THURSDAY, JUNE 21, 1917.

HISTORY AND MANUFACTURE OF EXPLOSIVES.

Explosives. By Arthur Marshall. Second edition. Vol. i., *History and Manufacture.* Pp. xv+407. (London: J. and A. Churchill, 1917.) Price 2 vols. 3*l.* 3*s.* net.

SELDOM has a book on a technical subject been so fortunate in catching the flood-tide of demand as the first edition of this treatise on explosives. The general excellence of the work, combined with the enormous development in the production of explosives, accounts for the issue of a second edition within two years of its first appearance. As Mr. Marshall points out in his preface, "the war has not caused the introduction of any very novel explosives, despite sensational statements of some journalists."

Although by far the best book written and the most comprehensive in the language, the first edition suffered from some important deficiencies, notably in the small amount of space devoted to nitro-aromatic explosives, and, in the section on materials, to the production of nitric acid and nitrates from the atmosphere, and synthetically. Mr. Marshall makes some apology in his new preface, as follows: "Picric acid, trinitrotoluol, and other nitro-aromatic compounds were formerly merely by-products of the dye industry, and consequently their manufacture seemed only to call for a brief notice in a work on explosives." It is difficult to reconcile this with the information in the text that picric acid was adopted by the Germans in 1888 for filling shell, and about the same time by England. It was used by us for the first time in war at the battle of Omdurman. Or, again, in the case of trinitrotoluol, which we read was adopted by the Germans in 1902 for shell filling, and by Italy in 1907 and by Russia shortly afterwards.

With reference to nitric acid, we find it stated that "before the war nitric acid made from the air could hardly anywhere compete with that manufactured from sodium nitrate, but the blockade of Germany has altered all this." Certainly before the war Germany had not neglected to obtain extensive interests in processes for the production of nitrates and to develop processes for the synthetic manufacture, so as to be in a position of independence of foreign supplies when the foreseen, or planned, developments should arise. On the question of cost, according to such a high authority as Prof. Thomas H. Norton, nitric acid by the Birkeland and Eyde process of fixation of atmospheric nitrogen was but little more than half the cost of the acid from Chile saltpetre at 1914 prices, and by the Ostwald process, from ammonia obtained from cyanamide in the first place, even less than half.

However, in the new edition, the nitro-aromatic explosives are now comprehensively dealt with and form a valuable section of the work. The first chapter of the section deals with the by-products of coal distillation, including outlines of benzol and toluol recovery, and the two succeeding chapters with the nitro-derivatives of aromatic hydrocarbons and other nitro-aromatic bodies.

This increased matter, together with an outline of the various processes for the direct production of nitrates and nitric acid, a section on colloids, and other minor additions, have made it necessary to issue the treatise in two volumes. The first of these deals with the production of military explosives and the principal explosives of the chlorate, perchlorate, and ammonium nitrate classes, most of the explosives of the latter classes constituting those of special importance in mining.

One of the most important matters in connection with aromatic hydrocarbons, and especially their nitro-derivatives, is that of toxic effect. Mr. Marshall devotes little more than a page to this; an inadequate space, and, in addition, the information is by no means up to date, the principal references being to a report of a French Commission (1912) and the curative measures adopted in Germany, quoted from a work by Escales and a journal of 1908. Workers in this country have unfortunately experienced the toxic effects of some of the nitro-products, and deaths from trinitrotoluene poisoning have been recorded in the public Press. Excellent preventive measures are now enforced by regulation, and this section would have been of greater value had some detailed reference to these measures been included. We do not find any reference even to the beneficial results from milk as a beverage. Of course Mr. Marshall is engaged so far from this country that it is not easy for him to keep informed on many of these current problems.

In the section on smokeless powders there is considerable extension of the information relating to French powders. One is particularly struck with the systematic nomenclature employed. Instability of the simple nitro-cellulose powders has often been marked. In France the process of "radoubage," which consisted in soaking old powders of impaired stability in a mixture of ethyl and amyl alcohols, was given up after the *Iéna* disaster, and "remalaxage," where the powder was reworked with ether-alcohol containing amyl alcohol, introduced, but this also has been abolished for some years. It is recognised that diphenylamine has great advantages as a stabiliser over amyl alcohol, the primary function of such addition being the absorption of oxides of nitrogen, which catalytically accelerate decomposition when once formed.

This second edition is dedicated to Mr. Lloyd George, and an excellent portrait of the Prime Minister appears as a frontispiece. Everyone realises under what a debt of gratitude the country is to Mr. Lloyd George, and in no office more so than as Minister of Munitions, but really one cannot see that the value of a manual on a technical subject is enhanced by the inclusion of a portrait of one only connected politically as an organiser with the industry. If any technical book is good, a portrait of a celebrity will not help its usefulness or sale; if bad, no one will want it because of the frontispiece. Technical literature might well be exempt from such embellishments.

"THOUGHT-SUBJECTS."

(1) *The Supervision of Arithmetic.* By W. A. Jessup and L. D. Coffman. Pp. vii+225. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1916.) Price 5s. net.

(2) *Second-Year Mathematics for Secondary Schools.* By Ernst R. Breslich. Second edition. Pp. xx+348. (Chicago, Ill.: University of Chicago Press; Cambridge: At the University Press, 1916.) Price 4s. net.

(3) *Elementary Dynamics of the Particle and Rigid Body.* By Prof. R. J. A. Barnard. Pp. vi+374. (London: Macmillan and Co., Ltd., 1916.) Price 6s.

(1) A CONSIDERABLE amount of elaborate investigation has gone to the making of "The Supervision of Arithmetic." It might very well have been analysed and the results presented in a small pamphlet. It is not clear why the book has been imported into this country. It can be of no earthly interest or value to the English teacher to know in detail a mass of information such as "the distribution of cities according to per cent. time, exclusive of recesses and opening exercises, devoted to arithmetic." The tables appear to be the kind of thing to which in American educational courses a diploma is awarded. If this be the case, it seems that pretentious theses for a master's degree may be compiled without any real thinking being done.

We are likewise at a loss to conjecture for whose benefit the tables are compiled, seeing that elaborate explanations are attached to so many that carry on the face of them their meaning. It is not always easy to see the object of some of the investigations—*e.g.* what is the point in a table showing the order of teaching the multiplication table in cities according to their population? No doubt we are stupid and old-fashioned, but we feel a pricking in our thumbs when we see certain tables which to the mind of the compilers seem to decide "whether the books are arithmetics or something else." It is only fair to add that they have a haunting suspicion that their task may seem "foolish." Be that as it may, they reach a limit (? superior or inferior) when they present us with tables showing from five elementary arithmetics the words that begin with "s" and with "w," respectively (they *say,* "beginning with *s* and *w*"), and when they tell us that 94 proper names are used 342 times, "Ella and Kate 6 times each, Helen 8, Henry 9, Carl 12, Fred and James 16 each, Frank 24, Mary 27, and John 40. There are in the same pages 224 words beginning with *c,* and these words are used a total of 1403 times." To the being of dim and bounded faculties this seems table-making gone astray. It makes us tired.

Though there is much that is interesting and much that is useful, the ideals do not always seem to us to be wholesome. "Translated into words, the table means that in June the graduate of a grammar school [whatever that may mean] should be able to work correctly in eight minutes twelve examples like that under Test i. [adding nine rows of three figures], in four minutes twelve examples like Test ii. [subtracting two rows of ten figures]," in six minutes twelve sums like 4179×36, in eight minutes twelve sums like $61,707 \div 67$, and so on. If the aim is to turn out cheap calculators for business men, we can understand how this will appeal to the commercial instinct, but what a cast-iron ideal for the "graduate of a grammar school," and at what a cost will it be reached!

All this apparatus of statistical stuff appears to be for the benefit of arithmetic "supervisors." *Quis custodiet custodes?* Already the note of revolt has been sounded. We observe that in the last number of *L'Enseignement mathématique* Prof. D. E. Smith delivers his soul on this point: "Unfortunately, our courses on education are so often concerned with measurements of pupils' accomplishment, with statistical curves, and with ephemeral theories based upon limited observations, that teachers of such thought-subjects as mathematics are generally suspicious of their value." We are not in the least surprised.

(2) "The material as arranged in this course opens to the student a broader, richer, more useful, and therefore more alluring field of ideas, and lays a more stable foundation for future work, than does any separate treatment. A great saving of the students' time is effected by developing arithmetic, algebra, geometry, and trigonometry side by side." The first of these statements contains a large claim, but we can say without hesitation that Mr. Breslich's volume is deserving of careful consideration by the teacher of elementary mathematics as a part of general culture. It is conceived on sound lines, and if there are many minor points that invite criticism—*Quot homines, tot sententiae*—the one fact emerges that at the end of a second year the student who has mastered these pages will be in possession of a very satisfactory body of mathematical equipment, and will be fully aware of its practical value in everyday life. His thoughts will be able to play freely, up to a certain point, in three dimensions; he will have acquired something more than a vague idea of the nature of a proof; he will have the feeling that he has assisted in the building up of something definite, and full of meaning, with the aid of tools in the use of which he will see every reason of interest and utility for endeavouring to become more expert. His interest in the great mathematicians

of all ages will have been aroused; he will, no doubt, have drawn from the portraits in the book very vivid and characteristic conclusions as to the personal appearance of men like Klein, Fermat, and Gauss; and, being a lucky American boy, his interest will have carried him yet further to the biographies in the school library. If this is indeed his gain, it is no small acquisition. In most cases it is to be hoped that he will have learned to dispense with the irritating "Why?" which peppers the pages with the doubtful stimulus of a confession of weakness.

(3) Prof. Barnard's volume is very straightforward and is clearly written. The difficulties of beginners are not unknown to him, and in the selection and construction of examples he claims to have borne in mind the advantage of extensive numerical applications and the necessity of constant appeal to fundamental principles. From the outset he brings in the use of limits "as the only satisfactory way of defining such quantities as velocity and acceleration." The advantages of vector analysis are very much in the (Australian) air at the moment, so we have a chapter on the "merest beginnings" of the elements, which is to be regarded as giving "an alternative method of dealing with questions connected with parallelogram laws." The value of what may be called a merely incidental reference to the use of a powerful tool may be questioned. "O the little more and how much it is!" The direct treatment of simple harmonic motion as rectilinear motion under a given law of force is justified by the statement that "it has the advantage that the student is not led to imagine that some special circle has to be thought of in connection with the motion, as is so commonly the case in the common method." About one-fifth of the book is devoted to rigid dynamics. Altogether it is a very interesting endeavour to smooth the path of the beginner who is to continue his study of the subject when provided with the additional weapon afforded by the calculus. W. J. G.

OUR BOOKSHELF.

The Advanced Atlas of Physical and Political Geography. A New Series of Maps Specially Designed for Schools, Colleges, and Private Students. By Dr. J. G. Bartholomew. Pp. 96+31. (London: Oxford University Press, 1917.) Price 8*s.* 6*d.* net.

AT last a British firm has supplied the atlas for which colleges and universities have been asking for years. For anything between school work and a general reference atlas it used to be necessary to go to Germany. The firm of Bartholomew has now produced something far better than a German atlas, and at a price that would be low even in peace-time. Both in its plan and in its execution the atlas is excellent and is deserving of all praise as the best atlas of its kind that has been published. There are ninety-six plates of maps, each plate 13½ in. by 8¼ in., and a full index of names. Most plates contain plans and inset maps, and all are printed in colours. Every country is shown by an orographical map, which contains also political frontiers, railways, and a considerable number of names. A few countries have separate political maps in addition. All the orographical maps are layer-coloured in brown and green. There are, in addition, vegetation, rainfall, temperature, and population maps for each continent. The fineness of the workmanship and the excellence of the colour-printing are noteworthy and maintain the high reputation of the Edinburgh Geographical Institute. The geological map of Europe and the orographical maps of Ireland and of France with Belgium are three specially fine examples of cartography. Among other features of this atlas it should be noted that the projections of all the chief maps are given, and that there are two plates illustrating projections. The countries of Europe are shown on scales varying from 1:1,700,000 to 1:5,000,000, except Russia, which is on a somewhat small scale. It is an atlas that will do much to promote the very necessary extension of geographical teaching which must be the immediate concern of this country. R. N. R. B.

Food and Fitness: or Diet in Relation to Health. By James Long. Pp. ix+208. (London: Chapman and Hall, Ltd., 1917.) Price 5*s.* net.

THIS book possesses a topical interest at the present time, inasmuch as it deals particularly with vegetable foods, giving details of their energy-values and cost at pre-war prices. Although the author states that he is not a vegetarian, the purport of the book is an advocacy of vegetarian principles in diet. It is remarked that the knowledge displayed by owners of stock regarding the proper feeding of their animals is much more profound than that which applies to themselves, which is very true. An excellent chapter deals with the most economical foodstuffs, and the cereals and pulses easily take the first place. The author pleads with justice for an increase in vegetable foods and a decrease in animal ones as age advances and for economy, and the qualities and characters of the principal vegetables and fruits are described, together with suggestions on serving and cooking them.

A chapter on the selection of foods, including animal foods, gives many valuable hints, and another gives records of weights of food before and after cooking. Finally, some useful suggestions are given on sleep and how to attain it, and tables of energy-values of the principal foodstuffs per penny cost complete the volume. While the author's advocacy occasionally leads him to make statements which are not entirely correct, the book as a whole contains a great deal of sound and useful information, and the caterer and housewife who wish to economise will glean from it many valuable suggestions.

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 Origin of Flint.

THE interesting letter of Sir E. Ray Lankester in NATURE of June 7 induces me to offer a brief account of certain experiments I have been making on this subject.

My interest in the origin of flint was aroused by the many fantastically shaped flints like gnarled roots that one comes across when walking over the Downs. These are of many curious shapes, but an interesting point is that when complete there is often one spot which looks like the gutter of a mould.

This suggests that the silica might have trickled through an opening in the chalk held up in colloidal solution by carbonic acid, and then the carbonic acid, combining with the calcium carbonate of the chalk, formed soluble calcium bicarbonate, thus at the same time enlarging the cavity and producing the conditions for the deposit of the silica, which is no longer held up by the carbonic acid, and is precipitated by the crystalloidal calcium bicarbonate now gone into solution. This view is, moreover, supported by the tabular flints referred to by Sir E. Ray Lankester.

If a very dilute solution of sodium silicate be prepared by diluting ordinary waterglass with about 200 times its volume of water, this may be saturated with carbon dioxide without any precipitation, and the solution can be dialysed, so yielding a colloidal solution of silicic acid in carbonic acid.

When a piece of chalk is dipped in this solution nothing happens immediately, but after twenty-four hours a silicic gel appears on the chalk; in the absence of chalk the silicic acid solution keeps for some weeks before passing from its metastable solution over into a gel.

An attempt was then made to simulate natural flint formation by percolating colloidal silicic acid charged with carbonic acid through chalk.

The chalk used was obtained from the South Downs near Jevington. A cubical block was sawn out about 3 in. in the side, a hole was drilled about $\frac{1}{4}$ in. in width and 2 in. in depth, and then a little chalk was scooped away to leave a shallow pit surrounding the hole. Several times daily this was filled up with the dilute silicic acid solution during a period of more than three months, until there was a solid core of silica in the place of the former hole in the chalk. At first the percolation is rapid, but after about a week becomes slower. The silicic acid jelly first formed is very porous, and takes up water readily. Even when a silicic jelly has hardened until it is as hard as and more brittle than glass, it will go on taking up a remarkable amount of dilute silicic acid into its pores, and giving off air-bubbles with a singing noise.

At the end of the experiment the bulk of the chalk was sawn away, and the part containing the deposited silica placed in dilute hydrochloric acid until nearly all the chalk had been removed, leaving just a thin layer at places to show contrast in colour; there remained a cast of the tube and pit at the top resembling in shape a small toadstool with a concave depressed top.

This was insoluble in acid, dark brown in colour, and semi-translucent. It looked like a flint, especially when wet, when it showed up dark brown and semi-transparent against the small amount of chalk that had been left. The only thing lacking was the extreme hardness of flint, for although harder than the chalk and glassy, it crushed under pressure more readily than flint. It still absorbed water, as do flints, and if there were many years of time to spare, it seemed as if it might be possible by such a process to arrive at true flinty hardness.

The process was tedious, and for some reason which I cannot at present understand did not always succeed; an attempt to feed the growth with a wick of cotton threads failed because of an interesting silicification on the fibres which stopped the flow.

BENJAMIN MOORE.

SIR E. RAY LANKESTER'S difficulties as to the origin of flint (NATURE, vol. xcix., p. 283) would be largely removed if it were more generally recognised that the vast majority of flints in all formations, excluding the occasional examples deposited along fissures, are chemical replacements of the limestones in which they occur. Microscopic observation of thin sections has, of course, furnished the most powerful confirmation of this view. The difficulties as to the cause of such replacement are similar in the case of all "concretions" where the original rock-substance has been removed and new material has been substituted. We now know that even iron pyrites may thus replace silicates or quartz, and that massive crystalline ores need not represent the infilling of cavities.

May I refer to some views which would dissociate flints from any special abundance of siliceous sponges along the horizons at which they occur ("The Rhythmic Deposition of Flint," *Geological Magazine*, 1917, p. 64)? The traces of sponges found in flint seem due to the fact that the deposition of the flint has preserved them, while they have been dissolved away from other zones. The paper above referred to may be regarded as a supplement to the general discussion of work on flints in my "Rocks and their Origins" (1912), pp. 38–42.

GRENVILLE A. J. COLE.

June 18.

WITH reference to Sir E. Ray Lankester's interesting notes on "The Origin of Flint" in NATURE of June 7, it is worthy of remark that the structure of black flints, referred to as consisting of minute crystals of silica embedded in colloid silica, may indicate the formation of such flints from the gradual crystallisation of silicic acid gels. Many cases of the production of micro-crystals in artificial inorganic and organic gels are known; indeed, these usually break up eventually with the development of such micro- or macro-crystals. The very slow crystallisation of gelatinous silica appears to be due largely to its small diffusion constant and insolubility.

S. C. BRADFORD.

The Science Museum, South Kensington,
London, S.W., June 14.

Electric Discharge from Scythe.

ON the afternoon of June 4 I was mowing a heavy crop of grass with the scythe when I noticed a sharp crack occurring during the cutting strokes. The noise did not occur at every stroke, but was sometimes heard three times during a stroke. The noise exactly resembled a high-tension discharge, and I can think of no explanation other than that the blade became charged, due to the friction on the very dry grass. It would be interesting to repeat the experiment in the dark, but I fear the grass would not be sufficiently dry. I may add that I am quite satisfied that the noise did not arise from the snapping of dry stems or from the scythe hitting stones, etc.

I should be interested to hear if any of your readers have had a similar experience.

J. R. PANNELL.

Twickenham, Middlesex.

THE RAMSAY MEMORIAL FUND.

THE executive committee of the projected memorial to the late Sir William Ramsay has now issued an appeal to the public for the sum of 100,000*l.* to carry out its objects. The intentions of the committee are described briefly in the subjoined letter, which we trust will be given earnest consideration and be made widely known among people in the position to give the financial support necessary to establish the memorial on a sound basis. The organisation of the movement for a memorial to Sir William Ramsay was described in an article in NATURE of May 10. The final form to be taken by the memorial will depend upon the fund obtained, but the main objects are the institution of Ramsay Research Fellowships and the establishment of a Ramsay Memorial Laboratory of Engineering Chemistry at University College, London. The sum already subscribed by Sir William Ramsay's friends, and through their private efforts, amounts to more than 14,000*l.* This includes the generous gift of 5000*l.* from Messrs. Brunner, Mond, Ltd.; 1000*l.* each from Lord Glenconner, Sir Hugh Bell, Sir Ralph C. Forster, Sir Robert Hadfield, Mr. Robert Mond, and Mr. J. B. Noble; and 500*l.* each from the president of the British Science Guild (Sir William Mather), Mr. Charles Hawksley, and Miss Lilias Noble.

The projected memorial has been conceived on a scale and in a form not unworthy of the great name it is designed to perpetuate, and it is to be hoped that the scheme will be carried speedily to completion by the good will and generosity of a very large public.

The appeal that is made has three features which deserve remark. In the first place it is perhaps the first crucial test put upon the public which will show how far the public opinion of this country, after the stimulus of things revealed by the war, has come to appreciate the worth of those who lead in the advance of science. In the second place it asks for the endowment of the study of science in special relation to its industrial application by the institution of something new in kind. Everyone admits the supreme importance for industry of a close association between chemistry and engineering. Discussion as to the possibility of a new type of university product in the form of chemical engineers or engineer-chemists has recently been eager, and no advocate has been more persuasive than Prof. Donnan, Sir William Ramsay's successor at University College, London. However opinion may differ on some aspects of the question, all will agree that there is much that may be done in the direction desired, and it will be entirely consonant with Sir William Ramsay's interests and his enterprise that first-rate provision should be made for this new experimental development of chemical education.

Lastly, the appeal, made to the whole country, asks for something that is to exist in substance only in one place. It is greatly to be hoped that this will in no degree impede support. It is very necessary that it should be realised in connection with the highest education that there must be some localisation of special branches, and this is eminently a case of the kind. The particular centre of localisation must be determined by the circumstances of the case. Centralisation in London is not likely to be carried beyond a certain point, but in the present instance it can scarcely be considered as otherwise than appropriate, if only from the consideration that the longest and greatest labours of Sir William Ramsay's splendid career were during the tenure of his professorship at University College.

The scientific world may be confidently expected to give its utmost support to the memorial not only by subscribing to the fund, but also by bringing the scheme before all who are interested in the promotion of national development through science. We trust that the appeal for funds will meet with a ready and generous response from a large public.

A COMMITTEE has been formed with the object of raising a suitable memorial to the late Prof. Sir William Ramsay, K.C.B., F.R.S., by collecting a substantial fund to be utilised for the purpose of promoting chemical teaching and research.

The committee, after prolonged and careful consideration, has resolved to aim at raising a sum of 100,000*l.*, and to devote that sum to two principal objects, viz.:—

(1) The provision of Ramsay research fellowships, tenable wherever the necessary equipment may be found.

(2) The establishment of a Ramsay Memorial Laboratory of Engineering Chemistry in connection with University College, London.

We should hesitate to ask for so large a sum of money in such exceptionally difficult times, were it not that the objects specified are objects of real and urgent national importance. The war has demonstrated in a manner previously unrealised the supreme importance of scientific, and in particular chemical, research to the national life, both in the conduct of the war and in the pursuits of industry and manufacture.

The late Sir William Ramsay was himself engaged up to within a comparatively short time of his death in various important problems concerned with the bearing of chemistry upon the war, and no one realised more completely than he the potentialities of the plans which have since been formulated by this committee as a memorial to him.

It is important that the fund should be raised speedily, so that the plans for the laboratory of engineering chemistry and the scheme for the award of fellowships may be prepared before the end of the war, and so that both schemes may begin to operate with as little delay as possible after the return of peace.

Accordingly, we desire, through the columns of your paper, to appeal to friends and admirers of the late Sir William Ramsay, to old students, and to all persons who are interested in chemistry and its application to industry and manufacture, to contribute to this great national and international memorial to the late Sir William Ramsay, and to send their subscriptions to the hon. treasurers of the Ramsay Memorial Fund at University College, London, W.C.1.

H. H. ASQUITH.	President.
D. LLOYD GEORGE.	Vice-Presidents.
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HUGH BELL.	Chairman of the Executive Committee.
GLENCONNER.	Treasurer.

June 16.

THE CATERPILLAR ATTACK ON FRUIT TREES.

A GOOD deal has been heard recently about the caterpillar plague on fruit trees. There has undoubtedly been an abnormal attack in many parts of the country, and much damage has been done. In some parts of Kent, Sussex, Herefordshire, and Worcestershire orchards have been denuded of their foliage, and many more partially damaged. In many instances not only has this year's promising crop gone, but the trees have had a serious setback for next season. Apples and cherries have suffered most, but in a few districts plums have been badly invaded; currants also have suffered. In some districts visited much of the fruit was only slightly affected; some orchards well cared for, not at all; whilst others were as bare as in midwinter, and a fresh set of leaves was already appearing.

Most of the harm has been done by the Winter Moth (*Cheimatobia brumata*). In company with it has been a fair sprinkling of the Mottled Umber (*Hybernia defoliaria*) larvæ. Another "Looper" larva has done much harm in parts of Herefordshire, the Pale Brindle Beauty (*Phigalia pilosaria*), and also in Kent and at one locality in Sussex; it is usually worst in plantations near oakwoods. Comparatively few March Moth (*Anisopteryx aescularia*) have occurred. All those mentioned have either apterous or nearly apterous females, and are incapable of flight. A few are, however, carried by the males *in copula*. From several localities in Kent and Sussex numbers of Clouded Drab Moth (*Taeniocampa instabilis*) have been received; this insect appears to be becoming more harmful to fruit in the south of England.

The main damage done has clearly been due to the insects mentioned, by far the greater part by the Winter Moth, the Pale Brindle Beauty having been very harmful in a few localities only. These caterpillars have now done most of their work, but the fruit-grower is still being harassed to some extent by the Lackey Moth (*Clissiocampa neustria*) and the Little Ermine (*Hyponomeuta padella*). How far these attacks will develop it is impossible to say.

The amount of loss has been due very largely to the serious lack of labour. Many plantations have been improperly cultivated or, from lack of labour, not cultivated at all. It has too often been quite impossible to spray the trees, and even last year there were not sufficient men on many farms effectually to grease-band them. For Winter Moth and its allies two methods of treatment meet with complete success, if properly carried out, which can only be with the necessary supply of skilled labour. The first is grease-banding; the second, spraying with arsenate of lead, where the former cannot be done, as on bush trees or where such pests as the Clouded Drab Moth occur. If grease-banding on standards and half-standards is to be of any use, the bands must remain sticky from October to April, and the bands must be complete, not, as the writer has seen this year, with many breaks in them. If arsenate of lead spraying is done, then, it must be carried out at the proper time and thoroughly. Many growers have sprayed when they found the blossom trusses going and the leaves fast disappearing. This is too late, for the damage is done, the caterpillar working most rapidly towards the close of its life. Apples should be sprayed as soon as the buds are well open, and may have to be sprayed again when the blossom trusses begin to expand. One good spraying as soon as the young "Looper" larvæ are seen will save the crop, whilst to spray when all the damage is done is waste of time and money.

Most of the loss this season to apples and other fruit could, and doubtless would, have been saved had proper provision been made for the necessary skilled labour.

One other point is worth mentioning, namely, that during the winter in many districts there was a great mortality amongst sparrows. The sparrow, especially when nesting, devours Winter Moth larvæ and undoubtedly helps to keep them in check, which, however, will not make up for its many evil habits. FRED. V. THEOBALD.

PROF. T. MCKENNY HUGHES, F.R.S.

THOMAS McKENNY HUGHES, Woodwardian professor of geology in the University of Cambridge, died at Cambridge on June 9, in his eighty-fifth year.

Hughes was born at Aberystwyth, and was the son of the Rev. Joshua Hughes (afterwards Bishop of St. Asaph), and grandson of Sir Thomas McKenny, Bart., who took a prominent part in promoting Catholic emancipation in Ireland. His brother is Bishop of Llandaff. On leaving school, he entered Trinity College, Cambridge, where he graduated in 1857, proceeding to the M.A. degree ten years later. When an undergraduate he attended the geological lectures of his predecessor in the Woodwardian chair, Prof. Sedgwick. In 1860 he was appointed secretary to the British Consul at Rome, and during part of that and the following year was left in charge as Acting Consul; but before the year 1861 closed he definitely gave up diplomacy for geology, and joined H.M. Geological Survey. He was a member of the Survey until 1873, when he was elected to the Woodwardian professorship. From that date until his death his time and energy were devoted to the cause of the Cambridge

School of Geology, with a success which is fully proved by the high position which that school now occupies.

Hughes's life-work may be conveniently regarded under two heads: his original work in geology and archæology, and his labours in connection with the Cambridge School. The greater part of his geological researches was carried out during his period of service on the Geological Survey and the earlier part of that of his occupancy of the Woodwardian chair. The duties of his professorship became heavier as time went on, and the output of geological papers naturally diminished, though it by no means ceased. During this time he found a pleasant relaxation from official work in archæological study, and enriched many archæological journals with contributions of considerable interest and value, many of which dealt with the antiquities of the Cambridge district.

His most important geological writings were concerned with some of the earliest and the latest deposits. He took a prominent part in the establishment of the pre-Cambrian age of certain rocks of North and South Wales, and wrote much of value concerning the Lower Palæozoic rocks of the Principality and of the borders of Lakeland. He was greatly attracted by the many vexed questions connected with the Glacial and post-Glacial deposits, especially those bearing upon the problem of the antiquity of man: here, also, he added much to our knowledge.

The value of Hughes's work was gracefully recognised by Sir Archibald Geikie when, as president of the Geological Society, he presented Hughes with the Lyell medal in 1891:—"You have not confined yourself . . . to the rocks of any one system or period, but have ranged freely from Archæan gneiss to raised beach, hovering for a moment here and resting a little there, generally critical, almost always suggestive, and with that happy faculty of enthusiasm which, reacting on younger minds, 'allures to older worlds, and leads the way.'"

Turning now to Hughes's work in connection with the Cambridge School of Geology, one was struck by his many qualities making for success. In addition to his scientific attainments, he possessed an acute instinct for judging character, unbounded energy, and an exceptional degree of enthusiasm, which he retained to the end. Not the least of his qualities were those social ones which, causing him to be a favourite among all ranks, were peculiarly valuable when dealing with those with whom he was brought into contact in his official capacity. He exercised a wise control over his department. Using much judgment in the selection of his subordinates, he ever afterwards allowed them a freedom of action which not only ensured a smoothness in the working of the machinery, but also greatly increased its efficiency. Much of the teaching was left to the lecturers and demonstrators, but his own courses were very attractive and highly appreciated. His qualities as a teacher stood out most prominently when conducting field excursions, whether around Cambridge or in other parts of the country. Few gatherings were more delightful than those at his long excursions, and the amount of knowledge acquired by his pupils was great, for Hughes was at his very best on these occasions.

Hughes was very successful in inducing people to take up the study of geology, and was responsible for the addition of many to the ranks of that body which is now becoming all too limited —that of the amateur geologists. To all students alike he was accessible and ever ready with help in the museum and at his home. Here he was greatly aided by his accomplished wife, who died last year. She was the daughter of the Rev. G. F. Weston, Hon. Canon of Carlisle, and was an able geologist and naturalist.

Owing partly to Hughes's own exertions, partly to his persuasive manner, he left the collections in the Sedgwick Museum, already valuable at the time of his election to the professorship, much enriched by his labours. Especially noteworthy is the collection of building stones, marbles, etc., brought together by Mr. John Watson, M.A., through the professor's influence, for he was fully aware of the importance which economic geology must assume in university study. Not only did he add largely to the collections, but, after many delays, he had the satisfaction of seeing them housed in the magnificent Sedgwick Museum, which, largely owing to his unwearied efforts, was completed and finally opened by King Edward VII. in 1904. Another task which partly fell to him was the writing of the life of his predecessor in office. This was finished in 1891, when "The Life and Letters of the Reverend Adam Sedgwick," by John Willis Clark and Thomas McKenny Hughes, appeared.

For want of space, full notice cannot be taken of his many activities unconnected or only indirectly connected with geology, but mention must be made of his interest in agriculture. He took an active part in the proceedings of the Cambridge and Isle of Ely Chamber of Agriculture, of which he was a past-president.

Some of the positions which Hughes occupied and the honours he received have already been mentioned. In addition, he was a professorial fellow of Clare College, F.R.S., and honorary member of many British and foreign learned societies. He was also a Chevalier of the order SS. Maurice et Lazarus (Italy).

It is interesting to note that Hughes and his predecessor occupied the Woodwardian chair for ninety-nine years.

He leaves three sons, all of whom are serving in the Army. J. E. MARR.

NOTES.

A MEMORIAL tablet, including a medallion portrait of the late Sir William Ramsay, K.C.B., F.R.S., is to be erected in the University of Glasgow, of which he was a graduate and teacher. The University Court has arranged that the memorial, which is designed by Sir John J. Burnet, shall be placed in a conspicuous position at the entrance to the Bute Hall.

IN order to promote the further development of the dye-making industry in the United Kingdom, the President of the Board of Trade has decided to establish a special temporary department of the Board of Trade to deal with matters relating to the encouragement, organisation, and, so far as necessary, the regulation of that industry. The department will be under the direction of Sir Evan Jones, Bart., who has placed his services at the disposal of the President, and will have the official title of Commissioner for Dyes. The Commissioner will act in close consultation with the various dye-making and dye-using interests concerned. Any communications on the subject should be addressed to:—Commissioner for Dyes, Board of Trade, 7 Whitehall Gardens, London, S.W.1.

WE learn from the *Scientific Monthly* that the Council of National Defence and the U.S. National Research Council have sent six American men of science to England and France to study problems arising out of the war. Members of the party and the subjects in which they will specialise are:—Dr. J. S. Ames, Johns Hopkins University, aeronautical conditions; Dr. R. P. Strong, Harvard University, and Dr. L. R. Williams, assistant health commissioner of New York State, health and sanitation; G. A. Hulett, Princeton University, chemistry of explosives; Dr. H. F. Reid, Johns Hopkins University, scientific map-making and photography from aeroplanes; and Dr. G. R. Burgess, of the Federal Bureau of Standards, metals suitable for guns and rigid dirigibles.

As a result of a long series of experiments an important use for horse-chestnuts has been found in connection with the war, one of the principal results of which will be the liberation of a large quantity of maize hitherto used for another purpose. An appeal has been issued by the Food (War) Committee of the Royal Society for the systematic collection of horse-chestnut seeds during the forthcoming season. It is estimated that every ton of chestnuts collected will be equivalent to half a ton of maize, so that the careful collection of all the available supplies becomes a matter of vital importance. Any quantity up to 17,000 tons of chestnuts per week can be used. An organisation for the collection and transport of this hitherto waste product is being perfected, details of which will be announced later. The work of collecting is one in which many people can render service, as the trees are so universally grown, and gathering the nuts is a matter of no difficulty. Owing to the fine weather during the blossoming time, there is every prospect this year of a heavy crop of chestnuts.

THE President of the Board of Agriculture and Fisheries has appointed an Advisory Committee to consider and report upon technical questions of poultry management and feeding, both in general and in detail, and on general questions of the organisation of the poultry industry, with the view of securing that the readjustment of the industry to war conditions shall be made in the most approved manner. The committee is constituted as follows:—Mr. T. W. Toovey (chairman), National Utility Poultry Society; Mr. Gerald Martin, Ministry of Food; Mr. P. A. Francis, Board of Agriculture for Scotland; Mr. Wilfred Buckley, Agricultural Organisation Society; Mr. Tom Barron, National Utility Poultry Society; Mr. W. G. Tarbet, Utility Duck Club; Mr. Tom Newman, Scientific Poultry Breeders' Society; Mr. C. Longbottom, Northern Utility Poultry Society; Mr. F. M. Youngman, J.P., Framlingham and Eastern Counties Egg and Poultry Co-operative Society; and Mr. G. Tyrwhitt Drake, Poultry Club; also a representative, when required, of the Poultry Research Society. The secretary is Mr. J. R. Jackson, Board of Agriculture and Fisheries, 4 Whitehall Place, S.W.1.

THE Edison medal of the American Institution of Electrical Engineers has been awarded to Mr. Nikola Tesla, for early original work in polyphase and high-frequency electric currents.

ACCORDING to notices in the French Press, the Société des Mines de la Loire has just started the first of two electric furnaces of 500 kilowatts for the manufacture of synthetic pig-iron, utilising current from its own generating station.

APPLICATIONS are invited for the Dr. Jessie Macgregor prize for medical science of the Royal College of Physicians, Edinburgh. The prize is of the value of about 75*l.*, and is awarded triennially for the best record of original work in the science of medicine. Candidates for the prize must send their applications before July 23 next.

WITH reference to a paragraph which appeared in NATURE of June 14 (p. 312), the (Italian) General Council of Limited Liability Companies has considered the proposal of the Scientifico-Technical Committee as regards contributions by manufacturers towards the scheme for improving science laboratories in Italy. The manufacturers present at the meeting decided unanimously on an annual grant of 25,000 lire for the object mentioned.

DR. H. R. MILL records, in the *Times* of June 19, that the thunderstorm between 5 and 7 p.m. (summer time) on Saturday, June 16, was, if measured by rainfall, one of the most severe ever experienced in London. More than 2 in. fell over an area measuring ten miles from Barnes to Finsbury Park and four miles from Hyde Park to Willesden Green. At two points within this area more than 3 in. was reported—viz. 3·20 in. at Campden Hill, Kensington, and 3·37 in. at Barrow Hill, north of Regent's Park. Such falls in a short period have only been exceeded in the London area, so far as Dr. Mill has been able to ascertain, by 3·42 in. at Blackheath on July 23, 1903, and by 3·90 in. at Hampstead on April 10, 1878. On June 23, 1878, Mr. Symons recorded at Camden Square a fall of 3·28 in. in about an hour and a half; on Saturday last the recording gauge showed that 2·86 in. fell in two hours, and no heavier rain has been recorded at Camden Square in the thirty-nine intervening years.

THE Geological Survey of Ireland has suffered a further loss in the death of Lieut. Horas T. Kennedy, who was killed on June 6 during the great operations south of Ypres. Lieut. Kennedy was born in London in 1889, but was of Irish parentage. After securing a senior scholarship at Trinity College, Cambridge, and taking a first class in the Natural Science Tripos, he gained, by open competition, the post of Geologist on the Geological Survey of Ireland in 1913. His work lay in the re-examination of the Leinster coalfield, in view of industrial developments in that district. He was also about to undertake the revision of certain Silurian strata in western Ireland, where he would undoubtedly have shown his powers of original research; but he obtained a commission in the North Staffordshire Regiment when war broke out, and was transferred later to the Royal Scots Fusiliers. During a short period of leave in the autumn of 1916, he married the second daughter of the Very Rev. C. T. Ovenden, Dean of St. Patrick's, Dublin. His scientific training led to his being attached to the Royal Engineers at the close of that year. He was keenly looking forward to a return to work in his own country at the conclusion of the war, and the loss of his helpful comradeship is deeply felt by his colleagues on the Survey staff.

THE death occurred at Leeds, on June 7, at fifty-nine years of age, of Mr. Samuel Margerison, a well-known Yorkshire botanist and authority on afforestation. Mr. Margerison did valuable work as a member of the Yorkshire Botanical Survey Committee of the Yorkshire Naturalists' Union, and being an enthusiastic and skilful gardener, he was for some time a prominent and active member of the North of England Horticultural Society. As an expert in afforestation, his advice and help were frequently sought by various local authorities, and he had given expert assistance to the Leeds Corporation Waterworks Committee in its scheme for the afforestation of the Washburn Valley, near Otley. At the Bradford meeting of the British Association in 1901 he read an interesting paper on British sylviculture, in which he pointed out the great importance of maintaining an adequate supply of native timbers. He directed attention especially to the fact that although the natural conditions in this country are not less favourable, the comparison of the results of Continental sylviculture with ours shows that our management is generally inferior, and our forests much less productive. He emphasised strongly the need, in this country, of a sound and effective training in scientific forestry, with adequate practical and scientific equipment, worthy of the subject and of its importance as a national industry.

BOTANISTS will learn with deep regret of the death on May 29 of Dr. Sarah M. Baker at the early age of twenty-nine. Dr. Baker was a student of University College, London, from 1905. She graduated in science (chemistry and botany) in 1909, and proceeded to the D.Sc. in 1913. For five years she had held the position of Quain student in the department of botany, and was shortly to have been appointed to a new lectureship specially created for her. The investigations which she completed in a relatively short period of activity tend to emphasise the loss which science has sustained. Her paper entitled "Quantitative Experiments on the Effect of Formaldehyde on Living Plants" (1913) shows her mastery of biochemical technique, and may serve as a model of what such an investigation should be. It was in connection with this work that Dr. Baker devised the very ingenious automatic waterer whereby the culture-plants could be raised from seed and grown on for long periods without interference of any kind with the progress of the experiment. This contribution was followed by researches on osmotic phenomena, with especial reference to the mechanism of entry and transport of water in plants. Dr. Baker was led to the assumption of both hydro- and aero-permeable regions in roots, the former admitting the nutrient salts, the latter vapour which underwent condensation. Her preliminary paper "On the Liquid Pressure Theory of the Circulation of Sap in Plants," as was to be expected, met with a good deal of criticism. The full paper dealing with this work was only recently completed and will, it may be hoped, be published shortly. In addition to these, there was a series of four papers on the ecology and biology of brown seaweeds, based on field investigations carried out at her father's country cottage at Mersea Island, at Blakeney Point, and elsewhere. The drawings which illustrate some of these are fine examples of line work, deserving of the highest praise. It was characteristic of Dr. Baker to throw herself ardently into whatsoever she undertook. Thus for the purpose of a public lecture recently delivered on vegetable dyes, she worked through the whole chemical basis of the subject, and was not content until she had discovered a number of new dyes by the employment of mordants not previously used. At the time of her death she was investigating critically the bread-making value of a number of substitutes for wheaten flour. Dr. Baker had many interests outside her scientific work, and it is possible that the cumulative draft on her energies may have hastened her death. Her loss will be felt as a personal bereavement by all her colleagues and pupils.

UNDER the title of "Thirty Years' Work of the Geographical Society" Dr. J. Scott Keltie gives, in the *Geographical Journal* for May, a charming sketch of the earlier "stalwarts," scholars, and explorers who have during that period contributed to the advance of geographical science. He dealt in detail with the most important developments during the last thirty years, and he pointed out the progress made by the society. The membership has increased from 3370 to more than 5000; its income from 8600*l.* to 13,000*l.*; and its library from 20,000 volumes to about 66,000. The want of accommodation for its members and collections has been met by the removal of the headquarters from Savile Row to Lowther Lodge. On the whole this instructive review marks a steady advance in the popularity and influence of this great society, on which the council and its officers deserve warm congratulations.

IN *Folk-lore,* vol. xxviii., No. 1, for March last Dr. R. R. Marett, who has done admirable work in guiding the Folk-lore Society during the inevitable difficulties resulting from the war, devoted his presidential address to a review of two pioneers of the society's work who have recently passed away—Sir E. Tylor and Sir L. Gomme. He pointed out that these two scholars, working on somewhat different lines, aimed at the same object, and that their work was in a true sense complementary. He contrasted the two phases of thought, the ethnological and evolutionary schools, which now occupy the field. He showed that the problem of culture-contact in its varied forms is now of primary importance, particularly in its bearing on the origin of the folk-tale. He suggests an eirenicon between the "diffusionist" and the "casualist" schools, the one advocating the origin of tales from a single centre, the other fixing its attention on survivals in custom, belief, and ritual which appear as incidents in the stories.

MISS MAUD D. HAVILAND contributes to *British Birds* for June some valuable notes on the breeding habits of the dotterel (*Eudromias morinellus*) on the Yenisei, where she found it nesting both in swampy ground, such as a snipe might choose, and in more typical places, where the ground is dry and stony. Her notes on the simulation of injury made by the brooding birds to draw off intruders from the neighbourhood of the nest are borne out by those of other observers, but we believe her observations on the protective character of the plumage of this species are new. In the same issue Lieut. D. H. Meares records the field-notes of his brother, the late Capt. C. S. Meares, on the nesting habits of this bird in Scotland. While these notes confirm those of Miss Haviland, they supplement them by describing the character of the lining of the nest.

THOUGH we are assured that "after the war" scientific research is to receive substantial aid from the State, there is reason to fear that this aid will be given with qualifications. In other words, the promise is extended only to investigations calculated to further the ends of commerce. Students of what is commonly known as "pure science" will not only not participate in the grants that are to be made, but they may be called upon to subsist upon even smaller doles than were allotted to them in the pre-war days. Our administrators seem incapable of appreciating the fact that "applied science" has its roots in "pure science," so that if these be starved the tree will of necessity be stunted. This much is well brought out by Principal Charnock Bradley in a presidential address delivered in 1915, and printed in the Proceedings of the Royal Physical Society, part ii., vol. xx., which might be read with profit by all concerned in allocating the grants which have been promised.

WE are glad to see that in spite of the strenuous times through which they are passing, our Russian Allies still manage to maintain their keen interest in pure science and to continue the publication of those journals which were recently founded with the view of making Russian investigators independent of German channels of publication. Some months ago we noticed the appearance of the first number of the *Revue Zoologique Russe*. The first volume (for 1916) is now completed, and the second (1917) already begun. The contributions range over a great variety of subjects, including systematic zoology, protozoology, cytology, embryology, and experimental zoology, and there is a comprehensive bibliography of current Russian zoological literature, which affords a striking testimony to the activity of Russian workers. Apparently there is no paper shortage in Russia, and the attitude of the authorities towards scientific publication during the war would appear to be very different from what it is in this country. The majority of the memoirs published in the *Revue Zoologique Russe* are naturally written in the Russian language, but there are a few in French or English, and the Russian papers have French or English summaries. The review should therefore appeal to zoologists in many parts of the world, especially as it contains numerous articles of general biological interest. Amongst the latter we may direct attention to a thoughtful paper by Eug. Schultz, written in French, on the application of experimental psychology to the phenomena of morphogenesis. The review is well printed and illustrated, and we hope that the enterprise of the publishers will be rewarded by a wide circulation.

THE sixth half-yearly review of the world's production, distribution, and consumption of fertilisers issued by the International Institute of Agriculture in March last is an interesting commentary on the influence of the war upon this important group of industries in the past year. Mineral phosphates, of which the production in 1913 amounted to roughly 6 million tons, and in 1915 to 3½ million tons, fell still further to 2·8 million tons. The decrease as compared with 1915 was due entirely to a great drop in the American production, which for the first time fell far below that of North Africa. The production of superphosphate showed an even more marked decline on account of the difficulties of obtaining supplies of sulphuric acid. The production and export of nitrate of soda reached the high-water mark of three million tons. The data for sulphate of ammonia are naturally incomplete, being limited to Allied and neutral countries. The British production showed a slight increase over that of the previous year, whilst the production of the United States was the largest on record, being practically 50 per cent. higher than in the previous year.

IN the report of the Board of Agriculture and Fisheries on the agricultural output of Great Britain (Cd. 6277), made in connection with the Census of Production Act, 1906, the output per person permanently employed in agriculture was ascertained to be 90*l*., counting the farmer in, or 129*l*. if the occupiers were excluded. A general confirmation of this figure, making due allowance for the rise in prices of agricultural produce since 1906, has been arrived at by Mr. C. S. Orwin, director of the Institute for Research in Agricultural Economics of the University of Oxford, in an analysis of the accounts kept at the institute in 1914–15 of six farms of varied type in widely different parts of the country. The results are summarised in the May issue of the *Journal of the Board of Agriculture*, and show an average net output per man (occupiers excluded) of 169*l*. The proportions of the net output assignable to farmer, labour, and landlord worked out at 47·9, 29·9, and 22·2 per cent. respectively, the variation from farm to farm being surprisingly small. The proportions of net *output* falling to the farmer and landlord are subject to considerable deductions before the net *returns* can be arrived at, and a recalculation of the figures with the view of assessing the latter indicated the average share of each interest on all the holdings to be 40·7 per cent. to the farmer, 39·5 per cent. to labour, and 19·8 per cent. to the landlord.

IN a paper read before the Carpenters' Company in London on April 4, published in pamphlet form by the Oxford University Press, Prof. W. Somerville gives an account of forestry in Britain during the last thirty years. Progress, except in increased facilities for education, has been very meagre. "There has been practically no afforestation of fresh land, and what little has taken place has been more than cancelled by the curtailment of the area of previously existing woodlands." Prof. Somerville, believing that national afforestation is essentially a subject for direct action by the State, advocates "the creation of a strong central authority with power to survey and schedule all land that is more suitable for afforestation than for other purposes. Experience in the past has unfortunately shown that the Government is apt to seize on any excuse for delaying action, and the country must see to it that directly the survey has revealed a single area afforestation shall proceed." In some cases the capital required for the work would be provided by the Government in the form of a loan. It is not to be expected, however, that private action will do much to clothe with trees the wide stretches of poor pastoral land that constitute the bulk of our afforestable area, and purchase outright by the State would seem in this case to be the only practical procedure, or, as an alternative, the owner might be given the option of granting a perpetual lease to the Government, receiving an annuity as rent. While most of the land would probably be obtainable by mutual agreement, the State must be provided with compulsory powers to be used where necessary.

THE fossil fishes in the United States National Museum, Washington, have lately been arranged by Dr. C. R. Eastman, who publishes notes on some of the specimens in a new part of the Proceedings of that museum (vol. lii., pp. 235–304, plates 1–23). American geologists appear now to be satisfied that the fragmentary fish-remains discovered by Dr. C. D. Walcott near Cañon City, Colorado, are really of Ordovician age, as originally claimed by him; and equally old fragments are now recorded both from the Bighorn Mountains of Montana and the Black Hills of South Dakota. Most of the specimens are too much broken for exact determination, and Dr. Eastman has not attempted any new study of them; but he describes a small dermal plate of Astraspis, which he compares with the median dorsal shield of the European Devonian Psammosteus. Among Lower Carboniferous remains from Missouri he identifies an interesting new form of the supposed Chimæroid head-spine, Harpacanthus. Triassic fishes are well represented in the collection, and parts of the trunk apparently of a new species of Lepidotus are described from Utah. The Jurassic and Cretaceous fishes are scarcely noticed, but there are several brief descriptions of American Tertiary fishes illustrated by well-reproduced photographs.

A COMMUNICATION has reached us from Messrs. Bellingham and Stanley, Ltd., in which attention is directed to an interesting point in connection with the design of the Zeiss Abbe refractometer. It has been observed recently by users of the instrument that, owing to want of illumination, measurements cannot be made for liquids having a refractive index greater than 1·52. It is plainly stated in the Zeiss catalogue that the Abbe refractometer may be used for the measurement of refractive indices from 1·30 to 1·7, and that the liquid to be examined is enclosed between two prisms of flint glass. In the instrument as actually constructed it appears that a crown glass prism of low refractive index ($N_D = 1·52$) has been substituted for the dense flint prism ($N_D = 1·75$) used at first as the lower or illuminating prism. The contact surface of this prism is left unpolished, so as to scatter the light entering the liquid film. The process of wiping the surface to remove the liquid which has been examined results in the removal of the thin sharp walls left by the abrasive, and the surface approximates to a polished face. When this is the case very little light can fall on the contact surface of the liquid and the upper prism at angles greater than the critical angle unless the lower prism has a refractive index greater than that of the liquid under test; for it is only when this condition is satisfied that light entering the liquid is bent away from the normal. Several such instruments have been rendered serviceable for the measurement of liquids of refractive index as high as 1·70 by replacing the crown illuminating prism by a suitable dense flint prism. In using the refractometer for solid and plastic bodies it would be more convenient if the prism box were designed to open away from the operator.

Engineering for June 8 contains an illustrated account of the reconstruction of the Union Pacific railroad bridge at Omaha. The new bridge consists of four through Pratt-riveted chord spans, 246 ft. long, one through riveted span 130 ft. long, and two through Pratt-riveted spans 120 ft. long, four deck-plate girders 67 ft. long, and two deck-plate girders 50 ft. long, for two tracks. The total length of the bridge is 1722 ft., excluding approaches; the total weight of the new bridge is about 11,250,000 lb., as against 5,500,000 lb. in the old bridge replaced. The new bridge rests on the original piers, and, in order to interfere with traffic as little as possible, the following method of reconstruction was adopted. The original piers were extended on the up- and down-stream sides by temporary timber piers. The new spans were erected complete on the temporary down-stream piers. The bridge was closed for traffic shortly after 11 a.m. on December 23, 1916, and by twelve o'clock the old spans had been rolled on to the temporary up-stream piers. The new spans were then rolled into position on the piers, this work being completed by 4 p.m. Track crews then closed up the tracks, and signalmen bonded the joints so that automatic signals were restored to operation immediately. Traffic over the bridge was restored at 9.39 p.m. The design and construction of the new bridge have been handled under the direction of Mr. E. E. Adams, consulting engineer of the Union Pacific system.

THE valuable scientific work carried out by Australian men of science is conspicuously shown in the thirty-ninth volume of the Transactions of the Royal Society of South Australia (1915). More than 800 pages, illustrated by seventy plates, are occupied by papers in various departments of science. Most of the shorter papers deal with zoology or botany, but geology and astronomy are also represented. Among the longer papers are notes on the "Fishes of the South Australian Government Trawling Cruise, 1914," by E. R. Waite and A. R. McCulloch; an account of the "Natives of Mailu, Papua," by Dr. B. Malinowski; and "Scientific Notes on an Expedition into the North-western Regions of South Australia," by members of the expedition. The report of the society also records its activities in the popularising of scientific studies by lectures, exhibitions, and excursions, in the discovery of new animals and plants, and in the preservation of Australian fauna and flora. The committee and members of the society may be congratulated on their fine record.

A TREATISE on "Gyrostatics and Rotational Motion" by Prof. Andrew Gray is in the press, and will be published by Messrs. Macmillan and Co., Ltd., as soon as present circumstances permit. The work aims at giving a complete account of tops and gyrostats, gyrostatic action in machinery, and gyrostatic appliances. The general theory is fully dealt with, but an attempt has also been made to treat all the more important special problems by direct reference to first principles in each case. Mathematical difficulties are not avoided, but the relative importance of physical ideas has been kept in view and enforced by careful descriptions of the latest practical gyrostatic inventions, so far as the public service permits.

MESSRS. O. DOIN ET FILS, of Paris, have begun the publication of a series of handy volumes entitled "Bibliothèque de Biologie Générale," under the editorship of Prof. M. Caullery. Up to the present two works have been issued, but volumes have been arranged for dealing respectively with Les Phénomènes vitaux; La Cellule (Morphologie et Physiologie), Prof. M. Henneguy; Les Formes larvaires et les Métamorphoses, Prof. C. Pérez; La Reproduction asexuée; La Régénération et la Greffe, E. Bordage; La Sexualité et la Parthénogénèse; Les Corrélations organiques et l'Individualité, E. Guyénot; L'Irritabilité et les Tropismes; Les Mutations matérielles dans les êtres vivants (aliment et milieux nutritifs); Les Mutations énergiques dans les êtres vivants (luminosité, chaleur, électricité, etc.); La Biologie des Pigments, Prof. J. Cotte; Ethnologie et Organisation; Commensalisme, Symbiose, Parasitisme; Les Milieux biologiques marins, P. M. de Beauchamp; La Biologie des eaux douces; Les principaux faciès biologiques terrestres; La Concurrence vitale; L'Hérédité; La Variation; L'Hybridation; L'Espèce; L'Adaptation; La Phylogénie; and Les Théories évolutionnistes.

THE Rede lecture, on "Science and Industry: the Place of Cambridge in any Scheme for their Combination," which was delivered on June 9 by Sir R. T. Glazebrook, and is abridged elsewhere in this issue, is to be published immediately by the Cambridge University Press.

OUR ASTRONOMICAL COLUMN.

COMET 1916*b* (WOLF).—The following continued ephemeris of this comet, which is now very faint, is given by Dr. Kobold :—

1917	R.A. h. m. s.	Decl. ° ′	Log *r*	Log Δ	Mag.
June 22	22 32 14	+23 51·9	0·2273	0·0751	10·2
24	36 6	24 3·5			
26	39 53	24 13·5	0·2282	0·0677	10·2
28	43 35	24 22·0			
30	47 11	24 28·8	0·2295	0·0604	10·2
July 2	50 42	24 34·0			
4	54 7	+24 37·6	0·2312	0·0531	10·1

The ephemeris is for Greenwich midnight.

SOLAR PROMINENCES IN RELATION TO SUN-SPOTS.—It has hitherto been generally supposed that solar prominences are inevitably, or usually, found in close connection with sun-spots and flocculi, but an extended investigation which has been made by Dr. O. J. Lee appears to show that there are no substantial grounds for this supposition (*Astrophysical Journal,* vol. xlv., p. 206). His conclusions are based on the photographs taken with the spectroheliograph of the Yerkes Observatory between March, 1904, and January of the present year, thus covering more than a spot cycle. Only 5·8 per cent. of 4068 prominences of all sizes, which were observed between +45° and −45° of solar latitude, were found in the immediate vicinity of spots, and in the same region only 8 per cent. of the prominences were associated with flocculi in which no spot was observed. On the other hand, 81 per cent. of the seventy-eight filaments observed near the solar limb showed a connection with prominences. A considerable number of the large eruptive prominences occurred either in unmarked regions of the solar surface, or where the surface was roughened. Intensely bright places in areas of flocculi, when traced to the limb, usually showed as jets, and rarely as prominences of any size.

THE ECLIPSING VARIABLE SS CAMELOPARDALIS.—Some interesting results with regard to this variable have been derived by R. J. McDiarmid from a series of nearly 11,000 observations made at Princeton between March, 1913, and December, 1915 (*Astrophysical Journal,* vol. xlv., p. 50). The period is 4d. 19h. 47m. 6·4s., and the visual and photographic magnitudes of the system are respectively 10·15 and 9·9. The depth of primary eclipse is 0·57 mag., and that of the secondary 0·15 mag. The primary eclipse lasts twenty-one hours, and is total for seven hours, while the secondary is annular and of the same duration. The discussion of the observations indicates that the system consists of a large red star of low surface brightness and a smaller white star of a little more than one-third the diameter of the other. The surface brightness of the whiter star is five times that of the larger star visually, and twelve times photographically, so that the smaller star is visually the fainter and photographically the brighter of the pair. The density of the large red star is about 1/200, and that of the smaller white star about 1/12 that of the sun. The combined spectrum is recorded as F?, and it is considered not improbable that the small star is of type A, while the larger is of type G or redder.

HIND'S VARIABLE NEBULA.—The variable nebula N.G.C. 1555 has been photographed by Mr. Pease on seven occasions since December, 1911, with the 60-in. reflector at Mount Wilson (*Astrophysical Journal,* vol. xlv., p. 89). The most prominent feature is a fan-shaped nebulosity, having its apex 25″ south-west of the irregular variable star T Tauri. Two knots near the apex, each with a streamer running southward, are the brightest parts of the nebula. The sides of the fan include an angle of 70°, and are about one minute of arc in length. A curved stream of faint nebulous matter lies to the west of the star, and midway between this and the star is a knot which varies in size and brightness. There is also evidence of very faint extended nebulosity filling the whole starless region in the neighbourhood of the variable star. The photographs show distinct changes in the form and intensity of the nebula, but the available data are not sufficient to establish a relation to the variability of the star. Mr. Adams finds that the spectrum of T Tauri is of type Md, with additional bright lines, and that the parallax is of the order 0·05″ to 0·10″; the bright lines extend beyond the dark lines of the spectrum, and would thus appear to be due to the surrounding nebulosity.

THE NATIONAL PHYSICAL LABORATORY.

THE annual meeting of the General Board of the National Physical Laboratory was held at the laboratory on June 19. The president of the Royal Society, Sir J. J. Thomson, is chairman of the board, and Lord Rayleigh chairman of the Executive Committee.

During the past year the laboratory has been closely engaged, with a largely augmented staff, of whom more than one hundred are women, on a variety of researches and investigations arising out of the war, and has dealt with a greatly increased volume of test work for Government departments. The outstanding feature of the year has been the growth of the gauge-testing work. Nearly the whole of the gauges required for the inspection of munitions are now examined at the National Physical Laboratory, the number averaging about 10,000 weekly. By arrangement with the Ministry of Munitions a new building has recently been erected to accommodate the work, the space otherwise available having become quite insufficient for the purpose. There has been a great increase also in the number of optical and electrical instruments tested for the Admiralty; a new branch of work is the testing of luminous dials for instruments of various kinds.

The investigations carried out have been, in the main, of a confidential character, and no details are given in the report. It has only been possible to make progress with a very few of the researches undertaken prior to the war, and these are almost entirely closely connected with war problems. Aeronautics research has continued to be of great importance. The William Froude National Tank has carried out much work for the Admiralty, and has been visited by members of the Board of Admiralty—including Mr. Balfour when First Lord—who have expressed much appreciation of the results attained. In the metallurgy department researches on light alloys and on optical glass have been continued, while a number of special problems have been dealt with. Various investigations have been in progress in the engineering department; hardness tests, methods of impact-testing, the fatigue resistance of materials under combined bending and twisting stresses, the transmission of heat from surfaces to fluids flowing over them—as in the flow of air over an aeroplane engine—are among the questions examined. The observations on the rate of growth of cracks in the buildings of the Tower of London have been continued. No serious disturbances have been detected.

The laboratory is at present under the control of a General Board and an Executive Committee appointed by the Royal Society and the great technical institutions, and the researches are assisted by a grant from the Treasury. The income during the past year was above 70,000*l*., an increase of nearly 20,000*l*. over that of the preceding year. The major part of this total is received in payments for work done, and this involves a serious financial liability. Much attention has been given recently to the question of the future of the laboratory, and in particular to its relations with the Department of Scientific and Industrial Research, and a scheme will no doubt be arranged whereby close relations with the department will be established.

PEAT AND ITS USES.

CONSIDERABLE interest attaches to a recent article in *La Nature* on "Peat," in view of the increasing attention being paid to the use of this substance to replace coal in countries in which the latter is absent or difficult to obtain. The author of the article, M. Renié, discusses concisely the distribution of peat-beds in the various countries, the treatment (drying and pressing) of peat and its uses. He does not pretend that it can compete successfully with coal, except where freights for the transport of the latter are excessive. The best solution, he suggests, is to transform it on the spot into energy, and to recuperate the by-products. The drying and mechanical treatment must be carefully carried out so as to render the fuel as homogeneous as possible. The pressing operation increases the specific gravity of dried peat from 0·7 to 1·03. The cost of treating is not high. Ekenberg has shown that peat heated for a short time at a temperature above 150° C. loses its gelatinous consistency, and thus allows of its being dried by compression. The final product is usually converted into briquettes without the addition of a "binder."

Peat in the agglomerate form has not, however, proved satisfactory in practical use, and to get over the difficulty the use of peat in powdered form has been proposed, a factory having been opened at Bäck (Sweden) to carry out a process invented by Ekelund, which is kept secret. Special grates have to be used for burning powdered peat, and in steam-raising in boilers large grate areas and closely spaced bars, together with modification of the furnace draught, are necessary.

In connection with the use of peat for steam-raising, the following quantities of steam are raised from 1 kilo of the following:—Compressed peat, 4·3 kg.; "half"-coke, 6·6 kg.; coal, 7·4 kg. Peat can be carburised for the extraction of coke and volatile products, a Ziegler continuous-type furnace being generally used in Germany and Russia. Peat coke can be used for metallurgical purposes, and the "half-coked" peat for steam-raising. Particulars of the process are given in the article. It is also possible to extract ammonia water and tars, the latter giving, on distillation, light and heavy oils and phenol. The yield of methyl alcohol is about 3·7 kg. from a ton of peat, and 3 kg. ammonia sulphate and 9 kg. of acetate of lime.

Peat is successfully used in Sweden, in combination with a gas-producer, for working engines of the "waste-gas" type. From one ton of peat 2000 to 3000 cubic metres of gas, giving from 1200 to 1400 calories per cubic metre, are obtained. As the author points out, special care is needed in purification.

Peat is advantageously used as a litter, owing to its deodorising properties, while during the war the Germans have employed it extensively as a substitute for absorbent cotton for bandages. Its antiseptic properties are well known.

E. S. HODGSON.

SCIENCE AND INDUSTRY.[1]

FOR the past three years war and the consequences of war have dominated our thoughts and compelled our actions. May we not hope now that the time is coming when we shall reap the fruits of the heroic efforts of those who have died that England might live? How can we best learn the lessons of this terrible time and turn the experience we have gained to the future welfare of our country? The question is much too wide and far-reaching to be dealt with in a single lecture, and it is beyond my powers to attempt to handle it in a general manner. I wish to deal only with one aspect.

We realised at a very early date that science was to be an important factor in success, and while against the heroism of our men all that the science of our foes could do proved unavailing, it was clear that bravery and self-sacrifice without the aid which science could bring would fail to give us victory. Let me remind you of some few of the methods in which scientific investigation has aided our cause; they are so obvious as to need little more than a passing reference.

Take flying, for example. Every part of a modern aeroplane is the product of a highly specialised science. In the machine itself, to combine strength with lightness, to select the right material for each part, to design the wings so that they may bear the greatest weight and offer the least resistance to the motion, to give the body ample strength to withstand the shocks of alighting, and yet not weight the machine unduly—all these points and many others have been the subject of long and difficult scientific examination.

At the National Physical Laboratory there are five wind channels continually in use to test on models all the various factors on which the aerodynamic efficiency of a machine depends. Two of these channels are 7 ft. in diameter and nearly 80 ft. in length; in one wind speeds up to sixty miles an hour can be obtained. The model is attached to a specially designed balance, or dynamometer, and the forces it experiences in various positions relative to the wind are measured; from these data the behaviour of the machine in flight is determined. Here Mr. Bairstow and his colleagues have worked out the practical conditions of stability of motion and determined by many ingenious devices the constants which occur in the theory. That theory was first given in a general form by Bryan, the theory of the disturbed motion of a body moving in three dimensions, under gravity, the thrust of the propeller, and the resistance of the air. The quadratic which gives the energy in terms of the six co-ordinates and velocities corresponding to the six degrees of freedom of the body contains twenty-one constants. Conditions of symmetry reduce these in number; the air channel experiments afford the means for determining their values, and thus predicting the properties of the machine. The work at Teddington would have proved of little value without the corresponding full-scale experiments brilliantly carried out at Farnborough by two Cambridge men, E. H. Busk and Keith Lucas, who gave their lives for the cause, and now continued by two other Cambridge men, Farren and George Paget Thomson. The name of Busk is, I trust, to be commemorated in Cambridge by a scholarship founded in his memory by friends who admired his powers and loved the man.

But it is not only in the structure of the aeroplane that science has done its part. The engine brought problems of the highest complexity, which are being

[1] From the Rede Lecture, delivered at Cambridge on June 9 by Sir Richard Glazebrook, C.B., F.R.S.

solved by patient application and earnest endeavour. Large powers are needed; the various parts move at great speed, hence strength is essential, but the weight must be kept down; at the same time endurance is necessary; risk of untimely failure must be reduced and the pilot made as secure as possible. Here the metallurgist has been at work, producing alloys little heavier than aluminium, yet comparable in strength with steel, and suitable for many new demands, and in this field Dr. Rosenhain, of the National Physical Laboratory, has arrived at many important results.

Or consider the instruments the pilot needs to determine his height, his speed, or the direction in which he is moving to enable him to drop his bomb at the right moment, or to sight his gun on his enemy as the two planes come within range. Cambridge, as represented by Horace Darwin and Keith Lucas, has done yeoman service in these various fields, while in all our many discussions on theory we have profited by the great knowledge and the clear thinking of our Chancellor—Lord Rayleigh, president of the Advisory Committee for Aeronautics.

Again, turning to another subject, consider the science involved in the manufacture of a big gun and its ammunition, or in the calculation of the trajectory of its projectile. Many gun problems are not new; artillerists had long realised the importance of experiment and calculation, the manufacturer to test his steel and determine the safe stresses to which it could be subject, the gunner to measure the resistance to the motion of the shell to plot its trajectory, determine its time of flight for various ranges, set his fuse, and design his sights so that his shooting might be accurate. But the long-range gunnery of our modern ships and the high-angle fire required for anti-aircraft work, have each introduced new difficulties, and in solving these Cambridge men, such as Littlewood, Hill, Richmond, Herman, Gallop, and Fowler, have been well to the fore, while for anti-aircraft work the Bennett height-finder in one of its many forms is in general use in the Allied Armies.

One striking feature has been the development of methods of accurate workmanship. With some few exceptions all the gauges for munitions pass through the National Physical Laboratory. About 400,000 have been dealt with in the last eighteen or twenty months. At first we were in despair. The limits of accuracy which the inspection department fixed were extremely narrow—in some cases only three ten-thousandths of an inch. Rejections were very numerous; to supply the requirements appeared impossible, but now gauges are examined at the rate of about 10,000 a week, and some 80 per cent. pass as a matter of course. Some firms get practically all their gauges through. Careful scientific examination of the causes of error, improved methods of manufacture, and a firmer grasp of the essentials have produced this change; the standard of manufacture has been gradually improved, and results at first thought unattainable have been realised.

Physics and engineering would afford many other instances, such as improvements in means of signalling, wireless telegraphy, sound-ranging, and weather prediction.

Chemistry and the biological sciences have contributed more than their full share, and though I cannot claim to speak with first-hand knowledge of the achievements of medical science, I must mention some facts for which I am indebted to the kindness of Surg.-Gen. Sir Alfred Keogh and Col. Webb, who informs me that the annual admission ratio for all causes other than wounds in action in France is approximately 428 per 1000. In the following campaigns the corresponding ratios were:—

Egypt, 1882	2276
Nile, 1884–5	557
Dongola, 1896	892
Nile, 1898	955
South Africa	843
China, 1900–1	933

In France the annual admission ratio

For typhoid fever is ... .. 0·9 per 1000.
And for the whole typhoid group of diseases ... ... 2·4 ,, 1000.

In South Africa the annual admission ratio

For enteric fever was ... ... 130 per 1000.
And for enteric fever *plus* other continued fevers ... ... 204 ,, 1000.

The figures speak eloquently of the triumphs of medicine, and the wonderful results achieved by the devotion of doctors and nurses.

The war has brought home to us, in a way that only an event of its magnitude can do, the dependence of the modern world on science and the advancement of natural knowledge; the need, then, is that when peace comes we should use this great power to the full to repair the ravages of war.

A distinction is often drawn nowadays between pure science and industrial science. I saw somewhere recently a protest against the use of the latter term. Science is one, and industrial science—so-called—is the application of the discoveries of pure science to the problems of industry. Huxley wrote long ago:—"What people call applied science is nothing but the application of pure science to particular problems." It is essential that we should remember this, and strive here in the first place for the advancement of pure science.

Scientific investigations we may divide into two classes: those in pure science which are directed solely to the advancement of natural knowledge, the discovery of Nature's laws, and those which have for their aim the application of these discoveries to the processes of our everyday life in art, or commerce, or manufacture. There is no need to lay stress in this room on the paramount importance of the first class. The Cavendish professor, speaking recently in London, said truly: "The discoveries in applied science may produce a reformation; those in pure science lead to revolutions."

The Röntgen rays, as Sir J. J. Thomson recently pointed out, were studied first as one means whereby we might hope to learn something of the nature of electricity. They are now the surgeon's trusted guide, telling him how to direct his knife and restore his patient to health and strength. Pasteur's work commenced in an inquiry into the crystallographic differences of certain chemical substances, leading him to the result that certain kinds of chemical fermentation are due to the action of living organisms which are not born spontaneously in the fermenting material, but are derived from infection. Lister seized on this and applied it to medicine and surgery. The medical statistics of the war will show, when they can be prepared, something of what the world owes, measured in lives saved for future work, to these two discoveries; the amount of pain the sufferers have been spared is immeasurable.

Lord Moulton, in his preface to "Science and the Nation," refers with special pleasure to Dr. Rosenhain's essay on modern metallurgy. The foundation of this work rests on Sorby's application of the methods of petrographic research to investigate the properties of meteorites, and on the study of the thermo-electric properties of metals due to Seebeck, Peltier, and

William Thomson. Petrographers had been in the habit of examining the structure of rocks by cutting the sections thin enough to be transparent, and examining them under the microscope. Sorby in 1861 found it was not possible to examine metals thus, and developed the art of polishing the surface and etching it with suitable chemicals, thus bringing out the internal structure. Its application to engineering problems passed unnoticed until the method was independently revived by Osmond in France, and Martens in Germany. Seebeck discovered that when in a circuit of two metals a difference of temperature exists between the junctions, an electric current is produced in the circuit. The strength of this current is a measure of the difference in temperature, and this discovery was applied many years later by Le Chatelier to construct a thermocouple for the measurement of temperature in metallurgical processes. Applying these two instruments of research, metallurgists have now a clear idea of the structure of the more important metals and alloys used in industry, and of the manner in which the properties which fit them for their various uses are related to that structure. The intensive study of pure science, the determined effort to hand on still brightly burning the lamp lighted for us by those who have gone, is perhaps the best contribution which Cambridge now can make to our national welfare.

The great discovery is usually small in its beginnings; it does not at first strike the imagination. The seeds from which the revolution is to come lie hidden in the ground, and the tiny sprout which first appears seems but of small importance. Few besides some students in the universities realised the wide-reaching scope of Maxwell's theory of the electromagnetic field, when it was first published; few, again, picture, when they read of the early experiments of Hertz and Lodge, the future marvels of wireless telegraphy, even in the short years that have passed since Lodge delivered his Royal Institution lecture. The successful applications of science to industry attract a wider notice and gain a fuller recognition. It is given to but few men to carry through the revolution that their own discoveries have produced. James Watt and Kelvin were such men. Pasteur and Lister saw, in some degree, the fruit of their labours. Faraday, on the other hand, died at Hampton Court in the receipt of a Civil List pension. The work of making the discoveries of science available to promote the prosperity and advancement of a nation appeals to others than the great discoverers, and is usually best left in other hands. Let me explain what I mean, even at the risk of some repetition, for I have recently spoken and written more than once on this subject, and, indeed, the applications of science to industry have been the work of the National Physical Laboratory since the twentieth century began.

Speaking at the opening of the laboratory in 1902, his Majesty—then Prince of Wales—said:—"The object of the scheme is, I understand, to bring scientific knowledge to bear practically upon our everyday industrial and commercial life, to break down the barrier between theory and practice, to effect a union between science and commerce," and these words still express our aims.

Various writers have pointed out recently that in this process three distinct stages are generally required. We need

(1) The work of the man of science in his laboratory.

(2) The investigations which go on in a laboratory of industrial research, developing new processes or introducing new products.

(3) The works laboratory proper, controlling the quality of raw materials, or of finished products.

I have spoken already of the work of the student of science in his university or college. Before dealing with the laboratory of industrial research, let me devote a few words to the works laboratory proper.

It is necessary, as I have said elsewhere, to maintain the standard of the output, to secure that the proper grade of material is supplied to the works, to check the instruments in use, and to test the product in its various stages of manufacture. The days are gone by when successful manufacture could be carried on entirely by rule of thumb, trusting to the skill of some trained workman for the success of each delicate operation, when the hereditary instinct passed down from father to son was sufficient to produce each year practically the same results. New processes come which appear likely to improve production or to reduce its cost; the works laboratory serves to test these. New products are suggested, which may or may not have the advantages claimed for them; this can be investigated in the works laboratory, and all these investigations and tests must go on in the works themselves under the eyes of men familiar with the process of manufacture in its every stage.

A distinguished Trinity man, Mr. Michael Longridge, when recently, addressing, as president, the Institution of Mechanical Engineers, traced the process by which during the latter half of last century England became the leading industrial nation, and concluded thus:—

"And as the mechanical engineer was responsible in no small measure for the transformation, so he must be held responsible for the maintenance and efficiency of the workshop on which the feeding of the people and the defence of the people against their enemies now depend. He became, and he remains, a trustee of the British Empire. How did he discharge the trust? By humbly seeking knowledge to turn the gifts of Nature to the use of man? By invoking the aid of science to develop the discoveries of the men who had prepared the road to his success? By caring for the welfare of the thousands who were spending their waking hours in his factories? By giving them a fair share of the profits of his business? I think we have the grace to-day to answer 'No.' I think we are willing to confess that our heads were turned by elation at our prosperity, that we were obsessed by admiration of our own achievements; too confident of the sufficiency of our limited knowledge; too contemptuous of the few who tried to throw the light of science on our path; too eager for wealth, and the social influence it could buy in the new state of society; too careless of the needs and aspirations of the 'hands' who helped to make the rapid accumulation of large fortunes possible. And what has been the consequence? For every lapse from the ideal—and there is an ideal even of industrial polity—Nemesis Adrasteia, sooner or later, exacts retribution."

The lesson has now been learnt with more or less completeness, and now each modern engineering works possesses its own laboratory and utilises the teaching of science at each stage of its processes. Cambridge can supply the men who will do this work.

But there is another need. The step between the university laboratory and the works laboratory is a long one. Discoveries do not leave the man of science in a form which can be at once assimilated by the engineer, the shipbuilder, or the manufacturer. Some means are needed to make them available to such men to secure the advantages which come from the growth of knowledge by which alone they may keep in the forefront of their trade. The problem has recently been discussed in a paper by Dr. Mees published by the Department of Scientific and Industrial Research, and by Dr. Rosenhain in a lecture, delivered at Glasgow, on "The National Physical Laboratory: its Work and Aims." For the industrial research laboratory the plant, etc., must be so planned that it is possible to carry out the necessary operations on a scale comparable with that required in works, and, moreover, the man who carries through the investigation must be not only acquainted with the latest scientific advances in his subject, but must know what is possible in works, and must mould his solution of the problem to harmonise with these possibilities. The undertaking is often more complex than that of the pure man of science. It is one which needs a special laboratory, a special equipment.

As examples of such a laboratory, both of which happen to be at works, I may instance the research laboratory of the Badische Anilin- & Soda-Fabrik, in which the commercial production of synthetic indigo was worked out, or the laboratory of the General Electric Co. of America at Schenectady, where in numerous instances the discoveries of modern electrical theory have been turned to practical use. The Coolidge tube, the most powerful source of X-rays which we possess, is one product of this laboratory. Such also are some branches of the Bureau of Standards at Washington, the Materialprüfungsamt at Gross-Lichterfelde, near Berlin, and, in some aspects of its work, the National Physical Laboratory and the research institutions for glass, pottery, fuel, etc., which are coming into existence as part of the work of the Department of Scientific and Industrial Research.

Thus, the task of an institution like the National Physical Laboratory differs from that of either a university or technical college laboratory or a works laboratory. In the first place, it is not educational; every member of the staff is, it is true, learning continually, yet he is not there to be taught, but to be asked questions and to find the answers. Its functions are primarily to encourage and initiate the applications of science to the problems of industry. It is, in the words of the Order in Council, an institution for the scientific study of problems affecting particular industries and trades. The staff devote themselves solely to this work; their whole time and energy are given to it. They have no educational duties; they are free from the responsibilities of the classroom and the burden of students' exercises. The senior members of the staff joined avowedly with the purpose of applying science to industry; they are prepared to make it their life-work. The juniors retain their posts for some time; thus all acquire a store of experience of the highest value, with a unique knowledge of the technical aspects of industry which it is difficult to gain in any other way. The laboratory has, I trust, acquired the confidence of the technical industrial world, and problems are brought before the staff with the knowledge that they will be handled in a confidential manner by men trained to deal with them. In such an institution it is possible to specialise as to both staff and equipment in a manner which can scarcely be done in a laboratory attached to an educational institution. The whole staff are engaged in applying science to industry; equipment is provided for this purpose only. The needs of the student and the educational value of the apparatus have not to be considered.

I would not advocate that work such as I have outlined should, as a rule, find a place in a university laboratory, but a university has its own task in connection with these laboratories, which, believe me, are a necessity if science is to be freely applied to industry. The universities and technical schools must provide and train the staff, not in the application of science, but in methods of investigation, in the knowledge of scientific truths, in the power of observation, the capacity to interpret the observations they make, and the experimental results they obtain, and, above all, in the desire to discover the truth and apply the consequences fearlessly to their daily work.

Nor is this all. No doubt the number of men engaged in the application of science to industry must increase, but if we are to reap the full advantages science can give, steps must be taken to ensure a wider appreciation of the value of her gifts, the greatness of her powers.

Some knowledge of the meaning of ordinary scientific terms, of the usual everyday processes of Nature —both chemical and biological—of the cause of the simple natural phenomena, and of the general scope and methods of scientific inquiry should be the possession of each undergraduate before he leaves Cambridge to take up his life-work elsewhere. "It is essential," as Prof. Keeble writes in his contribution to "Science and the Nation," "that our statesmen and administrators, our teachers and our poets, know something of the work and method and beauty of science." But how is this to be secured? Mr. Wells, in a recent review of the volume, is severely critical because the authors have not answered this question; the criticism is undeserved, it seems to me, because the authors did not set out with this object. "The time seemed propitious," says the editor, Dr. Seward, "for emphasising a particular aspect of the general question of the interdependence of many phases of national prosperity and a just appreciation of the value of pure science." Still, the question needs an answer. We look forward with some eagerness to the report of the committee, of which Sir J. J. Thomson is chairman, which is dealing with the place of science in education.

Meanwhile, it may not be out of place to hazard some few remarks. I will quote again from the president of the Institution of Mechanical Engineers, who, after pointing out that the education of an engineer must be varied to suit the capacities of different minds, writes thus:—

"And my complaint. It is against the obstinacy of our two most famous universities in retaining Greek as a compulsory subject in their examinations. This reacts upon our public schools, and is a serious handicap on those who, intending to deal with the concrete rather than the abstract in their future lives, yet wish to find their levels in the social life and moral discipline of these two universities. The English public-school boy can generally be relied on to face difficulties, lead men, and keep his hands clean in business. Engineering cannot afford to lose him to satisfy those who rule Oxford and Cambridge in this matter."

To insist on the retention of Greek in the Previous Examination is to close Cambridge to many of those who would profit most by its lessons, who would carry the rich benefits three years' residence here can give to places where at present they never penetrate, and who themselves, in not a few instances, would add to the lustre and the glory of our university.

The study of Greek is not really advanced by its compulsory character. Lord Bryce, in a recent article addressed in the first instance to a classical audience, writes, after a reference to the very few who retain a competent knowledge of Latin and Greek beyond an early age:—"Let us frankly admit the facts. Let us recognise that the despotism of a purely grammatical study of the ancient languages needed to be overthrown," and he continues:—"What is the chief aim of education? How should the mental training fitted to produce the capacities which go to make an educated man begin? First of all by teaching him how to observe and by making him enjoy the power of observation. The attention of the child should from the earliest years be directed to external Nature. His observation should be alert and it should be exact. Along with this he should know how to use language, to know the precise difference between the meanings of various words apparently similar to be able to convey accurately what he wishes to say."

Then, after distinguishing between the world of Nature and that of man, he discusses how the time available for education is to be divided between these two spheres, urging the need for plenty of knowledge of both to produce a capable and highly finished mind. "No man," he says, "in our day can be deemed educated who has not some knowledge of the relation of the sciences to one another and a just conception of the methods by which they respectively advance." He presses strongly the importance of literary studies because of the service they render to us for practical life, for mental stimulus and training, and for enjoyment, and as an introduction to his views on the claims of the classics, he writes:—"A word must be said on the practical aspect of the matter as it affects the curricula of schools and universities. I do not contend that the study of the ancients is to be imposed on all, or even on the bulk, of those who remain at school until eighteen or on most of those who enter a university. It is generally admitted that at the universities the present system cannot be maintained—we shall effect a saving if we drop the study of the ancient languages in the case of those who, after a trial, show no aptitude for them. For the schools, the problem is how to discover among the boys and girls those who have the kind of gift which makes it worth while to take them out of the mass and give them due facilities for pursuing their studies at the higher secondary schools, so that they may proceed thence to the universities and further prosecute them there. Many of you, as leaders, know better than I how this problem may be solved; solved it must be, if the whole community is not to lose the benefit of our system of graded schools."

And in this connection let me quote a few words from a recent letter in NATURE by Mr. M. D. Hill, an Eton master of twenty years' experience. He writes:—"The boys who are best at classics are also best at science. . . . Every intelligent boy must be given equal opportunities in science and languages in the widest sense of the word until he is old enough to show which line of study he can most profitably follow."

Here is a problem which the university must attack at once. I have already pointed out what seems to me the first step towards its solution. Cambridge must open her doors wide to every son of our great Empire who can show that he will reap benefits from studying within her walls any branch of knowledge for which she offers opportunities; this step should be taken without delay. Lord Bryce has indicated, I think, the lines for our future development. Let me briefly outline how they appear to me to run. The university must remain the home of ancient learning, but the course pursued to secure this end must not be such as to demand that Latin and Greek should remain the principal part of the school tasks of all boys. It must train men to be leaders in all walks of life, and not least in industrial pursuits, and this not by undertaking the technical training of the men who go out hence into the world, but by laying a broad foundation of the scientific principles and laws on which technical knowledge, be it of theology, medicine, or law, or of the more modern branches of applied science, must rest. And lastly, but most important of all, it must produce the leaders in every branch of science.

For the highest work of all, be it literary or scientific, the course is fairly simple. Men in whom are implanted the thirst for new knowledge, the power of discovery, the keen logical insight to follow the right path and avoid the wrong, will come to the front helped by the traditions of the past, the enthusiasm and devotion of the teachers, the generosity of our founders and benefactors. Funds, it is true, will be needed, and must be supplied. A man whose researches may produce a beneficial revolution, whose discoveries may prove of untold benefit to mankind, should not depend for a scanty livelihood on the proceeds derived from his yearly cycle of tutorial lectures. Means must be found to increase the endowments of the university for pure research, and funds so expended will in time produce a full harvest.

Let me, however, endeavour to say something as to the steps to be taken to give science its due place in the education of every man. Have we attacked this question in the right manner? and by "we" I mean teachers of science generally.

It is nearly forty years since the present Chancellor asked Sir Napier Shaw and myself to help in his work at the Cavendish Laboratory. Practical physics as a branch of study for undergraduates generally was almost non-existent. Maxwell had inspired a few of the leading mathematicians with the desire to work at the laboratory, but the organised classes were small and their organisation was incomplete. Elsewhere Carey Foster had classes at University College, Balfour Stewart at Manchester; Kohlrausch's book had been published and translated into English some few years previously. Shaw had worked in Berlin under Helmholtz. We commenced the endeavour to systematise the teaching, to devise experiments to illustrate and "prove" fundamental laws and principles, to teach students the reality of many things of which they read in books, and show them that effects do follow their causes in the manner there described.

Laboratory notebooks were written. In due course (in 1885) Glazebrook and Shaw's "Practical Physics" appeared, and, I am glad to say, after more than thirty years of life, is vigorous still. It has been followed by many similar books, and has, I trust and believe, done much useful and important work. A man who is to develop into a physicist must have an intimate knowledge of the existing methods of physical investigation. Measurement is so important a factor in many branches of knowledge that an acquaintance with the fundamental methods of measurement, and skill in using instruments and apparatus, are of the highest value for large classes of men.

But for the great majority the mental food thus offered affords but little nourishment. The teaching of practical physics on these lines fits in with our examination system. Problems can be set and questions asked admitting of definite and precise answers the value of which an examiner can easily assess in marks. A sum in arithmetic is classed as a physical problem because the term "specific heat," or "electrical resistance." is used in stating the question. "Our examination system," says Principal Griffiths, "has endeavoured (but, thank Heaven! unsuccessfully) to kill the soul of science in the rising generation. There is, however, a stirring among the dry-bones, and we are awakening to the fact that science must be taught as if we believed in it for its own sake, that we must teach it as a disciple preaches his religion, and that we must refuse to be bound by the fetters in which tradition has entangled us. If we are to succeed, we must make science a living reality to our pupils, and cease to regard it merely as a convenient machinery for the manufacture of conundrums." We do not really so regard it, any of us teachers, but our methods of teaching and examinations tend to produce this impression. It is clear, I think, that a plan which is excellent for men who intend to specialise in science is not the one best suited to give to all—"some knowledge of the relation of the sciences to one another and a just conception of the means by which they advance." For the limited class an exact knowledge of the elements is essential. If this exact knowledge is required from all, the majority find the process dull; they get no further than the elements, and when the dreaded examination is over they forget even these, and have no further interest in the subject. Natural science, like Latin and Greek, disappears from their lives.

And so, if this be at all the correct view, an important task for the university is to develop a new method for the ordinary teaching of science, not merely to require that science should be taught, but to discuss and determine how this can best be done, and then to train and send out into the world men capable of doing it. The method will not lend itself easily to "the process of controlling education by examination with a limited time," and if a test of the pupil's knowledge is required, some other plan for this purpose must be devised.

One of the consequences of the war will be a greater appreciation of the value of science. Let us in Cambridge be ready to take advantage of this and help to strengthen our country by raising up a generation which realises to some extent what science has done, and how real progress in nearly every walk of life is inseparably bound up with the advancement of natural knowledge, which in the past the university has done so much to promote.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. F. H. Jackson, of Peterhouse, has been approved for the degree of Doctor of Science.

LONDON.—The Senate has resolved to institute for external students a B.Sc. degree dealing with the administration and management of urban and rural lands and estates, and a scheme with the necessary syllabuses and regulations is in course of preparation.

OXFORD.—Mr. J. J. Manley, the curator of the Daubeny Laboratory, has been elected to a fellowship at Magdalen College, Oxford, for the prosecution of special researches in physics and chemistry. Mr. Manley's talents as a teacher of practical chemistry have long been recognised by several generations of pupils, a list of some 500 of whom has been recently printed. Among them we note the names of Prof. Soddy and of many well-known younger science teachers. Mr. Manley is widely known for his interesting observations on the anomalous behaviour of delicate balances and by his ingenious devices for increasing accuracy in weighings. A re-investigation of Landolt's work on the apparent change of weight during chemical reaction was the subject of a more recent paper in the *Philosophical Transactions*, and he has lately succeeded in constructing platinum resistance thermometers of a sensitiveness greatly in advance of any that had previously been made. Magdalen College and Mr. Manley are equally to be congratulated on this election, which promises to be of considerable service to the cause of physical and chemical research.

On June 19 the annual report of the delegates of the museum was presented to Convocation. The report directs attention to the fact that the members of the staff and other workers in the museum departments on war service have been further increased. The death in action of Mr. Geoffrey Smith, demonstrator in zoology, is recorded; and details are given of the handing over of a large part of the museum buildings for the use of the Royal Flying Corps. Separate reports from the various scientific departments are added, all of them giving evidence of much activity in spite of the present adverse conditions. The report of the curator of the Pitt-Rivers Museum includes an especially long list of valuable donations.

At the same meeting of Convocation, decrees were passed allowing, under certain conditions, that candidates in the science and other honour schools should be examined in part only of their subjects, and empowering the examiners to award distinction to those who have attained a high standard therein. This provision will apply solely to those whose regular course of study has been interrupted by war service.

The extremely valuable collections of Arachnida, containing more than 1000 types, with the library, notebooks, drawings, and papers in connection therewith, bequeathed by the late Rev. O. Pickard-Cambridge, were gratefully accepted, and ordered to be deposited in the University Museum, and placed in the charge of the Hope professor of zoology, Prof. E. B. Poulton.

THE Maharaja of Benares has founded a gold medal, to be known as the "Lady Chelmsford Medal," for award annually to the best student of the Lady Hardinge Medical College for Women, Delhi.

Two "British Dyes" open research scholarships, each of the yearly value of about 60*l*., are offered in connection with the Huddersfield Technical College. They are tenable for one year, with the possibility of renewal. Applications must reach the secretary of the college by, at latest, July 6.

Two scholarships in naval architecture, each of the value of 90*l*., have been founded by Col. Smith Park, C.B., of Glasgow, for students of the University. The scholars are required to have remained at a secondary school until they have obtained the higher grade leaving certificate, which admits to the University courses for graduation in arts or science.

THE debate in the House of Lords on Tuesday, June 12, dealing with the future policy of the Board of Education so far as it has been foreshadowed in the speeches of Mr. Fisher, was chiefly notable for the views expressed in protest against a too early or undue specialisation in the schools, whilst demanding that science should find its due place in the scheme of education, especially in the great public schools, as a subject of vital importance for the effective training of the citizen, so as to enable him to take a sound view of the questions which arise in modern life. The events of the war, intimate and contingent, have made it plainly clear that training in the facts of science and the inculcation of the scientific habit of mind are essential to the national well-being. The purpose of the schools is, as Lord Haldane well put it, not to make of their pupils Latin or Greek scholars, or men of science, but to make them men, and to develop their humanity in the best and broadest sense. In short, their business is so to train their pupils as to give them a liberal outlook in preparation for such specialised teaching in the classics or in the various branches of science, pure or applied, or in other departments of knowledge, as the universities can offer, or as the various professions may require. In no other way can the public schools ensure the generous training of all their pupils, and especially of those who aspire to take a prominent part in public affairs, or shake themselves free of the incubus of conflicting external examinations. Indeed, not until the older universities cease to retain compulsory Greek as an essential feature in the examination for their most valuable scholarships will it be possible for the public schools to give to science its rightful place in their curriculum. It is now seen to be essential that in the treatment of most great questions of national policy the principles and facts of science must be accorded their due place. It is satisfactory to note that the Government does not intend, in measures having for their object the reform and development of educational policy and methods, to disturb the basis of the Act of 1902 in respect of denominational education.

THE forty-third annual conference of the Association of Headmistresses was held in London on June 8 and 9. Miss Escott, the president, referred in her address to necessary reforms of the educational system, and to the subjects which should be included in educational schemes for girls. "Science in girls' schools," she said, "ought to be greatly developed as part of a liberal education and with special reference to life around them. It would be in the interest of both science and mathematics if the science teacher had a good knowledge of mathematics, and the mathematical teacher a working knowledge of chemistry and physics. In the beginning of general elementary science it would be very helpful for one teacher to take both the science and mathematics in a form, and it is scarcely necessary to say that in advanced work the mathematical teacher should have a knowledge of physics." Among the resolutions passed was one in favour of the metric system, and another welcoming the formation of the Secondary-School Examinations Council. An educational programme put forward by the Executive Committee, and adopted by the meeting, included the following recommendations:—(1) The complete co-ordination of all forms of education; (2) improvement of the teaching of boys and girls in the upper standards of elementary schools; (3) better provisions for the intellectual, moral, and physical discipline of young persons during the period of adolescence; (4) maintenance allowances for more promising pupils; (5) better salaries and better prospects for teachers; (6) a reduction in the number of examinations which may be taken in schools. "The association further hopes that the leaving age for all pupils in elementary schools without exemption will be fixed for the present not earlier than the last day of the term in which a pupil reaches the age of fourteen years; and that the leaving age may be raised to fifteen within the next few years; that the continued education of young persons who have left school and are below the age of eighteen years may occupy not fewer than twenty hours of the daytime in each week, and may be largely of a general rather than a technical character. That this conference is of opinion with regard to university education that there should be a common standard of entrance, accepted by all the universities of the British Empire, and Greek should not be a compulsory subject."

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, June 6.—Dr. Alfred Harker, president, in the chair.—Dr. E. J. **Garwood** and Edith **Goodyear**: The geology of the Old Radnor district, with special reference to an algal development in the Woolhope Limestone. The district comprises an inlier of Archæan grits and Woolhope Limestone forming an elongated dome bounded by Wenlock Shale. It was regarded by Murchison and the Geological Survey as consisting of Mayhill Sandstone succeeded conformably by Woolhope Limestone, and they attributed the unfossiliferous character of the sandstone and the abnormal facies of the limestone to alteration by igneous intrusions. Dr. Callaway, in 1900, first suggested that the so-called "Mayhill Sandstone" was of Archæan age, and recorded an unconformity at the base of the limestone. The authors confirm Dr. Callaway's views, and give evidence for correlating these Archæan rocks with Prof. Lapworth's "Bayston Group" of the Longmyndian. The unconformable relation of the limestone to the Archæan is established in several portions of the district, while a study of the trilobite and brachiopod fauna of the limestone and included shale confirms the Wenlock age of the deposit. The most interesting fact brought out by a study of the limestone is the important part played in its formation by the calcareous alga Solenopora (of which a new species is described), the deposit constituting by far the most striking development of algal limestone yet recorded from British rocks.—S. S. **Buckman**: Correlation of Jurassic chronology. This paper owes its inception to certain discoveries made by the officers of the Scottish Geological Survey during their investigations of the Jurassic deposits of the Isles of Raasay and Skye. The ammonites and brachiopods were sent to the author for examination, and the sequence of faunas which they disclosed necessarily led to comparison with results obtained in other areas. The paper is chiefly concerned with the Liassic ages hitherto known as Domerian, Charmouthian, and Sinemurian. In all of them there is proposed a considerable increase of the number of faunal horizons indicative of consecutive time-intervals, or hemeræ. One of the most interesting discoveries which have resulted, partly from the great thickness of Scottish strata investigated and collected from, partly from comparisons with, other areas, is that the so-called "*armatum* zone" of the English midlands and that of the Radstock district, of Yorkshire, and of the Scottish Isles are not isochronous, but are separated by a time-interval which corresponds with a thickness of some 300 ft. of deposit in the Scottish area.

Royal Astronomical Society, June 8.—Major P. A. MacMahon, president, in the chair.—A. S. **Eddington**: Further notes on the radiative equilibrium of the stars. In the author's previous paper the calculations had been made on the assumption of an average molecular weight of 54 for the material of a star—representing the hypothesis that the ultimate particles are atoms. He was now convinced that under the high temperatures in question an extreme state of disintegration is more probable, and in the calculations in the present paper the average molecular weight is taken as 2.—Rev. T. E. R. **Phillips**: Micrometrical measures of double stars. Special attention was directed to the rapid motion of Boötis, in which the angle diminishes about a degree in six weeks, while the distance has shown little change during the last few years. He had also specially noted the star 70 Ophiuchi, which shows a small progressive diminution both in angle and distance, while the latter should be increasing. He suggested that in this case there may be evidence of a systematic error due to the changing slant of the line joining the two stars as observed before and after opposition.—Mrs. E. W. **Maunder**: Sun-spots in high southern latitudes. These spots were found on the Cape photographs. Some of them were in more than 60° S. latitude, but they are mostly evanescent; they are also small, and it was often uncertain whether they were real sun-spots, or only "pores," which are found on all parts of the solar surface. But in one case the marking had all the characteristics of a true sun-spot, and on the whole the evidence showed that markings of the order of sun-spots can persist in very high latitudes.—R. A. **Sampson**: Notes on the southern magnitude distribution, with special reference to the Perth astrographic zone. In a recent paper Mr. Seares had contended that the galactic condensation of small stars, arrived at by Chapman and Melotte from a study of the Franklin-Adams charts, was erroneous, and that the older estimate of Mr. Cooke was nearer the truth. The author concluded that the galactic condensation obtained by Chapman and Melotte does not in the least represent the actual distribution in the Perth zone, $-32°$. In one section of a recent paper Dr. Halm had dealt with the corrections to the scale of the Cape Photographic Durchmusterung, and Prof. Sampson's paper concluded with a discussion of Dr. Halm's methods and results.

EDINBURGH.

Royal Society, May 7.—Dr. J. Horne, president, in the chair.—Prof. L. **Becker**: The arithmetical mean and the "middle" value of certain meteorological observations. This was a discussion of a large number of temperature observations in Glasgow, in which it was shown that the "middle" value did not agree with the arithmetical mean.—Dr. D. **Ellis**: Phycomycetous fungi from the Lower Coal Measures. Three organisms had been found which could be placed in the Phycomycetes. The first was identical with the organism found by Renault in the French Carboniferous rocks, and named by him *Palaeomycites gracilis*. But there was evidence that the genus was the same as Peronosporites, and it was proposed to re-name the organism *Peronosporites gracilis*. The second was identified as *Peronosporites antiquarius*, previously discovered by earlier investigators. The new material obtained from the Lancashire rocks, taken along with the rock sections in the British Museum, enabled Dr. Ellis to sketch the probable life-history of this fungus. The third organism was new, and was named *Saprolegnites bacilloides*. A full account was given of the characteristic structure of this fungus.—Dr. J. **Tait**: Experiments and observations on Crustacea. Parts iv. and v. In part iv. the author dealt with the structure of Glyptonotus, a large Antarctic isopod taken by the *Scotia* Expedition under Dr. W. S. Bruce. The exceptional size of the animal made it possible to settle certain disputed problems relating to isopod anatomy. The paper also brought out a number of relations between structure conformation and functional use. In part v. it was experimentally shown that the joints in the tail of a lobster or other similar crustacean are so arranged as to obviate change of internal volume during the flapping of the tail.

CALCUTTA.

Asiatic Society of Bengal, May 2.—Dr. A. **Oka**: Zoological results of a tour in the Far East. Hirudinea. Fourteen species of leeches are represented in the collection made by Dr. Annandale in Japan, China, and Siam. Of these, three are described as new. Two of the new species are forms of general interest and have been made the types of new genera. One, which was obtained from considerable depths in Lake Biwa, belongs to the family Glossisiphonidæ, and is remarkable for the curious processes on its proboscis, while the other, which was collected in a small stream on the Peak at Hong-Kong, belongs to the family Hirudinidæ, and is distinguished by the unique character that the furrows separating the somites are deeper and more conspicuous than those separating the annuli.—Dr. N. **Annandale**: Weighing apparatus from the Shan States. The collection described was made in February and March, 1917, in the markets of villages round the Inlé Lake, in the southern Shan States. The weighing apparatus used in these markets is remarkably diverse in construction and at the same time generally primitive in character. The three types to which most simple weighing apparatus conforms are all represented, viz. the scales, the steelyard, and the bismer, or weightless beam.

BOOKS RECEIVED.

Reform in Scottish Education. Pp. 158. (Edinburgh: Scottish Education Reform Committee.) 1*s*. net.

Baillière's Popular Atlas of the Anatomy and Physiology of the Female Human Body. With descriptive text by H. E. J. Biss. Third edition. Plates by Dr. G. M. Dupuy. (London: Baillière, Tindall and Cox.) 4*s*. net.

Friendly Intercourse with the Arch Fiend. Pp. 72. (Letchworth: The Cloisters.) 6*d*.

British Insects and How to Know Them. By H. Bastin. Pp. ix+129+12 plates. (London: Methuen and Co., Ltd.) 1*s*. 6*d*. net.

Food Gardening for Beginners and Experts. By H. V. Davis. Pp. vii+44. (London: G. Bell and Sons, Ltd.) 6*d*. net.

W. and A. K. Johnston's War Map of Palestine. (Edinburgh: W. and A. K. Johnston, Ltd.; London: Macmillan and Co., Ltd.) 6*d*. net.

Shell Shock and its Lessons. By Prof. G. Elliot Smith and T. H. Pear. Pp. xi+135. (Manchester: University Press; London: Longmans and Co.) 2*s*. 6*d*. net.

DIARY OF SOCIETIES.

THURSDAY, JUNE 21.

ROYAL SOCIETY, at 4.30.—Revolving Fluid in the Atmosphere: Sir Napier Shaw.—Absorption Bands of Atmospheric Ozone in the Spectra of Sun and Stars: Prof. A. Fowler and Hon. R. J. Strutt.

FRIDAY, JUNE 22.

PHYSICAL SOCIETY, at 5.—The Determination of Coma from a Central Ray: T. Smith.—Chromatic Parallax and its Influence on Optical Measurements: J. Guild.

MONDAY, JULY 2.

ARISTOTELIAN SOCIETY, at 8.—Relation and Coherence: Miss L. S. Stebbing.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN AND CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.
Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.