probably those on the theoretical duty of heat in the steam engine (Institution of Naval Architects, 1885); the ether pressure theory of thermodynamics applied to steam (*ibid.*, 1889); the rationalisation of Regnault's experiments on steam (Institution of Mechanical Engineers, 1889, and Royal Society, 1900); and the variable and absolute specific heats of water (Institution of Civil Engineers, 1901).

Mr. Gray was a member of the Institution of Mechanical Engineers. He was a vice-president of the Institution of Naval Architects, and vice-president of the Institution of Marine Engineers from its inception. Of humble origin, he was essentially a self-trained engineer, and his early training undoubtedly influenced his attitude towards scientific research, his independence of judgment being specially noticeable. His seventy-six years show a record of useful activity, and he may be said to have created a field of investigation for younger engineers, who have fully recognised the influence of his guidance. An excellent portrait of Mr. Gray accompanies the lengthy biography published in *Engineering* of January 17, from which source these brief particulars have been drawn.

NOTES.

WE regret to see the announcement of the death, on January 4, of Prof. C. A. Young, for many years professor of astronomy at Princeton University, at the age of seventy-three.

DR. FEODOR ČERNYSHEV, St. Petersburg, has been elected a foreign correspondent of the Geological Society of London.

PROF. REGINALD W. BROCK, professor of geology in the Queen's University, Kingston, has been appointed director of the Geological Survey of Canada.

AT the annual meeting of the Royal Meteorological Society on January 15, the Symons memorial gold medal was presented to M. Leon Teisserenc de Bort, of Paris, "in consideration of the distinguished work which he has done in connection with meteorological science, especially the study of the upper air."

THE freedom of the city of Glasgow was conferred upon Lord Lister on Tuesday at a large and representative meeting of citizens, over which the Lord Provost, Sir William Bilsland, presided. In making the presentation, the Lord Provost recalled Lord Lister's connection with the city while professor of surgery at the University and visiting surgeon at the Royal Infirmary, where he achieved world-wide distinction as an investigator and a surgeon by discovering and perfecting the antiseptic system of treating wounds, which marked a new epoch in modern surgery. Lord Lister was unable to be present at the meeting owing to his condition of health, but a letter was read from him in which he said:—"Having in due time been elected by the managers of the Royal Infirmary as surgeon to that institution, I experienced uniform consideration at their hands when applying to the treatment of wounds the great truth which had been recently revealed by the illustrious Pasteur regarding the nature of fermentative changes in organic substance. That truth, though it seemed to me to shine clear as daylight from Pasteur's writings, was for many years not generally recognised, and thus it was my privilege to witness in my own practice, as the application of the principle became greatly improved, the revelation of pathological truths of fundamental importance and a revolution in practical surgery, and I looked upon the years spent in your city as the happiest period in my life."

ON Tuesday next, January 28, Prof. F. J. Haverfield will deliver the first of two lectures at the Royal Institution on Roman Britain. The Friday evening discourse on January 31 will be delivered by Prof. Rutherford, on recent researches on radio-activity, and on February 14 by Dr. C. W. Saleeby, on biology and history. The discourse on March 13 will be delivered by Signor G. Marconi, his subject being Transatlantic wireless telegraphy.

AT the annual meeting of the Entomological Society on January 15, the following fellows were elected as officers and to serve on the council for the session 1908–9:—*President*, Mr. C. O. Waterhouse; *treasurer*, Mr. A. H. Jones; *secretaries*, Mr. H. Rowland-Brown and Commander J. J. Walker; *librarian*, Mr. G. C. Champion; *other members of the council*, Dr. T. A. Chapman, Mr. A. J. Chitty, Mr. A. Harrison, Mr. W. J. Kaye, Dr. G. B. Longstaff, Mr. H. Main, Mr. G. A. K. Marshall, Prof. R. Meldola, F.R.S., Prof. L. C. Miall, F.R.S., Prof. E. B. Poulton, F.R.S., Mr. R. Shelford, and Mr. G. H. Verrall. The president read his address, which dealt chiefly with the present unsatisfactory state of nomenclature in entomological science. He also advocated the establishment of a central "type" museum, on the lines of an experimental collection now formed at South Kensington, for the purpose of loaning specimens to institutions, whereby it was suggested that the existing confusion might be avoided, and the general work of identification made easier.

At a meeting of friends of the late John Samuel Budgett held in Cambridge on February 8, 1904, it was decided to perpetuate his memory by the publication of a memorial volume which should contain reprints of his various zoological papers, together with descriptions of the more important material brought back by him on his various expeditions. The syndics of the Cambridge University Press undertook the responsibilities of publication, the necessary expenses of illustration being met by a fund subscribed by Budgett's friends. The volume has been edited by Prof. Graham Kerr, and Mr. A. E. Shipley, honorary treasurer of the fund, has contributed a biographical sketch. The preparation of the volume has taken a considerable time, particularly the working through of the extensive embryological material of Gymnarchus and Polypterus so as to make it possible to give a fairly complete sketch of the development of these forms.

We regret to announce the death of Dr. H. G. Knaggs in his seventy-sixth year. Though little known to the present generation of entomologists, his name deserves to be honoured as that of one of the founders of the *Entomologists' Monthly Magazine* in 1864. At that time he possessed one of the finest collections of British Lepidoptera in existence, but ten years later he found that his professional engagements required all his attention, so he sold his collection and withdrew from the staff of the magazine, to which, however, he continued to contribute occasionally up to July, 1906. He also published one or two small books and pamphlets, especially "The Lepidopterist's Guide," one of the most useful publications on the collection and preservation of these insects which we possess. It originally appeared in separate papers in the early volumes of the *Entomologists' Monthly Magazine*, and was afterwards enlarged and published in book form, and has gone through several editions. Dr. Knaggs was born on March 21, 1832, in High Street, Camden Town, and was educated at University College School, and trained for the medical profession at University College Hospital. He practised as a medical man in Kentish Town and Camden Town until about ten years ago, when he retired in consequence of ill-health, and settled at Folkestone, where he died after a long and painful illness on January 16. His remains were interred in Highgate Cemetery on January 20, in the presence of a small company of relatives and friends.

Nos. 5 and 7 of vol. li. of the Bulletin of the Museum of Comparative Zoology at Harvard College are devoted to echinoderms. In the former, Messrs. A. Alexander and H. L. Clark describe the echinuses collected during the cruise of the *Albatross* in the North Pacific. In the latter, Mr. Clark publishes a revision of the Cydaris group, with a full account of the intricate questions connected with nomenclature.

The "waltzing instinct" in ostriches forms the subject of an article by Dr. J. E. Duerden in the Journal of the South African Ornithologists' Union for December, 1907. Ostriches, it appears, are in the habit of running off suddenly with a peculiar whirling movement, sometimes one way, sometimes another, simultaneously spreading their wings, which are alternately raised and depressed. These movements, the author suggests, may be connected with escape from the clutches of the large Carnivora. "Indulged in instinctively as play while young, and even when adult, the performance gives the bird expertness in the rapid jerking movements which are those first followed on alarm."

The use of chrysanthemum powder as a means of destroying mosquitoes in houses is strongly recommended by Dr. A. L. Herrera, of Mexico City, in a paper published in the Proceedings of the nineteenth annual meeting of the Association of American Economic Entomologists (U.S. Department of Agriculture, Entomological Bulletin No. 67). Care has to be exercised in order to avoid the production of throat-inflammation in the operator, and also against ignition, but if proper precautions are taken in these respects, the powder seems to produce most satisfactory results. The consumption of the powder has largely increased during the last year, while the sale of tablets, which only paralyse the insects, and at the same time give off noxious fumes, has shown a corresponding decrease.

An interesting addition to the exhibition galleries of the British Museum (Natural History) has been made in the shape of a copy of a water-colour drawing made about 1585 by John White, containing the earliest known representation of the American king-crab, *Limulus polyphemus*. John White, who was one of the first settlers in Virginia, of which he was for some time Governor, served as lieutenant to Sir Walter Raleigh. In three volumes of drawings by him preserved in the department of prints and drawings in the British Museum, many of the delineations of natural objects are of great beauty, and show a fidelity to nature rare at the period. The drawing in which the king-crab is depicted was engraved, with some modifications, for de Bry's "America" ("Grands Voyages," part i., pl. 13) in 1590. In the engraving the king-crab is, however, shown in somewhat greater detail, thus suggesting that the engraver had an actual specimen or another drawing from which to copy.

It is encouraging to find Dr. Whitehead, Bishop of Madras, giving an example to other missionaries of the true method of dealing with the beliefs of those non-Aryan tribes which offer the most promising field for Christian work in India. He is, we believe, a comparative stranger to the people of the south, and hence his essay lacks that intimate familiarity with these strange cults which is essential to one whose mission is to comprehend and refute them. But in his pamphlet on "The Village Deities of Southern India," recently published in Mr. Thurston's valuable series of Bulletins of the Madras Museum, he has collected much curious information hitherto inaccessible to English students. Although most of his facts appear to have been derived from Christian converts, his account of these strange beliefs seems as complete as is possible in the present state of our knowledge. He points out that these deities are usually female, are almost universally worshipped by animal sacrifice, and that their priests are not Brahmans, but drawn from the lower castes. He describes in detail the grosser modes of sacrifice, which he regards as not in the nature of gift or propitiation, but as methods of gaining communion with the deity. This study of the seamy side of Hinduism shows that this comprehensive faith is not, as is too commonly believed, a purely philosophical creed. His essay will be useful to ethnologists as a study of the lower beliefs of a pagan polytheism, which, crude and monstrous as some of its practices are, is still on a higher level than the foul Sákta worship current in Bengal, to which it presents many obvious analogies.

In the *Times* of January 17, Dr. H. R. Mill gives an interesting statement of the rainfall of the British Isles during the past year, compiled from a preliminary examination of the large mass of material so far received from the observers of the British Rainfall Organisation. It shows that, for the United Kingdom generally, the year 1907 was not a wet one, despite the popular belief, but that, in fact, the rainfall was very close to the average of thirty years (1870–1899). Expressing the amounts in percentages, the following provisional values are obtained:—

General Rainfall in 1907. Average=100.

England (South)	Wales	England (North)	Scotland	Ireland	British Isles
99	101	97	106	102	101

The most prominent features were the very wet three months of spring and early summer, and the extremely dry September; this month scarcely yielded a quarter of its average rainfall in England and Wales, and less than a third for the British Isles as a whole. In London (Camden Square) the annual fall was 23·01 inches, 8 per cent. below, and the number of rain-days 9 per cent. above, the average of fifty years (1858–1907). Dr. Mill states that the large number of rain-days, combined with the unusually low temperature of the summer, quite account for the general impression that last year was very wet in London.

In *Mitteilungen aus den deutschen Schutzgebieten* (vol. xx., part iii.) there is an important discussion of the climate of Swakopmund by A. Gülland, based on observations for the years 1899–1905. Swakopmund lies in 22° 42′ S. lat., on the west coast of the German South-West African Protectorate.

A paper on the fruits and seedlings of *Rhus succedanea*, contributed by Mr. S. Tabata to the Journal of the College of Science, Tokio (vol. xxiii., article 1), furnishes a brief account of a microchemical examination of the substances found in the fruits. The fruits are the source of the fat or tallow that enters into commerce as Japan wax. The fat is present in all parts, but only assumes a waxy consistence in the mesocarp. Before germination of the seeds, the cotyledons contain fat, magnesia, and proteins in considerable quantity, but no starch. Starch is formed during germination at the expense of these substances.

An article on the absorption spectrum of protochlorophyll is communicated to the *Bulletin du Jardin impérial botanique*, St. Petersburg (vol. vii., part ii.), by Mr. N. A. Monteverde. An alcoholic solution of the colouring matters prepared from the leaves of etiolated oats and wheat plants provided the protochlorophyll and accessory yellow pigments. Five bands were observed in the absorption spectrum, of which one in the blue is attributed to the yellow pigments, and the other four, in the orange, yellow, green, and blue, are referred to the protochlorophyll.

The first of a series of papers by Dr. L. Cockayne dealing with the coastal vegetation of the South Island of New Zealand is published in the Transactions of the New Zealand Institute, vol. xxxix. In this part the author presents a general sketch of the coastal plant covering. Although the saline nature of the soil and the strong winds are recognised as potent factors influencing distribution, the opinion is expressed that the coastal plants as a whole occupy their peculiar station, not from choice, but from necessity, having been driven out of more favourable situations by better equipped competitors. The vegetation of the South Island below the parallel of 42° S. bears the impress of a subantarctic origin in some of the coastal formations, whereas in the North Island a subtropical element is more characteristic. Of ninety-four species enumerated, more than half are endemic and thirteen are subantarctic.

Under the title of "Heredity and Forestry," Prof. W. Somerville discusses in the Transactions of the Royal Scottish Arboricultural Society (vol. xxi., part i.) an interesting matter with regard to the results obtained by sowing seed of forest trees from different localities. Comparative experiments in Switzerland have shown that plants raised from the seed of the common spruce grown at a high elevation, *e.g.* 6000 feet, make much slower growth than plants raised from seed grown at a lower elevation, *e.g.* 2000 feet. Similar results have been recorded for spruce in Austria. Other characters, such as the weight of the seed, length of growing period, and possibly tendency to disease, appear to vary with the situation of the trees from which seed is taken. It becomes, therefore, important to obtain seeds for afforestation purposes from a locality similar to that in which the plantation will be made. The conclusions appertaining to the spruce do not necessarily apply to other trees, such as the Scots pine, for which data are not available.

Mr. Drysdale Turner contributes to the December (1907) number of the *Agricultural Students' Gazette*—the organ of the Royal Agricultural College, Cirencester—an interesting summary of the life-history of the warble-flies *Hypoderma lineata* and *H. bovis*. Considerable losses are caused by the ravages of this insect in Great Britain, and farmers and stock-keepers are fully alive to the necessity of keeping it in check. *H. lineata* resembles a bee in appearance, and can be seen from the middle of May to the beginning of September. It attaches its eggs to the hair on the various parts of the bodies of cattle, particularly the legs, just above the hoofs. The animal licks the place where the eggs are deposited, and the larvæ are carried by the tongue into the mouth and to the gullet, through the walls of which they pass, and eventually lie just under the skin on the animal's back; the developed maggots finally work their way out of the skin about June, and fall to the ground, where they pupate. *H. bovis* probably has a similar history. Various remedial measures are quoted, and in particular it is stated that the parish of Bunbury, in Cheshire, has been freed from the pest by systematically destroying the maggots. The same journal also contains a *résumé*, by Prof. Duncan, of the regulations that have been made from time to time concerning contagious diseases in animals.

The Journal of the Department of Agriculture of South Australia for November, 1907, contains an account of the wheat yield during the last decade, and the estimated yield for the present season. The figures are very striking; they are as follows:—1897–8, 2·64 bushels per acre; 1898–9, 4·91 bushels; 1899–1900, 4·64 bushels; 1900–1, 5·88 bushels; 1901–2, 4·60 bushels; 1902–3, 3·64 bushels; 1903–4, 7·72 bushels; 1904–5, 6·53 bushels; 1905–6, 11·46 bushels; 1906–7, 10·19 bushels. The fact that the last two seasons gave much higher yields than usual is attributed to the use of artificial manures and to timely rains. As the rainfall during the past twelve months is below the average, a yield of only 8·75 bushels is predicted for the present season. When we remember that the average wheat yield in Great Britain is 30·9 bushels, and the average of the yields of all other countries is 17·5 bushels, it would appear that there is considerable scope in South Australia for agricultural investigation, and that a strong scientific staff would prove a really sound investment.

IN a paper on "ghost images" published in the Journal of the Royal Microscopical Society, clxxxi. (December, 1907), Mr. A. A. C. E. Merlin discusses the resolution of the images of a substage stop formed by the secondary markings of the diatom *Coscinodiscus asteromphalus*. The diameter of the secondaries was 1/83300th of an inch, and the images appeared well defined under a magnifying power of about 3200. In connection with this effect, the author discusses the advantage of high magnification, independently of the question of resolving power, and especially advocates the use of powerful eye-pieces in studying minute structures. While a structure may be equally well defined under a lower magnification, and may be visible when it is known to exist, the author considers that for the recognition and detection of unknown detail a powerful eye-piece is a necessary adjunct to a picked objective.

THE Transactions of the Theosophical Congress for 1907 contain much matter that falls outside the range of "science" as included in the columns of NATURE. There are two papers on the dimensions of space which form in some ways an exception to the above statement, and the writer of one of these, who does not publish his full name, gives some diagrams by which it is possible to construct models of projections of the simpler four-dimensional solids. The author, however, considers that the sections of the 600-cell and the 120-cell "become so complicated as not at present to be worth calculating," and on p. 258 he shows by his own statements that he is unaware of the work that has been done in "exhausting" the regular figures in space of higher dimensions than four. Indeed, he says:—"It seems to me quite possible that we might find that in a five- or six-dimensional world *no regular hypersolids at all were possible.*" But a little thought can be made to show anyone with a small mathematical knowledge that the triangle-tetrahedron series, the square-cube series, and the octahedron series are capable of extension to space of any dimensions whatever.

THE December (1907) number of the periodical of popular science, *Himmel und Erde*, published by the scientific society "Urania," of Berlin, contains an article on the microscopic structure of photographic films by Dr. W. Scheffer. It is illustrated by twenty-two reproductions of photomicrographs, which show how the nuclei of silver salt are affected by various modifications of the times of exposure, the method of development, and the use of intensifiers and of restrainers.

THE December (1907) Bulletin of the Bureau of Standards contains the results of a long investigation on the Clark and Weston standard cells, by Messrs. F. A. Wolff and C. E. Waters. They conclude that the agreement between cells set up with different samples of mercurous sulphate prepared by any of the recognised methods, or by treatment of commercial sulphate with sulphuric acid, is highly satisfactory, and suggest that the standard cell should serve as one of the two fundamental electrical standards. It has been shown that the cells now constructed can be carried long distances without changes of electromotive force of more than a few parts in 100,000 being produced. It will be seen from this statement that the results obtained in America are in agreement with those found at the National Physical Laboratory and communicated to the Royal Society a few weeks ago.

AN article on some of the present problems of radioactivity, by Dr. G. A. Blanc, appears in the December (1907) number of *Le Radium*. The author considers that Rutherford's disintegration theory is the explanation of radio-activity, and asks whether disintegration is not taking place in all forms of matter? After reviewing the evidence for the α particle being either half an atom of helium with a unit charge or an atom with a double charge, he comes to the conclusion that neither is satisfactorily established. Nor is the genealogical tree of the radio-active elements yet made out. Is it possible, he asks, that lead and silver, which are so intimately associated in nature, belong to this tree, and that one is the parent of the other? The amount of radium in the earth's crust is more than sufficient to maintain the temperature constant, and now he finds there is more thorium present than is necessary to supply the heat required. He is sanguine that some means will eventually be found which will allow us to stimulate radio-active disintegration, and thus obtain a source of energy the utility of which we can scarcely at present conceive.

THE product of the world's gold mines for the year 1906 could be all packed in a room 10 feet square and 9 feet high, says Mr. T. F. Van Wagenen in an article on gold in the current number of the *Popular Science Monthly*. The value of this 90 cubic feet of gold was nearly eighty-one and a half millions sterling, and its weight nearly 674 tons. Very nearly one-third of this amount was obtained in South Africa, about one-fifth from Australasia, and nearly a quarter from the United States and Alaska. Eighty-three per cent. of the total output was secured by the Anglo-Saxon world. According to calculations and estimates made in 1900 by the director of the United States mint, the gold taken from the mines of the world since the discovery of America has amounted in quantity to about 21,424 tons, and in value to more than 2,520,000,000*l*. Nineteen per cent., or nearly one-fifth of the whole, has been mined in the last ten years, and 30 per cent. in the last twenty years.

MESSRS. SAMUEL BAGSTER AND SONS, LTD., have published a fifth edition of Mr. W. T. Lynn's "Astronomy for the Young."

A SECOND edition of Mr. George J. Gray's "A Bibliography of the Works of Sir Isaac Newton, together with a List of Books illustrating his Works," has been published by Messrs. Bowes and Bowes, of Cambridge. The work has been revised and enlarged, and many important additions have been made.

THE first volume of the sixth edition of A. Wüllner's "Lehrbuch der Experimentalphysik," dealing with general physics and sound, has just been received from Mr. B. G. Teubner, Leipzig. The volume contains more than a thousand pages, about seven hundred of which are concerned with the general properties of matter, while the remainder deal with wave motion and sound. The price of this elaborate treatise on the fundamentals of physics is sixteen marks.

THE "International Geography," edited by Dr. H. R. Mill, and written by seventy authors, with special knowledge of the subjects on which they contribute articles, has been re-published by Messrs. Macmillan and Co., Ltd. The work is now issued, not only in one complete volume, but also in parts. The sections dealing respectively with the British Isles, Europe, Asia, Australasia, North America, South America, and Africa can be obtained separately. The parts each contain a selection of original questions and exercises, and a miscellany of questions set in various public examinations, and they should prove of great service in the higher classes of schools.

OUR ASTRONOMICAL COLUMN.

OBSERVATION OF ENCKE'S COMET ON DECEMBER 25, 1907.—From No. 4226 of the *Astronomische Nachrichten* (p. 31, January 7) we learn that, having found Encke's comet on January 2, Prof. Wolf examined some earlier plates, and found an image of the comet on one taken at 7h. 20m. December 25, 1907 (Königstuhl M.T.). Its position at that time was R.A.=22h. 57·4m., $\delta=+0°\ 54'$, and its magnitude 13·0. Owing to its being near the edge of the plate, this image was overlooked at first. From this observation it appears that the recently published ephemeris (*Astronomische Nachrichten*, No. 4222) requires corrections of +2·4m. and −24′.

A NEWLY DISCOVERED BRIGHT MINOR PLANET (1908 B.M.).—A comparatively bright planet was discovered by Dr. Kopff at Heidelberg on January 4. Its position at 12h. 27·6m. (Königstuhl M.T.) was α=7h. 33m. 48s., $\delta=+14°\ 57'$, and its daily motion −1·4m. and −20′. The magnitude of this object was recorded as 9·2. Dr. Przybyllok observed the planet with the 12-inch refractor of the Astronomischen Institut on January 5, and found it to be equal in magnitude to B.D.+14°.1717 (magnitude, 9·4) (*Astronomische Nachrichten*, No. 4226, p. 31, January 7).

MEASURES OF DOUBLE STARS.—In No. 4227 of the *Astronomische Nachrichten* (p. 33, January 8), Messrs. C. P. Olivier and R. E. Wilson publish the results of 420 observations of 116 double stars made at the Leander McCormick Observatory, University of Virginia, during the years 1904–7. Seven of the doubles in this list were discovered by Mr. Olivier, and are now published for the first time. Notes as to the probable motions of some of these doubles are appended to the paper.

EPHEMERIS FOR COMET 1907*e*.—A bi-daily ephemeris for comet 1907*e*, covering the period January 13 to February 22, is published in No. 4226 of the *Astronomische Nachrichten* by Herr M. Ebell. An observation by Dr. Wirtz, made at Strassburg on December 4, gave the magnitude as 12·7.

THE ABSORPTION OF D_3 (HELIUM) IN THE NEIGHBOURHOOD OF SUN-SPOTS.—In an article appearing in the *Observatory* (p. 51, No. 392, January), Father Cortie discusses some photographs of sun-spot spectra obtained by Mr. Nagaraja at the Kodaikánal Observatory last year. The special point of these photographs was that, with a spot near the limb of the sun, they are supposed to show the bright line at the limb and the dark absorption line in the region of the spot at the same time. Father Cortie's discussion tends to show that the dark line in question is, possibly, not coincident with D_3, and is perhaps the water-vapour absorption line at λ 5875·963. He has many times recorded lines attributed to water-vapour in the spectra of sun-spots, and suggests the possibility of the presence of superheated steam in sun-spots.

In regard to the recent suggestions that a permanent dark D_3 line occurs in the solar spectrum, Father Cortie points out that Mr. Higgs and he thoroughly investigated the question seventeen years ago, and concluded that there was no permanent dark line coincident with the bright D_3; since then no conclusive evidence has been adduced to lead him to alter that conclusion.

THE ORBIT OF THE SPECTROSCOPIC BINARY θ AQUILÆ.—No. 6, vol. i., of the Journal of the Royal Astronomical Society of Canada (p. 357, November–December, 1907) contains a preliminary set of elements for the orbit of the spectroscopic binary θ Aquilæ. This star has a photographic magnitude of 3·6, and its spectrum is of the type VII*a*. Mr. W. E. Harper, of the Dominion Observatory, Ottawa, who publishes the elements, finds that Deslandres's conjecture of a 16·8-day period and a high eccentricity is confirmed. The present elements give 17·17 days as the period, −26·7 km. per sec. as the velocity, 0·725 as the eccentricity, and 8,455,500 km. as the length of the semi-major axis of the orbit.

ECLIPSE OBSERVATIONS, AUGUST, 1905.—No. 15 of the *Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg* contains M. Donitch's report of the results obtained by the expeditions dispatched by the academy to observe the eclipse of 1905. Two expeditions were organised, one going to Alcala de Chisvert (Spain), the other to Assouan. The object of the former was to study the chromosphere and corona, whilst the attention of the latter was chiefly devoted to observations of terrestrial magnetism. In the present paper M. Donitch, who directed the expedition to Spain, discusses the purely astronomical results. Photographs of the chromospheric spectrum were obtained, and the wave-lengths and origins of some 110 lines are given in tabular form. In addition to those of H, He, Ca, Sc, Ti, Cr, Fe, Sr, Yt, and Ba, there are indications of the presence of lines of Co, Zr, Eu, and, possibly, Ge in the spectrum. The depths of the layers of these various elements in the chromosphere were measured, those of hydrogen and calcium giving the highest numbers, 49,300 kilometres and 44,000 kilometres respectively. The dimensions of five prominences as shown in radiations of various wave-lengths are also given.

The photographs of the corona show it to have been of the "maximum" type, as one would expect in 1905. Reproductions from several of the photographs obtained accompany the paper.

We have also received a finely illustrated volume containing a full discussion of the results obtained by the astronomical section of the Observatory of Cartuja, Granada, Spain. In this work, published under the direction of P. José Mier y Terán, S.J., most of the questions and theories arising from eclipse observations are discussed at length, so that the volume, which is printed in Spanish, forms a useful reference work for future observers.

SCIENCE AT RECENT EDUCATIONAL CONFERENCES.

THERE is no ebb in the tide of educational congresses. On the contrary, the number of teachers' organisations increases year by year, the number holding annual meetings during the last month in London alone running well into double figures. Nor is there any falling off in the vigour of the individual associations; indeed, in the case of the London County Council Conference, large numbers were unable to gain admission owing to the crowded state of the hall. This particular conference brought together more than twelve hundred workers in education, the majority of whom were teachers in L.C.C. elementary and secondary schools and technical institutes. We propose to review this meeting and that of the Public Schools Science Masters' Association, but desire to preface a few remarks on the effect of the multiplication of societies for the furtherance of various branches of education.

The time has gone by when a schoolmaster was expected to be able to teach all the subjects of the curriculum. Improved methods of teaching have in every subject called for a greater mastery on the part of the teacher, so that just at present we appear to be saved from having a specialist for every subject in the curriculum solely by considerations of financial economy. The science master teaches nothing but science, and is apt to lose interest in, and to be out of touch with, other subjects, and, *mutatis mutandis*, this is true of the modern language master and of the others. Hence we find segregation of teachers into their respective associations, each dealing with its particular branch of study. The advantages of these independent meetings are not far to seek. If the discussion refers to the teaching of physics, for example, the whole audience may be assumed to have some expert knowledge and to be intimately concerned in arriving at a right judgment. The informal and social side of the meetings, not their least valuable function, may be easier to promote, because each feels that he can exchange views with his neighbour to their mutual profit. But there are drawbacks to this segregation. Nothing was more frequently insisted on during the debates of the Public Schools' Science Masters than the need for cooperation between the teachers of mathematics and physics. One speaker urged that nominees of the Public Schools' Science Masters' Association should confer with nominees of the Mathematical Association to promote this end. In our opinion, this proposal falls very short of what is required. It would be better to hold a joint general meeting of the two associations, which would be better calculated to lead to an appreciation on the part of individual members in each body of the aims and difficulties of their colleagues in the allied camp. It would be easy to suggest other joint meetings of associations which would be helpful just now. Sections of the British Association unite to discuss problems on their boundaries, and this with better effect than by joint committees. Moreover, the various sections of the British Association belong to one body, and the general public recognises the importance of conclusions carrying its imprimatur. Would not teachers have more public influence if the existing associations were federated? The specialising influence to which we have referred should not be allowed to become a narrowing influence, and to that end teachers should from time to time hear addresses from first-rate men on subjects outside their own branch. The influence of science is probably weakened at the present time by the confinement of all scientific subjects to a technical society or body of experts. Science was practically omitted from the agenda of all the educational conferences this winter, except of the two which we will now describe.

London County Council Conference.

The subjects dealt with fall under the four heads nature-study, commercial education, manual work, and pædogogic experiments, and we will omit all further reference to the second of these.

"The Place of Nature-study in the School Curriculum" was the title of the opening paper by Dr. Percy T. Nunn, and it would be difficult to imagine a better introduction than the philosophical exposition given by the vice-principal of the London Day Training College. The basis of Dr. Nunn's arguments was the principle that it is the business of the educator to cultivate groups of interests rather than to teach useful subjects. While recognising that nature-study could well contribute to the æsthetic side of the curriculum, it had clearly to be recognised on the whole as an integral part of the instruction in science. The science curriculum should be so thought out as to secure continuity of development in conformity with the characters which distinguished the successive levels of the scientific process. Of these levels or stages, the highest and latest was the stage of system pursued for its own sake, a stage scarcely reached at school by ordinary pupils. Before this was the utilitarian stage, in which the greater part of elementary science teaching should fall. The foundation should be the nature-study stage, in which "science is born of wonder." These stages were not separable by clear lines of demarcation, and it was a mistake to allow their continuity to be interrupted, as when topics introduced in the nature-study lessons were afterwards allowed to drop. In the case of rainfall, for instance, the first simple studies should lead through the investigation of dew-point to hygrometry, the measurement of vapour-pressure, and thence to the doctrine of the continuity between liquids and gases. Dr. Nunn stated, in conclusion, that science of the higher type could not be a completely healthy growth unless it sprang out of the foundation of nature-study. The papers which followed, on school excursions, and the use of the school museum, dealt with practical points in the management of these aids to teaching. Both authors and subsequent speakers emphasised the importance of observations being made under conditions as little artificial as possible. The superiority of open-air work was generally admitted, but, in addition to difficulties with regard to time and place, some speakers found obstacles in the regulations under which they worked.

The afternoon discussion was practically confined to the subject of botany teaching in girls' schools, Miss Lulham discussing the approach to the subject through nature-study, Miss Lilian Clarke describing the botanical laboratory and school gardens at Dulwich, and Miss von Wyss tackling the difficult problem of teaching large classes in elementary schools. Space does not permit us to enter into detail, so we must content ourselves with stating that each of these papers bristled with practical suggestions based on actual experience, and suited to ordinary conditions of work, where the pupils are many and the time circumscribed. We may remind our readers that a verbatim report of the conference will be issued by the County Council, and advise teachers working with strictly limited funds and a lack of cupboards and other fittings to study the very helpful recommendations made by Miss von Wyss. It is not surprising that, stimulated by her teaching, a natural history club could be started and be continued as an evening class after leaving school in a district which at first sight appeared unpromising. In passing, we may note that Miss Lulham pointed out the virtues of colt's-foot as a plant for all-the-year-round study by beginners, so we may bless as teachers the persistent weed which as gardeners we are disposed to ban. In the discussion the papers met with hearty approval, an inspector of secondary schools pointing out that many important girls' schools had given up botany after trying to teach the subject on wrong lines. There was general agreement that the study of botany became highly interesting and educative if the following conditions were fulfilled:—(1) the living plant must be studied; (2) the pupils must keep plants under observation for lengthened periods, making notes and diaries illustrated by their own sketches direct from nature; (3) the pupils must experiment; (4) the teacher must prepare the lessons very carefully, and then leave as much as possible to be done by the pupils themselves. The moral and æsthetic influences of the study of nature were not forgotten, and it was rightly pointed out that the teacher must not forget that plants are living and beautiful. Is it too much to hope that a love of nature may attract youngsters to healthier interests than those stimulated by the poor silly trash which is so much read?

Sir John Cockburn presided at the discussion on manual training, and pointed out its importance from the physiological standpoint. Motor instruction conformed to natural methods, and the moment these methods were departed from the work of the teacher became a distortion of what it should be. The brain could only be built up properly through the action of the muscles. Dr. Slaughter, late assistant to Dr. Stanley Hall, read a paper on the need of manual training in the lower standards, in which he insisted on the idea of training all classes for citizenship. Scientific investigation showed that the human body was no longer to be regarded as separate from the human mind, and that thought was truncated action. He based his hopes for the future of education on manual training, although present methods were open to serious criticism. Perhaps their greatest fault was that they aimed too much at the acquisition of technique, whereas such training should be in daily use for its adaptive educational value. It should mean more than hand training, should make use of drawing, and should give knowledge about geography, animals, and plants. Mr. J. C. Hudson gave an account of manual work in American elementary schools, some making it merely supplementary, whilst others use it as a means of correlating all subjects. Perhaps the underlying idea may be indicated by the substitution of the terms "expression work" and "associative activities" for the term "manual training." Mr. P. B. Ballard considered the position of manual work in Standards I. to IV. of the senior departments of English elementary schools. As the result of a recent inquiry, he obtained replies from 120 educational authorities, which showed that only sixteen authorities adopted a systematic course of hand-work. As regards London, courses in brush-work, clay-modelling, &c., were rare, except in the special schools for the mentally and physically defective, so that in the matter of motor training the lost sheep was looked after and the ninety and nine forgotten. Mr. Ballard proceeded to advocate the application of hand-work to ordinary school subjects, and gave a series of illustrations of his ideas as applied to arithmetic, geography, and history. He wished to bridge the gap at present existing between the kindergarten occupations of the infants' department and the manual and domestic work of the senior standards.

During the sitting devoted to educational experiments in elementary schools, a paper was read by Mr. H. J. Hazlitt, in which the author described in detail how he had been conducting classes in open-air geography. By making previous provision of home-made survey maps and notes, the class was able to take an enlightened interest in an excursion to Crowhurst. Open-air work gives a genuine foundation to the study of geography, and thereby that essential factor, the map, can be properly understood.

PUBLIC SCHOOLS' SCIENCE MASTERS' ASSOCIATION.

The salient features of the annual meeting, held at Westminster School on January 14, were:—(1) the address from Prof. H. A. Miers, F.R.S.; (2) the instructive exhibition of apparatus; (3) the discussion on the position of mechanics in the physics course; (4) the repeated expression of the need for cooperation between the masters responsible for mathematics and physics respectively.

Prof. Miers took as his subject the order in which scientific ideas should be presented. He deprecated any rigid division of science into subjects, and believed that harm had resulted from attempts to keep mathematics, physics, and chemistry apart from each other, and to confine them to separate teachers. He desired to leave freedom to the individual teacher as regards method, but felt that as regards order there should be more system in our science teaching. In other subjects there was an advantage in having a recognised order based upon prolonged experience, and science should stand upon the same level as languages and mathematics in our schools, and should form an integral part of any liberal education. It was not easy to find out at the moment what the pupil understood of the instruction, and where he had succeeded in analysing the difficulty of a pupil he generally discovered that he himself was at fault in having presented ideas in the wrong order, and assumed something which was not yet familiar to the pupil. He found a useful guide to the proper order in the succession in which the ideas of a science had been developed in its past history.

Prof. Miers advocated nature-study in the wide sense; the boy should be taught to notice the ordinary objects and events of his own world, and to draw scientific nourishment therefrom, including in his intelligent observation all that was going on around, and not merely the processes of nature familiar in country life. If only the ordinary boy could get into his head the notion that science was the intelligent study of ordinary things, he would cease to regard it as a mere educational task. It was unwise, if not impossible, to teach chemistry and physics as independent subjects. In the preparatory school the boy should be trained in observational work, which would impart information useful in the experimental science that was to come next. The systematic teaching at a public school should from the outset be experimental, and the spirit of inquiry should be cultivated, and scientific dogmatism guarded against.

Coming to the university teaching of science, we had now to deal with mature minds, and the spirit of research should absolutely dominate the teaching. There was nothing better for encouraging research than natural history, which was admirably suited for advanced study at the university. Original papers were more stimulating than text-books, and there is need for an English series reproducing the original researches of highest importance, perhaps with the translation of archaic expressions into modern equivalents. Lectures should follow the historical order, laboratory work the method of research.

Prof. Armstrong felt it to be a deplorable fact that science had lost ground in public estimation. We felt the absence of Huxley and Playfair, and it rested with the public schools to carry the banner forward. The Davy-Faraday laboratory had, with one exception, failed to attract the gilded youth, fired with enthusiasm for science by their work in public schools. We must teach, so as to excite more interest, so as to make that interest more continuous and permanent, and so as to cultivate, not powers of observation only, but the faculty of keen, intelligent criticism also. He held that Germany had achieved her position owing to the cultivation of originality by her universities.

The other papers read during the meeting were:—(1) the educational value of mechanics, by Mr. C. F. Mott (Giggleswick); (2) the teaching of practical mathematics, by Mr. H. Wilkinson (Durham); (3) scheme for laboratory work in physics, by Mr. Cumming (Rugby); (4) a suitable physics curriculum for the first and second years, by Mr. W. E. Cross (Whitgift); (5) the compulsory teaching of elementary physics to junior forms, by Mr. J. M. Wadmore (Aldenham).

In the course of the discussions, it was pointed out that there is a great leakage from schools of boys who are under the proper leaving age, and that such boys necessarily receive little scientific education. There was no lack of enthusiasm for science on the part of boys who fulfilled the course of instruction. The fact that boys were promoted in many schools without regard to their science work placed difficulties in the way, such as were met by re-arranging the schools in sets in the case of mathematics. The study of scientific mechanics might be postponed until boys had obtained some experience in general experimental physics; practical work in heat could be introduced earlier. Boys should be allowed to use modern electrical plant, such as the cheaper voltmeters and ammeters now available through being put on the market for motorists. Mr. Cross advocated the abandonment of the usual exercises in mensuration and Archimedes's principle, and the substitution of a course of experimental construction of working cranes, &c. He would devote the first two years to such work, which stimulates interest and leads to a grasp of principles, *e.g.* the inquiry into the transmission of power by belts leads to true notions about energy and friction. It is a pity that there was little criticism of this interesting and unorthodox paper, for there is no doubt that most boys want to know "how it works"; moreover, the course which Mr. Cross outlined can readily fulfil Prof. Miers's requirement that the application of the instruction to everyday life should be straightforward. The relative merits of working collectively or individually in the laboratory were discussed, and Mr. Cumming claimed that the former system proved successful at Rugby. In summing up the discussion, Prof. Miers remarked upon the extreme diversity of methods adopted in different schools.

The exhibition of apparatus attracted well-deserved attention. Several dealers in apparatus, and some of the leading publishers, sent extensive exhibits, but the most gratifying, and in many respects the most instructive part of the exhibition was the ingenuity of the home-made contrivances sent from a good number of schools. We must congratulate and thank those responsible, and particularly Mr. D. J. P. Berridge, to whose organisation much of the success of this feature of the meeting was due. There were so many items of interest that it is impossible to describe them all, and it seems invidious to select. On the score of daring simplicity, we may perhaps award the palm to a motor armature shown by Mr. C. J. L. Wagstaff, which consisted of a bottle-cork, a few turns of insulated wire, and a dozen pins. Dr. T. J. Baker reached the acme of simplicity in his supports for prisms, lenses, &c. These were mounted by being stuck in their appropriate positions into lumps of plasticine—*voilà tout*! We would suggest to the management the advisability of printing a large number of copies of the catalogue; they might be put on sale; in any case their wider diffusion would help to improve experimental teaching by simple apparatus of homely invention and make.

G. F. DANIELL.

THE INTERDEPENDENCE OF MEDICINE AND OTHER SCIENCES.[1]

AN historical sketch, necessarily brief and inadequate, of some of the principal phases in the reciprocal relations between medicine and the physical sciences, up to the time when the latter became fully independent at the close of the seventeenth century, will show with what propriety medicine has been called the "mother of the sciences."

Physical science has derived from the Greeks no such extensive records of sound observation and experience as those which medicine has inherited from the writings of Hippocrates and his followers. Physical theories embodied in the speculations of the nature-philosophers concerning the constitution and properties of matter furnished the

[1] From an address delivered by Dr. W. H. Welch, professor of pathology, Johns Hopkins University, Baltimore, as the retiring president of the American Association for the Advancement of Science, at Chicago, December 30, 1907.

starting point for the Hippocratic doctrine of the four humours and other generalisations, but these theories sat so lightly upon Hippocrates that his name is attached to that method of medical study which rejects dogma, authority, and speculation, and confines itself to the observation and record of clinical facts. As Gomperz in his admirable work on the "Greek Thinkers" has clearly pointed out, the age of enlightenment in scientific thought was inaugurated by Hippocrates and his medical contemporaries.

The influence of physical theories upon medical thought in antiquity can be traced, not only in the humoral doctrines of Hippocrates and of Galen, but also in rival schools, and especially in the so-called methodic school founded upon the atomistic philosophy of Democritus, which is so interesting in the history of scientific theories. As this school produced such admirable physicians as Asclepiades, Soranus, and Aretæus, it is to be regretted that their solidistic pathology was so completely displaced by the authority of Galen.

The large body of medical knowledge and doctrine which had grown up during the six centuries since Hippocrates was further developed and fixed by Galen at the end of the second century after Christ into a system not less complete in its field, nor less satisfying to the minds of men for nearly fifteen centuries, nor scarcely less remarkable as a product of the human mind than the physical and philosophical systems of Aristotle. Within their respective spheres the system of doctrine of each of these great men has exerted a similar dominating influence upon human thought, and has met a similar fate through influences almost identical.

The great awakening of western Europe, marked by the revival of learning and the Reformation, stirred the long dormant spirit of inquiry and led to revolt against authority, a fresh outlook upon a wider world, the study of original sources, the questioning of nature at first hand, and the search for new knowledge in all her kingdoms. The seat of learning was transplanted from the cloisters to the universities, which multiplied and flourished in the sixteenth and seventeenth centuries as never before.

In the sixteenth century practically all the valuable contributions to botany and to zoology were made by physicians, so that natural history scarcely existed apart from medicine. Of the medical contributors to botany, it must suffice to mention the names of Brunfels, Fuchs, Dodoens, Gesner, and, above all, Cesalpinus, who has been called "the founder of modern scientific botany," the most important name before John Ray in the history of systematic botany, and a distinguished figure likewise in medical history. Of names associated with the history of zoology in this century, the most important are those of the physicians, Conrad Gesner, a marvel of encyclopædic learning, and Aldrovandi, who ranks with the founders of modern zoology and comparative anatomy; of lesser lights Edward Wotton may be singled out for mention as the pioneer English zoologist. He was doctor of medicine of Padua and of Oxford, president of the Royal College of Physicians, and physician to Henry VIII.

A name of the first rank in the history of science is that of the physician, Georg Agricola, who founded before the middle of the sixteenth century the science of mineralogy, and developed it to a state where it remained for nearly two hundred years without important additions.

The student of medical history who takes up a history of physics will probably be surprised to find how many of the contributors to the latter subject in the sixteenth century were physicians, and that among these are such old friends as Fernel and Fracastorius, whom he has identified so intimately with the annals of his profession. It is to be presumed that he already knew that the most famous of all, Copernicus, was a doctor of medicine of Padua, and practised the medical art gratuitously among the poor in Frauenburg.

Far more important for the subsequent history of science than any relations between medicine and physics at this period was the union between medicine and chemistry effected by Paracelsus, and strengthened by van Helmont and Sylvius in the following century, a union so intimate that for nearly a century and a quarter chemistry existed only as a part of medicine until freed by Robert Boyle from bonds which had become galling to both partners. The story of this iatro-chemical period, as it is called, has been told by Ernst von Meyer in his fascinating "History of Chemistry" in a way not less interesting to the student of medicine than to one of chemistry, and should be there read by both.

William Gilbert, second in importance only to Galileo among the creators of experimental science, the founder of the science of magnetism, and a significant name in the history of electricity, was fully identified with the medical profession, being the most distinguished English physician as well as man of science of his day, physician to both Queen Elizabeth and James I., and president of the Royal College of Physicians.

Galileo's younger contemporary, William Harvey, the discoverer of the circulation of the blood, occupies in the history of experimental science an independent position quite unlike that of the other experimental physiologists of the century. These other physicians, as Sanctorius, Borelli, Lower, Mayow, consciously took possession of the method of experiment as a powerful and newly discovered instrument of research, and were swayed in all their physiological work by the discoveries of the physicists. Not so Harvey, who was influenced but little by contemporary physical science, and is linked on, not to Galileo or to Gilbert, as exemplars of experimentation, but in a very direct way to the experimental physiologist, Galen, and to Aristotle, as well as to the Italian anatomists of the preceding century. Harvey's genuinely scientific mind was in greater sympathy with Aristotle than with the essentially unscientific Lord Bacon, who was his patient, and of whom he said, "He writes philosophy like a Lord Chancellor."

Descartes was an anatomist and physiologist as well as philosopher, mathematician, and physicist, and John Locke, the other great liberator of thought in this century, was educated in medicine, practised it, and, like Boyle, accompanied Sydenham on his rounds. Kepler studied the pulse, contributed to physiological optics, and calculated the orbits of the planets. Borelli was an important mathematician, physicist, and astronomer, as well as one of the greatest physiologists and physicians of the century. Bartholinus was also professor of mathematics as well as of medicine, and discovered the double refraction of Iceland spar. His even more remarkable pupil, Steno, left a name memorable in geology and palæontology, as well as in anatomy and physiology, and died a bishop of the Roman Catholic Church. Mariotte, a pure physicist, discovered the blind spot in the retina. Boyle anatomised, experimented on the circulation and respiration, started chemistry on new paths, and perpetuated his name in attachment to an important physical law. Hooke, most versatile of all, claimed priority for a host of discoveries, and did, in fact, explore nearly every branch of science with brilliant, though often inconclusive, results. Malpighi was an investigator equally great in vegetable and in animal anatomy and physiology, and what a glorious time it was for the microscopists, like Malpighi, Leeuwenhoek, Swammerdam and others, who could immortalise their names by turning the new instrument on a drop of muddy water, or blood, or other fluid, or a bit of animal and vegetable tissue!

After the seventeenth century in Europe the natural sciences, though often cultivated by those educated in medicine and practising it, were independent, and followed their own paths, which, however, communicated by many by-ways with the road of medicine and with each other.

Botany and zoology acquired their independent position probably more through the work of Ray and Willughby than by that of any other naturalist. Botany, however, remained for more than a century still mainly in the hands of physicians. An interesting chapter in its history is the story of the various apothecaries' and other botanical gardens established through the efforts of physicians, and conducted by them primarily for the study of the vegetable materia medica. From such beginnings has grown the Jardin des Plantes in Paris, started by two physicians, Herouard and la Brosse, in 1633, into the great museum of natural history made by Buffon, Cuvier and others as famous for the study of zoology as by the de Jussieus and by Brongniart and his successors for botany. Less humble was the foundation of the British Museum and its appanage, the great Museum of Natural History in South Kensington, the gift to the nation of his valuable collections in natural history and other departments by Sir Hans Sloane, a leading London physician in the first half of the eighteenth century.

Aspects of my subject, full of interest, which I can now barely touch upon, are the influence of previous medical or biological training upon the work of a physicist or chemist, and closely connected with this the extent to which purely physical problems have been approached from the biological side. Call to mind how the central physical and chemical problem of the eighteenth century, the nature of combustion, was throughout this period intimately associated with the identical physiological problem of respiration, and how John Mayow in the seventeenth century, approaching the subject from the biological side, reached a conclusion in accord with that fully demonstrated a century later by Lavoisier, who thereby opened a new era for physiology as well as for chemistry. For the first time clear light was shed upon the function of respiration, the nature of metabolism, and the sources of animal heat, and such physical interest was attached to the study of these physiological phenomena that physicists of the rank of Laplace, in association with Lavoisier, Dulong, W. E. Weber, Magnus, A. C. Becquerel, Hirn, Regnault, and of course Helmholtz, have all made valuable contributions to the elucidation of these subjects.

The study of electricity, especially after the physiologist Galvani's epochal discovery, more correctly interpreted by Volta, engaged the attention of physicians and physiologists scarcely less than that of physicists. The latter became greatly interested in animal electricity, a subject partly cleared up by the physicists Ritter and Nobili, but mainly by the physiologist Du Bois Reymond.

There is no more striking illustration of the correlation of two apparently distinct lines of approach to the same problem than the attack from the biological and from the purely physical sides upon the thermodynamic problem, which is as fundamental for biology as for physics. The conception of the principle of conservation of energy was supplied independently and almost simultaneously, on the one hand, by students of the conditions of mechanical work done by the animal machine, and on the other by investigators of technical machines. Much of the essential preliminary study was on the biological side by Boyle, Mayow, Black, and Lavoisier. Mainly from the same side the physician and physicist, Thomas Young, first formulated the modern scientific conception of energy as the power of a material system to do work. Davy and Rumford contributed, and from the physiological side Mohr, Mayer, and Helmholtz, and from the purely physical side, after preliminary work by Poncelet and Sadi-Carnot, Joule, Thomson, and Clausius reached the same grand conception. The first to enunciate clearly and fully the doctrine of the conservation of energy and to measure the unit of mechanical work derived from heat was the physician J. R. Mayer. Joule's work completed the demonstration, but Mayer's name is deservedly attached to this principle by Poincaré and others, as Lavoisier's is to that of the conservation of mass, and Sadi-Carnot's to the principle of degradation of energy. As regards this last principle, it is almost as interesting to biologists as to physicists that in the so-called Brunonian movement, discovered by the physician and more eminent botanist Robert Brown, and the subject of interesting physical investigations in recent years, we behold an apparent exception to the principle of degradation of energy, such as Clerk Maxwell pictured as possible to the operations of his sorting demon.

I must forego further citation of examples of this kind of correlation between the work of physicists and of physiologists, and leave untouched the chemical side, which is much richer in similar illustrations. The significance to organic chemistry of the synthesis of urea by Wöhler, and to agricultural chemistry of the bacteriological studies of nitrification in the soil and fixation of nitrogen in plants, will perhaps indicate how large and fascinating a field I must pass by.

The light which has transformed the face of modern practical medicine came, in the first instance, not from a physician, but from a physicist and chemist, Pasteur. The field of bacteriological study thus disclosed was placed on a firm foundation and thrown open to ready exploration by Robert Koch, and thereby that class of diseases most important to the human race, the infectious, became subject in ever-increasing measure to control by man. Thus hygiene and preventive medicine, through their power to check the incalculable waste of human life and health and activities, have come into relations, which have only begun to be appreciated, with educational, political, economic, and other social sciences and conditions, and with the administration of national, State, and municipal governments. It is an especial gratification to record the stimulating recognition of these relationships by the social and economic section of this association, in which was started a year and a half ago a movement for public health, particularly as related to the Federal Government, which has already assumed national significance.

To the marvellous growth of the medical and other sciences of living beings during the past century, and especially in the last fifty years, physics and chemistry and the application of physical and chemical methods of study have contributed directly and indirectly a very large and ever-increasing share. In many instances there is no telling when or where or how some discovery or new invention may prove applicable to medical science or art. Who could have dreamed in 1856 that Sir William Perkin's production of the first aniline dye should be an essential link in the development of modern bacteriology, and therefore in the crusade against tuberculosis and other infectious diseases? As Robert Koch has said, it would have been quite impossible for him to have developed his methods and made his discoveries without the possession of elective dyes for staining bacteria, and colouring agents of no other class have been discovered which can serve as substitutes for the anilines in this regard. And how much assistance these dyes have rendered to the study of the structure and even the function of cells! If we trace to their source the discovery of Röntgen's rays, which have found their chief practical application in medicine and surgery, we shall find an illustration scarcely less striking.

No important generalisation in physical science is without its influence, often most important, upon biological conceptions and knowledge. I have already referred to the great principles of conservation of mass and of energy which are at the very foundation of our understanding of vital phenomena. Although we cannot now foresee their bearings, we may be sure that the new theories, regarding the constitution of what has hitherto been called matter, will, as they are further developed, prove of the highest significance to our conceptions of the organic as well as of the inorganic world.

The ultimate problems of biology reside in the cell. Whatever the future may hold in store, at the present day only a relatively small part of these problems are approachable by physical or chemical methods, and the day is far distant, if it ever comes, when cellular physiology shall be nothing but applied physics and chemistry. We cannot foresee a time when purely observational and descriptive biological studies, which to-day hold the first place, shall not continue to have their value. They represent the direction which makes the strongest appeal to the great majority of naturalists. The broadest generalisations hitherto attained in biology, the doctrine of the cell as the vital unit and the theory of organic evolution, have come from this biological, as distinguished from physical, direction of investigating living organisms, and were reached by men with the type of mind of the pure naturalist, who loves the study of forms, colours, habits, variations, adaptations, inheritances of living beings.

It is well that the sciences of nature hold out attractions to so many different types of mind, for the edifice of science is built up of material which must be drawn from many sources. A quarry opened in the interest of one enriches all of these sciences. The deeper we can lay the foundations and the farther we can penetrate into the nature of things, the closer are the workers drawn together, the clearer becomes their community of purpose, and the more significant to mankind the up-building of natural knowledge.

RAINFALL AND WATER-SUPPLY.[1]

IT happens that rainfall is not only the most difficult of all the meteorological distributions to map accurately, it is also that one which is of the greatest importance, for by rain the rivers are fed, and the rivers both water and drain the land. Every year makes clearer the vast national importance of accurate knowledge of the rainfall of a county, for the problem of the rivers is becoming acute. The growing populations of the great towns are tapping the upper waters and diverting the water from its natural channels, and at the same time they are polluting the lower courses with the waste of the factories and the streets. Toll is taken all along the banks of industrial streams for raising steam and carrying on the multitudinous processes of manufacture. There is sometimes anxiety as to whether the waterways can be kept sufficiently supplied to float the water-borne traffic or to fight the silting action of the tides, and there is growing alarm as to the possibility of fish traversing the depleted and polluted streams to reach their spawning beds.

Of recent years, the value of the water-power which may be generated in the lonely and lofty places amongst the western heights of Great Britain, where the rainfall is large and unfailing, has been recognised, and chemical works for the production in electric furnaces of what a few years ago were rare substances are becoming familiar features in Wales and the Highlands. In Ireland, too, the rainfall is an unrecognised source of wealth which as yet has not been drawn upon to any appreciable extent. The increasing strenuousness of the struggle for the possession of large water supplies is producing in England, and especially in Wales, a great amount of local jealousy and strife, for the boundaries of parishes and counties coincide but rarely with water-partings, and the argument has been brought forward again and again that the rainfall of one county should not be diverted for the use of the inhabitants of another. The feeling is intensified when the boundary to be crossed is that of a historical division of national importance, like the boundary between England and Wales, but the map-study of rainfall can do something to suggest the lines on which such disputes should be settled.

Although the exceptional deluges of a thunderstorm or a great depression fall with equal and impartial heaviness on the hills of the west or the flat plains of the east, the common every-day rains are precipitated on the high lands and in the mountain valleys which cross the track of the prevailing wind in much greater abundance than on level and low stretches of country. Most of the rain is borne to our islands from the Atlantic, and when it comes torrentially it is of the air, and no boundary checks it; the largest annual falls come down on and near the watersheds, because there the land produces its maximum influence as a rain compeller.

From the high ground the rivers seek the plains, carrying off the excess of rainfall into the less liberally watered districts. The Dee, the Severn, the Wye, and the Usk restore to England part of the rains which the Welsh mountains have abstracted as the air passed over them. The high rainfall of the whole Pennine district, sometimes by circuitous routes across the comparatively dry plains of the east, swells the volume of fresh water that pours into the Humber. The Thames itself receives the comparatively high rains of the Cotswolds, the Chilterns, and the Downs, and forwards the water slowly through less and less rainy districts, until it reaches the sea in the driest part of England. Thus, I think, at least as good an argument can be drawn from this consideration of physical geography in favour of supplying the great towns of the east from the large precipitation of the west as can be drawn in the opposite sense from the artificial divisions of political geography. Care for the water supply of the country, coming as it does from the air that knows no bounds across the land, is by no means a parochial, but in the fullest sense a national matter, and should be dealt with in the interests of the nation as a whole, the units of subdivision, when such are required, being the natural units of river-basins.

[1] From the presidential address delivered befor the Roya Meteorological Society on January 15 by Dr. H. R. Mill.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Senate has approved the affiliation of the University of Bishop's College, Lennoxville, Quebec, under the conditions laid down in the report of the council of the Senate dated November 25, 1907.

The Senate has assigned a site on the Downing ground, situate to the south of the botanical laboratory and parallel to it, for a building in connection with the Department of Agriculture.

Dr. James, Provost of King's College, has been appointed a member of the council of the National Trust for Places of Historic Interest or Natural Beauty.

The special board for physics and chemistry reports that the prize of 50*l.* from the Gordon Wigan fund for an investigation in chemistry was awarded in the year 1907 to F. Buckney, of Sidney Sussex College, for his essay entitled "A Study of some Quinquevalent Cyclic Nitrogen Compounds."

MANCHESTER.—A communication has been received from the Treasury intimating that to remove any uncertainty which may prevail in regard to the arrangements of the University during the current session, a special grant of the same amount as that paid before the proposed reduction, viz. 12,000*l.*, will be made to the University for the current year. The question of the future distribution of the Treasury grant is left open for decision after the Chancellor of the Exchequer has consulted the Advisory Committee which deals with grants to universities and colleges.

MR. F. M. SAXELBY, head of the department of mathematics at the Technical College, Belfast, has been appointed to a similar position at the Battersea Polytechnic.

IN the *Engineer* of January 17 is published the first instalment of a series of articles on the training of engineering apprentices, describing the methods followed at a number of works. The result of the inquiry has to a great extent been disappointing. No real general upward movement in the training of apprentices has been observed, and, with the exception of a few firms, the old indifferent method of training by hazard still obtains.

THE Government of Mysore has, the *Pioneer Mail* states, made public the new rules for regulating the grant of scholarships for scientific research and technical education from the Damodar Dass charities fund. The scholarships will be open to all Indians who have taken with credit a degree in arts, medicine, or engineering in an Indian or other recognised university. Each candidate selected will be given travelling allowance to England or elsewhere from Bangalore on the completion of his course of study or research. He will be allowed, during his stay in England or elsewhere, outside India, a sum of 200*l.* per annum, this allowance to be inclusive of college fees, cost of books, instruments, and boarding charges.

LORD AVEBURY was formally installed as Lord Rector of St. Andrews University on January 16, and delivered his rectorial address. Lord Avebury, during the course of his remarks, said there never was a time when St. Andrews was more adequately equipped, had a more distinguished list of teachers, and a curriculum more generous, wider, and less one-sided. The question is not, as is sometimes alleged, between a scientific and a classical education. No scientific man wishes to exclude classics. No degree should, in the opinion of scientific men, be given without demanding some classical knowledge. A man who is entirely ignorant of the classics, even if he is a profound mathematician, biologist, chemist, or geologist, is but a half-educated man. But the same is true even of the profoundest classical scholar who knows nothing of science. Science is of vital importance in human life; it is more fascinating than a fairy tale, more brilliant than a novel, and anyone who neglects to follow the triumphant march of discovery is deliberately rejecting one of the greatest gifts with which we have been endowed.

THE prospects of a university for Bristol were much discussed at the annual dinner last week of the Bristol University College Colston Society. The financial position was explained by Mr. J. W. Arrowsmith. Eight or nine years ago, about 400*l.* was collected yearly to forward higher education in Bristol, and the amount is now nearly 600*l.* per annum. In all, the society had collected a sum of 4732*l.* Speaking as to the University itself, Mr. Arrowsmith said the promise of Mr. H. O. Wills, announced in NATURE last week, was satisfactory to all, and all welcomed it very heartily and with deep gratitude to Mr. Wills. But the 100,000*l.* gift is not everything. The amount aimed at before the Privy Council is asked for the charter is 250,000*l.* The aggregate sum of 30,000*l.* was promised at the dinner a year ago. The sums were:—Lord Winterstoke, 10,000*l.*; Mr. J. S. Fry, 10,000*l.*; Mr. Frederick Wills, 5000*l.*; and Mr. F. J. Fry, 5000*l.* Adding for buildings and endowments in connection with University College the sum of 55,000*l.*, a total of 85,000*l.* is reached. Add to that the 100,000*l.*, and 185,000*l.* is obtained. Mr. Arrowsmith said that a friend, since he had been in the building, had added another 10,000*l.*, giving a total in hand or promised of 195,000*l.* It is obvious, therefore, that a sum of 55,000*l.* must be secured before the charter can be sought. Four sums each of 1000*l.* from Mr. Charles Thomas, Mr. Edward Robinson, Mr. Hiatt Baker, and an anonymous benefactor have also been offered. It should not be long, therefore, before the quarter of a million required for the university is raised by the men of wealth in Bristol who realise the value of higher education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1907.—"The Effects of Temperature and Pressure on the Thermal Conductivities of Solids. Part ii. The Effect of Low Temperatures on the Thermal Conductivities of Pure Metals and Alloys." By Prof. C. H. **Lees,** F.R.S.

The object of the work described in the present paper was to extend the measurements of thermal conductivities of metals and alloys made by Lorenz, Jäger, and Diesselhorst and others at temperatures between 0° C. and 100° C. down to the temperature of liquid air, and thus provide a means of comparing the thermal and electrical conductivities of these substances over a much wider range of temperature than has hitherto been possible. The method adopted was a modification of that used originally by Wiedemann and Franz.

The results obtained are tabulated, together with those given for higher temperatures by Jäger and Diesselhorst, and they justify the following statements:—

(1) The thermal conductivities of most pure metals decrease as the temperature rises within the range −160° C. to 100° C.

(2) The thermal conductivities of all alloys tested increase as the temperature rises within the range −160° C. to 100° C.

Institution of Mining and Metallurgy, January 16.—Prof. William Gowland, president, in the chair.—The Vaal River diamond diggings: Mungo **Park.** A brief description of the diamondiferous terrace deposits flanking the course of the Vaal River. The author stated that the diamonds obtained from the river gravels are, taken collectively, probably the finest stones obtainable, averaging about 6*l.* per carat as sold to buyers on the diggings. Methods of working these deposits, and a few notes on the general conditions of digging, are dealt with in this short paper.—The eruptive diamond-bearing breccias of the Boshof district, South Africa: J. P. **Johnson.** A paper describing the three occurrences of diamond-bearing rock in the district, principally from a geological point of view. Special attention is directed to the lherzolite and eclogite boulders, which contain in proportionate abundance all the characteristic minerals of the eruptive diamond-bearing breccia, and which the author thinks are the more resistant portions of a rock which has gone to form the bulk of the breccia, and was the real home of the diamond. This lherzolite-eclogite rock may exist either as a widespread consolidated formation occurring at great depths or as a deep-seated molten magma, the former condition being more likely. The author can see nothing in the breccia other than a purely fragmentary formation, nor has he been able to detect traces of contact metamorphism either of the walls of the vent or of the included boulders. He concludes, therefore, that the type of volcanic phenomenon producing the peculiar features of these diamond-bearing vents would be a geyser rather than a volcano, more especially as there is not the least evidence of any molten rock or lava having passed through them.—The auriferous banded ironstones and associated schists of South Africa: Owen **Letcher.** Five principal mines working in the banded ironstone beds and associated schists are passed under review in turn under the following heads:—salient geological features; occurrence of gold in the formation; methods of mining and productive and economic values; and metallurgy of the series. The author points out that these banded ironstones are the oldest known auriferous sedimentary rocks in South Africa, lying between the basement schists and the conglomerate series, and he considers that on account of what is at present known as to the great width of the gold-bearing formation, the occurrence of gold in many places in payable quantities, and the amenability of the ores to a simple method of treatment, the exploitation of mines in the series is likely to assume considerable importance in future South African history.

PARIS.

Academy of Sciences, January 15.—M. Henri Becquerel in the chair.—Note on the density of graphite: H. **Le Chatelier** and S. **Wologdine.** On account of the wide range of densities which various experimenters have given for graphite, it has been assumed that graphite is not a single variety of carbon, although this is contradicted by the constancy of the heat of combustion of purified graphite. The authors have examined the following:—Acheson graphite (artificial); graphite from Ceylon, Australia, Bohemia (Mugrau and Scharzbach), Greenland, commercial graphite, and from cast iron. The method employed was flotation in a heavy liquid (mixtures of acetylene bromide and ether), care being taken to eliminate all air bubbles. The figures for the unpurified material from these sources varied between 1·62 and 2·66. Purification by Moissan's method was then tried, but the results were no more concordant, the deviations being finally traced to the imperfect removal of air. This was surmounted by removing the air by a vacuum, strongly compressing, breaking up again, placing a second time in a vacuum, and re-compressing. Under these experimental conditions all the natural and artificial graphites after complete purification gave the same density of 2·255 at 15° C. compared with water at 4° C.—The utilisation of turf for the purification of sewage: A. **Muntz** and E. **Lainé.** The experiments detailed show that natural turf is a highly satisfactory medium for forming sewage filter beds. The experimental filter has been at work for more than seven months, and its activity is still unimpaired. It is capable of treating a volume of from three to four cubic metres of sewage per square metre of surface per day. Figures are given of the chemical and bacterial purification effected, and fish live without inconvenience in the effluent. If loaded above this, the effluent is fair, but not so good, and it has been noted that on reducing the load to the normal figure the filter immediately recovers to original efficiency.—Observation of the transit of Mercury at the Observatory of Rio de Janeiro: M. **Morize.** The atmospheric conditions were unfavourable to good observations.—Observation of the transit of Mercury of November 13–14, 1907, at Schoi, Italy: Fr. **Faccin.** The atmospheric conditions were bad.—The summability of Fourier's series: A. **Buhl.**—The choice of the exponent of convergence for integral functions of infinite order: A. **Denjoy.**—The measurements of general movements of the soil by means of levellings repeated at long intervals: Ch. **Lallemand.** An analysis of the degree of exactitude practically possible in levelling operations shows that it is only in exceptional cases that a repetition of the measurements will permit the demonstration with certainty of gradual general movements under 1 decimetre.—The statics of a deformable surface and the dynamics of a deformable line: Eugène and François **Cosserat.**—The transformations of solutions of white phosphorus into red phosphorus: Albert **Colson.** Experiments with solutions of phosphorus in carbon bisulphide and in turpentine at various temperatures between 230° C. and 290° C. showed that the presence of the solvent causes the rate of transformation of the white into the yellow modification to be reduced.—The constitution of cast irons containing manganese: L. **Guillet.** Manganese displaces the eutectic point, which is produced for lower percentages of carbon than with the iron-carbon alloys. Other changes caused by the gradual increase of the percentage of manganese are noted.—Ammoniacal cuprous sulphate: M. **Bouzat.** The salt is formed by the interaction of aqueous ammonia, cuprous oxide and ammonium sulphate, and precipitated by alcohol. It is filtered off on asbestos, and washed with alcohol and ether. Great care has to be taken to exclude all traces of air, all reagents being freshly boiled, and the whole series of operations carried out in a current of pure hydrogen. Analyses of the precipitated salt show it to possess the composition $Cu_2SO_4.4NH_3$. The reactions are those of a cuprous salt, oxidising instantly when exposed moist to the air, and giving copper, cupric sulphate, and ammonium sulphate when treated with dilute sulphuric acid.—Syntheses in the camphor group. The complete synthesis of β-campholene lactone: G. **Blanc.** The starting point of this synthesis is $\alpha\alpha$-dimethyladipic acid, and this is converted successively into its sodium derivative, dimethyl-*cyclo*pentanone-acetic acid, and the ethyl ester of the latter. The bitertiary glycol obtained from this by Grignard's reaction forms a lactone identical with β-campholene lactone.—The constitution of the α- and β-methylsparteines and of isosparteine: Charles **Moureu** and Amand **Valeur.**—The synthesis of racemic dihydrocamphoric acid: L. **Bouveault** and R. **Locquin.**—The innervation of the sterno-mastoid and cleido-mastoid muscles: F. X. **Lesbre** and F. **Maignon.**—The action of fresh kola nut on work: J. **Chevalier** and M. **Alquier.**—The apparent double refraction of vibratory cilia: Fred **Vlès.**—The action of choline on the arterial pressure: A. **Desgrez** and J. **Chevalier.** Choline furnishes the first example of a physiological substance of well-defined chemical composition, producing a marked lowering of the arterial pressure. It behaves as an antagonist to adrenaline, and it is possible to associate these two substances in such quantities that the one neutralises the effect of the other on the blood pressure.—Hexamer sea-urchins: Edouard **de Ribaucourt.**—*La graisse* in wine: E. **Kayser** and E. **Manceau.** The change in wine known technically as *la graisse* is complex, and is not caused by a single organism, but by the combined growth of several organisms.—The diminution of the salinity of sea water after filtering through sand: J. **Thoulet.** It is popularly supposed that the salinity of sea water is considerably reduced by filtration through sand. Direct experiments of the author have failed to confirm this.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 23.

ROYAL SOCIETY, at 4.30.—Report on the Eruptions of the Soufrière in St. Vincent in 1902, and on a Visit to Montagne Pelée in Martinique. Part II.: The Changes in the Districts and the Subsequent History of the Volcanoes: Dr. Tempest Anderson.—Petrographical Notes on the Products of the Eruptions of May, 1902, at the Soufrière in St. Vincent: Dr. J. S. Flett.—On the Intimate Structure of Crystals. Part VI., Titanic Oxide, its Polymorphs and Isomorphs: Prof. W. J. Sollas, F.R.S.—Dietetics in Tuberculosis; Principles and Economics: Dr. N. D. Bardswell and J. E. Chapman.—The Origin and Destiny of Cholesterol in the Animal Organism. Part I.: On the so-called Hippocoprosterol: C. Dorée and J. A. Gardner.

ROYAL INSTITUTION, at 3.—Recent Light on Ancient Physiographies: Prof. W. W. Watts, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Standard Performances of Electrical Machinery: R. Goldschmidt.

FRIDAY, JANUARY 24.

ROYAL INSTITUTION, at 9.—The Extinction of Malta Fever: Col. David Bruce, C.B., F.R.S.

PHYSICAL SOCIETY, at 5.—Recalescence Curves: W. Rosenhain.—An Experimental Examination of Gibbs' Theory of Surface Concentration Regarded as the Basis of Adsorption, and an Application to the Theory of Dyeing: W. C. M. Lewis.

INSTITUTION OF CIVIL ENGINEERS, at 8.—A Cost Theory of Reinforced-Concrete Beams: J. R. Wade.—The Neutral Axis in Reinforced-Concrete Beams: E. I. Spiers.

SATURDAY, JANUARY 25.

ROYAL INSTITUTION, at 3.—The Electrification of Railways: Prof. Gisbert Kapp.

MATHEMATICAL ASSOCIATION, at 2.30.—Address by the President, Prof. G. H. Bryan, F.R.S.—On the Teaching of Elementary Mechanics, with Special Reference to the Preparation and Use of Simple and Inexpensive Apparatus: W. J. Dobbs.—On the Teaching of the Elements of Analysis: C. O. Tuckey.—On the Geometrical Treatment of Series in Trigonometry, with Lantern Illustrations: F. J. W. Whipple.—On a New Treatment of Similarity in Elementary Geometry: W. E. Bryan.—Machine for Drawing Rectangular Hyperbolas: H. L. Trachtenberg.

ESSEX FIELD CLUB (at the Essex Museum, Romford Road, Stratford), at 6.—Report of Club's Delegate at British Association, Leicester, 1907: F. W. Rudler.—On Plant Distribution in the Neighbourhood of Felstead, Essex: J. French.

MONDAY, JANUARY 27.

SOCIETY OF ARTS, at 8.—The Theory and Practice of Clock Making: H. H. Cunynghame, C.B.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration and Climbing in the Gurhwal Himalayas: Dr. T. G. Longstaff.

INSTITUTE OF ACTUARIES, at 5.—On the Construction of Mortality Tables from Census Returns and Records of Deaths: G. King.

TUESDAY, JANUARY 28.

ROYAL INSTITUTION, at 3.—Roman Britain: (*a*) Its Frontiers and Garrison: Prof. F. J. Haverfield.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Annual General Meeting.—President's Address: Anthropology in the Eighteenth Century: Prof. D. J. Cunningham, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Continued discussion*: Experimental Investigations of the Stresses in Masonry Dams subjected to Water Pressure: Sir J. W. Ottley, K.C.I.E., and Dr. A. W. Brightmore.—Stresses in Dams; an Experimental Investigation by Means of India-rubber Models: J. S. Wilson and W. Gore.—Stresses in Masonry Dams: E. P. Hill.

WEDNESDAY, JANUARY 29.

SOCIETY OF DYERS AND COLOURISTS, at 8. Colloidal Dyestuffs: Dr. E. Feilmann.—Notes on the Dyeing of Celluloid: Dr. J. N. Goldsmith.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, JANUARY 30.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Observation of Sun and Stars made in some British Stone Circles. Third Note: The Aberdeenshire Circles: Sir Norman Lockyer, K.C.B., F.R.S.—On the Non-periodic or Residual Motion of Water moving in Stationary Waves: Mrs. W. E. Ayrton.—The Refractive Index and the Dispersion of Light in Argon and Helium: W. Burton.—On the Generation of a Luminous Glow in an Exhausted Receiver moving near an Electrostatic Field, and the Action of a Magnetic Field on the Glow so produced: Rev. F. J. Jervis-Smith, F.R.S.

FRIDAY, JANUARY 31.

ROYAL INSTITUTION, at 9.—Recent Researches on Radio-activity: Prof. E. Rutherford, F.R.S.

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