NATURE

SATURDAY, MARCH 30, 1929.

CONTENTS.

Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 3100, Vol. 123]

Petrol.

THE problem of petrol arises in acute form once again, and the lay mind is finding it difficult to reconcile continually increasing production of crude oil with, apparently, a directly proportional rise in price of its most valuable derivative. As a purely economic consideration, petrol is not exactly a straightforward commodity to assess in terms of supply and demand, for the simple reason that this usually close relationship does not in this particular case express the condition of the oil industry at any time. When complicated by conflicting commercial and political issues, these confined to no one country, it is small wonder that a number of the less obvious controlling factors in the situation fail to be appreciated by the public at large.

From the technical aspect, the data of the problem are quite clear. Of a total world-production in 1928 of crude oil amounting to 182 million tons, the United States accounted for 127 millions, nearly 70 per cent; Venezuela, the next on the list, yielded 15 million tons, about 8 per cent; Russia contributed 11½ million tons, or about 6 per cent; Mexico, 6½ million tons, about 3 per cent; and Persia, the oil industry of which figures especially prominently in contemporary discussions in the British press, produced 5 million tons, or 2½ per cent (the figures are approximate). Thus all the remaining countries combined account for only 10 per cent of the total output, and the United States persists as the dominating factor in the industry, so far as resources and exploitation are concerned. Incidentally, in spite of local 'proration' agreements, that country continues to flood the market with some 385,000 tons of crude oil per day, a steadily rising figure. Statistics can, of course, be made to prove practically anything, but a sense of proportion born of a grasp of these data is the first step in understanding the present petrol situation.

So many tons of crude oil output, however, do not constitute the barometer of the industry. As E. H. Davenport has recently shown in a pamphlet entitled "The Price of Petrol" (London General Press), in order to appreciate the true economic position, the supply-demand relationship of other important derivatives of crude oil must be ascertained, since petrol is only one of a series of vital products to modern civilisation.

Now excluding paraffin and lubricants, fuel-oil, a heavy residuum from crude oil distillation, has its own particular scheme of economics. Apart

from its enhanced use as a basis of 'cracked' derivatives, it is essentially this oil of which we hear so much in competition with coal. By no means an unimportant influence in the present petrol 'crisis' is this very item fuel-oil, the market vicissitudes of which operate directly in response to fluctuations of coal supply and demand. There is a great deal of nonsense written about the antagonistic purposes of oil and coal, but one thing is abundantly clear: the two commodities, in so far as supply and demand are concerned, are as sensitively balanced in the world of fuel as any delicately poised beam in a laboratory.

If for any reason fuel-oil receipts drop in favour of other forms of thermal energy, the deficit must be spread throughout the oil industry as a whole. Since petrol is the most thriving product of all for which that industry is responsible, it must perforce shoulder its share—a lion's share at that—of the burden. This means that the net profits on the sale of petrol tend to be lessened periodically by a fluctuating amount. Since the oil companies with all their faults are at least financially sane, and realise better than anyone else what is the economic minimum at which petrol may be retailed to show a working profit *on the total cost of their complete operations*, not being philanthropists, they have perforce to pass on such fluctuations, either plus or minus, to the consumer; the latter is, after all, the only possible individual who can harmonise the contending factors. But this is only one other aspect of the matter.

Whatever may or may not be the wisdom of amalgamations or 'combines' as they have come to be known, monopoly, if this be implied and providing it be not abused, can operate in favour of the public by supplying standard commodities at standard or at least economic prices. Any undercutting of such prices as may ensue, unless backed by resources constituting a serious menace to the major interests, will be local and short-lived. The public gains a penny here and there, but is soon forced back to acceptance of 'combine' prices, either through restricted operations of the external interests involved, or through ultimate failure of the latter to contest the market. Should there be, however, a definite attempt at breaking monopoly by prolonged attack, supported by the formidable weapons of large resources of equally high quality products, then competition runs keenly and the public is undoubtedly the gainer during the phase of severe price-cutting which ensues.

If during this period natural resources were for any reason to decline, a truce might automatically be called; but if, as is the actual case, resources increase at a rate which definitely establishes supply in excess of demand, then sooner or later the position has to be faced by the contending parties which, put briefly, means compromise or bankruptcy. There must always be an economic limit, especially in petroleum undertakings, below which it pays no one to produce and distribute petrol, or any other commodity for that matter. In the present circumstances, both competition, heavily backed by adequate resources, and over-production have helped to bring about the logical situation now being faced by producer and consumer.

The recent increase in price of petrol in Great Britain is not an impetuous act of economic or political spite. Its incidence is a direct outcome of a chain of circumstances the operation of which has all along been perfectly clear to the intelligent observer who is not content to accept at face-value *ex-parte* statements in the daily press.

The immediate post-War price of petrol was, of course, excessive, but rendered inevitable by the difficult conditions of restabilisation of international trade, in which petroleum played no unimportant part. This price, however, did not last long, for despite an enormously increased demand for petrol since 1920, supplies more than kept pace, due not so much to over-production of crude oil, but, as Davenport points out, to the economic operation of 'cracking' in refinery process. Thus, applied science has had a direct hand in price-control, for perfection of cracking plants has led to considerably enhanced petrol yield per barrel of oil run to the stills, apart from influencing paraffin production, etc. Hence the principal organisations responsible for producing and marketing petrol were able to take full advantage of public demand, and to hand on to the consumer a small share—in the shape of decreased price per gallon—of the success they were enjoying.

Then came, as it was bound to do, the Russian entry into the market. To understand the full significance of this incursion, it should be recognised that, apart from any commercial or political prejudice, petroleum emanating from the Russian fields is, technically speaking, of exceptionally high quality, a fact well known from the earliest days of the oil industry. While this statement in no sense implies inferiority of competitive oils or products, the temporary exclusion of this fuel from European markets was something of a calamity. Nothing but abundant resources and sound refining values could have re-established so quickly Russian oil in the world's markets, to the

extent of constituting that country the third most important producer last year. Whatever may be the ethics of the case, there has been an undoubted demand for Russian oil in Great Britain during the last few years, a demand which, in its growth, has forced the very issue to which we have referred. A measure of the economic situation created in 1928 is to be found in the price of petrol in London prior to Government tax: 1*s.* 0½*d.* per gallon (ex pump). Anyone, even with the slightest knowledge of the technical side of the oil industry, knows that such a price is unsound and can never bear a proper ratio to capital outlay and cost of production, especially when it is remembered that from that figure transport charges and retailer's commission must be deducted before the producer can reckon his profit. Consequently, things were destined to alter in any case, and compromise between conflicting interests was an inevitable policy foreseen long before the *fait accompli* was realised. The natural corollary to such compromise is the raising of the price of petrol to an acceptable economic minimum.

In the meantime, however, the Government made an imposition of 4*d.* tax per gallon of petrol last year, to which the retailer added ¼*d.* as cost of collection. Thus in London the price of petrol rose to 1*s.* 4¾*d.* ex pump, or 1*s.* 5¾*d.* (or more) in the provinces. This, however, had nothing to do with the economic situation in the industry, though it may since have had some slight repercussion in the matter of decreased demand. The price of petrol at the round figure of 1*s.* 5*d.* or 1*s.* 6*d.*, though possibly distasteful to the consumer, clearly left the main problem of economic minimum unaffected, and something was bound to happen to alter these conditions from the point of view of the well-being of the industry as a whole. The plain fact is that, until the recent increment of 2¼*d.* per gallon was made by the industry on Mar. 1, nothing had occurred to alleviate the serious position of a year ago; the addition of this increment is an expression of compromise between contending interests, or, in the absence of any specific agreement at the moment, it is a measure of consolidation of the inevitable position which the industry must take up to 'put its own house in order' whatever may fall in the future. Even now, it should be noted, the increase only brings the total price of petrol to 1*s.* 2¾*d.* per gallon excluding tax: it remains to be seen for how long that price will be considered adequate to the needs of a complex industry.

Petroleum, once exploited, is a wasting asset. In the face of production on a scale never before achieved or even contemplated, it is difficult to forecast events; but anything which tends to promote its economic production and utilisation may be construed as a measure of conservation, and this care it is the duty of the industry to foster. If enhanced price of petrol is economically justified, as we believe it to be, then it will have the effect of strengthening the industry in a determination to prevent waste of this valuable commodity at all costs. To this extent recent events have perhaps been beneficial. H. B. M.

Practical Oceanography.

Science of the Sea: an Elementary Handbook of Practical Oceanography for Travellers, Sailors, and Yachtsmen. Prepared by The Challenger Society for the Promotion of the Study of Oceanography. Originally edited by Dr. G. Herbert Fowler. Second edition, edited by Dr. E. J. Allen. Pp. xxiii + 502. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 15*s.* net.

THE Challenger Society has done well in issuing a new and revised edition of this well-known and useful book, which has been out-of-print for some years, and the new editor, Dr. E. J. Allen, is to be congratulated on having retained the original character of the work, while bringing it abreast of modern progress. Oceanography has advanced in several directions since the War, and its progress has been due in no small measure to British work, though we have had no great oceanographical expedition devoted purely to such problems, as the Germans have had in the *Meteor* expedition. One would like to see Britain again taking the lead in great oceanographical explorations, as befits her position as the greatest seafaring nation. Much of interest will no doubt come of the *Discovery* expedition, but this is necessarily tied down somewhat strictly to the investigation of the very pressing economic problems arising out of the exploitation of whaling. May the "Science of the Sea" help in stimulating that interest in the problems of the ocean which is dormant in the heart of every Briton, and bring the time nearer when the purse-strings will be loosened to enable Britain take her rightful part in oceanographical exploration.

The book is addressed primarily to "travellers, sailors, and yachtsmen," to all those whom business or pleasure takes upon the great oceans, and it will prove of inestimable service to all such who wish

to take part, in however modest a fashion, in the study of marine problems. To those who ask, "What can I do for oceanography?" this book supplies a sufficient and thoroughly practical answer. It will be of interest also to others, to those who have no opportunity to do work at sea, but wish to learn about oceanographical problems and the methods by which they are studied. Also, the student who is beginning to take up marine or fishery work will profit greatly by a careful reading of this book, which has the great advantage of being written throughout by practical workers of long experience and proved competence.

As we have said, the volume follows fairly closely the arrangement adopted in the original edition, and certain sections show little change, though all have been revised. The chapters on the air and water have been completely re-written, the former by Capt. Brunt and Comdr. Garbett, the superintendents respectively of the Army and Navy Meteorological Services of the Air Ministry, the latter by Mr. D. J. Matthews and Dr. W. R. G. Atkins. Both chapters are extremely well done. Dr. Atkins's contribution deals with the alkalinity of sea water, and gives a full account—perhaps just a little difficult for the beginner—of the methods to be employed in determining the *p*H of sea water. Mr. Matthews describes in outline the main current systems of the oceans, and gives eminently practical instructions for the use of hydrographical instruments and methods. It might have been well to mention Lumby's surface sampler, which makes the collection of water samples from vessels under way much easier and more satisfactory than the old bucket method. The definitive description of this instrument has, however, only just recently been published (*Jour. du Conseil*, **3**, 3; 1928). An interesting comment is made by Matthews on the echo-sounding method of determining depths. He rightly fears that the spread of this most valuable method will result in a serious decrease in the number of bottom temperatures and samples of bottom deposits collected.

In the biological sections there is apparent a certain inequality of treatment—the fixed plants, for example, are dealt with in a very adequate manner by Mrs. Weber van Bosse, while the fishes receive much less space. But one must admit that to treat of the fishes in a comprehensive way would have taken up practically the whole volume. The section on phytoplankton, by Dr. Marie Lebour, is new, and, though short, is admirably done. Prof. Stanley Gardiner has re-written his fascinating and practical account of tropical shore-collecting, and the section on fishing gear has been considerably strengthened. Of great practical value is the chapter on the preservation of marine animals, by Dr. Allen and Mr. E. T. Browne—a subject on which expert advice is always welcome. Prof. D'Arcy Thompson's charmingly written account of whales and seals—and sea-serpents—will be of especial value to the ocean traveller.

The illustrations are on the whole good, with the exception of some of the small figures of plankton and benthonic animals. The useful appendices of the original edition are retained and expanded—a list of marine stations, of literature, of recommended firms for the supply of apparatus, and an outline biological classification. The list of literature might have been extended with advantage. One notes with interest and some surprise that the number of marine stations listed, in all parts of the world, amounts to more than one hundred. The frontispiece is, most appropriately, a portrait of the late Sir John Murray, to whom the science of the sea owes so much.

Colliery Economics.

The Economics of Coal Mining. By Prof. Robert W. Dron. Pp. vii+168. (London: Edward Arnold and Co., 1928.) 10*s*. 6*d*. net.

THE subject of the above work is one of the greatest possible importance at the present moment when coal mining problems bulk so largely in the public interest. Prof. Dron has produced a very readable and very useful little book in which most of the problems connected with the economics of coal mining are succinctly reviewed. It comprises ten chapters: namely, an introductory chapter, one devoted to mineral leases, two to valuations, the first of these referring to the valuation of a mineral property and the second to the valuation of an operating colliery; another chapter considers the economics of the development of a new undertaking; another gives estimates of capital expenditure, another the cost of power production, whilst the final chapters are devoted to the organisation of a colliery, to coal cleaning, and to legal considerations, the latter being devoted mainly to the questions of subsidence and trespass.

As might be expected from a colliery engineer of Prof. Dron's knowledge and experience, the work is throughout of a high order; since, however, a large number of the questions treated of are of a distinctly controversial nature, few mining engineers

will be found to agree with all Prof. Dron's views, though a large majority of them will agree with the greater portion thereof.

When critically examined, the chapters on valuation are probably the weakest in the book, and give evidence of less clear thinking on this important subject than might perhaps have been expected from the author. Thus, in the chapter dealing with the valuation of mineral properties, the author introduces a consideration of the costs of mining operations; such costs have, however, nothing at all to do with the case, because the value of a mineral property is determined solely by the consideration of the income which this property would yield and, therefore, the capitalised value of the mineral royalties. In a previous chapter the author has considered the true meaning of royalty and quite correctly distinguishes between it and an occupation rent, and quotes the authoritative statement on the subject from the Report of the Royal Commission on the Coal Industry (1925), which shows that "a rent is paid for the use of a thing which endures," whilst "a mineral royalty is paid for the purchase of the thing itself."

Prof. Dron is, however, in error when he considers that the word royalty is a survival from Queen Elizabeth's time. The word was never used in this modern sense by medieval writers, and, in fact, its first use in this particular sense appears to date from the first half of the nineteenth century. Prof. Dron refers correctly enough to the decision about the year 1568, which assigned all mines except royal mines to the owners of the land in which they occur, but he omits to point out that the Crown never at any time even claimed the ownership of or a royalty in respect of coal. The distinction is sufficiently important for Prof. Dron to have directed attention to it. It may also be suggested that the Scotch term 'lordship,' which is the Scotch equivalent of royalty, should not be used without defining it for English readers.

Prof. Dron has fallen into a curious arithmetical blunder in his footnote to p. 31 in discussing the local rates payable by mineral owners in Scotland. He states quite correctly that in Scotland the local rates on a colliery are payable approximately one-half by the owner and one-half by the lessee, but goes on to say that in England and Wales, "so far as the writer is aware, no part of the local rates is paid by the mineral owner." Prof. Dron's statement on the latter point should have been much more definite, and he appears to be unaware of the reason for this difference; in England and Wales the fixing of rates is based upon the well-known statute of Queen Elizabeth's time, which enacts that rates may be levied upon every occupier of coal mines, etc.; this statute has since been greatly extended and modified and other rates have been added, but the basal principle that the occupier is liable for the rates has never been altered.

In Scotland, on the other hand, the fundamental legislation which controls rating is contained in an Act of Queen Victoria's time passed in 1854; and although the general principle laid down in that Act is varied to some extent by the local Acts, its general effect remains, so that approximately one half of the rates is paid by the owners of the mine and the other half by the occupiers. The reason for the difference in treatment of mine owners in Scotland and England is thus quite clear.

Prof. Dron's error, which has been referred to above, is in his calculation of the amount of the local rates payable by mineral owners, which he states "is equal to about 1*s.* 6*d.* per ton of output." He bases this on his statement that the local rates payable by mineral owners in 1925 were about £230,000 per annum. He has previously given the output for that year as 28,394,000 tons (a clerical error in the table on pp. 10 and 11 would make this about 28,000 million tons, but this error does not affect the case.) A simple calculation will show that the rate above given amounts not to 1*s.* 6*d.* per ton but to nearly 2*d.* per ton, and it can only be surmised that Prof. Dron has carelessly misplaced a decimal point. Such an error is a comparatively venial one, but in the present instance would lead to important results. Prof. Dron has no doubt a long and varied experience in dealing with Scottish mineral owners, but it may gravely be doubted whether he has come across one so constituted as to be willing to accept 6*d.* per ton in payment for his coal and pay out in return 1*s.* 6*d.* per ton for his rates. Scotch mineral owners are not usually credited with such a degree of quixotic altruism or such utter carelessness to their own interests as a bargain on Prof. Dron's lines would appear to indicate, and it is incomprehensible why this fact should not have struck him whilst he was writing the lines in question.

It may also be asked what Prof. Dron means by stating that his chapter on the valuation of minerals is devoted to the simplest case, namely, "the valuation of minerals in actual course of working," and a few lines further down to discuss such a valuation in the case "if the winding pits are not established on the property under investigation." It

would be interesting to know how the mine could be in the course of working before the winding pits are sunk.

In his next chapter, on the valuation of a going colliery, Prof. Dron commits an error into which very many, perhaps the majority, of mining engineers are apt to fall. He tabulates for a valuation of a colliery the estimated future output and the life of the coalfield; in other words, he commences by stating what the quantity of coal is which the field in question contains. This is a fact that neither he nor anyone else can know in advance; he might be entitled to state that the field is estimated to contain a certain quantity of coal, though the more correct statement would be that the most probable quantity of coal contained in the field is so much, the most probable quantity being that which is as likely to be exceeded as to be fallen short of when the coal comes to be actually worked. Until it is worked, no one can say how much the field actually contains.

Prof. Dron deals very briefly with the problem of deferred royalties, and it seems evident that he has not seen the elaborate discussion of the subject in a paper on "The Value of a Deferred Annuity, with Special Reference to the Valuation of a Mineral Property," by Charlton Carpmael (*Jour. Inst. Actuaries*, vol. 56, pp. 25-72; 1925).

In conclusion, it may be said that the chapters here selected for detailed criticism are on a subject which is perhaps the most difficult and the most controversial of any in the book; and the fact that different views are here put forward on many points to those advanced by the author must not be taken as any indication that the book is not an exceedingly valuable one; indeed, it is likely to be of the utmost use to all colliery engineers.

British Sea Anemones.

The British Sea Anemones. By Dr. T. A. Stephenson. Vol. 1. (Ray Society Volume No. 113.) Pp. xiv + 148 + 14 plates. (London: Dulau and Co., Ltd., 1928.)

WHILST in some branches of science, especially physics, there are so many workers in the field that monographs can be continually revised, in others many years must pass by before an expert can bring our knowledge up-to-date. Dr. T. A. Stephenson, one of the two leading workers on anemones at the present time, is to be congratulated on his effort to bring together and set in order the facts known about British sea anemones, their structure, development, bionomics, and classification. It is the first successful attempt to supplement the famous work of Gosse completed so long ago as 1860, when the comparative anatomy of anemones had not been studied.

It will perhaps be a disappointment to some who have looked forward to the appearance of this important work that the body of it is apparently being held back for a subsequent volume. Although the author lays stress on the fact that for the purposes of the monograph a clear understanding of anatomy is necessary, it is doubtful whether the general reader will feel urged to read through the technical and well-illustrated section on structure, which occupies the greater part of the text, until the appearance of the next volume: this will presumably contain descriptions of the species. But the remaining sections, particularly that on bionomics, are full of absorbing interest.

The author describes the different haunts of these animals; and points out where the best collecting grounds are, and which species can best be maintained in aquaria. Interesting notes are given of the rapid way in which some anemones can move about, of how they capture and digest their food, and, above all, of the various methods of reproduction, even at the mature age of three score years and ten. He instances one anemone which, as soon as it begins to rove about, leaves behind pieces of its base, which, retaining hold of the substratum, regenerate into normal individuals. True budding is not a characteristic of these animals, the total absence of colonialism and skeleton building being correlated with a relatively active habit. Their ancestors were probably creeping, bilaterally symmetrical forms, and radial symmetry supervened when a more sedentary life was adopted.

Dr. Stephenson is an artist of no mean order, and has drawn a number of beautiful and convincing studies of living anemones. He is careful to explain, however, that individuals can look quite unlike the portraits given of their particular species, and that his illustrations necessarily represent fleeting aspects of selected colour varieties of most changeable organisms. He goes into the questions of coloration and pattern, and the methods of collecting and maintaining anemones in aquaria. Notes are given on natural enemies and messmates. The author mentions their use for fishermen's bait, and that they form a considerable part of the diet of some fish like cod, whiting, haddock, and especially flounders. A long list of works on anemones is given, and the reader is shown where to look for information under various sub-headings.

A. K. TOTTON.

Our Bookshelf.

The Yearbook of the Universities of the Empire, 1929. Edited by T. S. Sterling. Published for the Universities Bureau of the British Empire. Pp. xiv + 852. (London: G. Bell and Sons, Ltd., 1929.) 7*s*. 6*d*. net.

IN pre-War days, "Minerva" was the standard reference book of the personnel of the universities and learned bodies of the world. After a lean period, it has regained its position, but at the cost of growth to three very bulky volumes. The "Universities Yearbook" covers the universities of the British Empire and is a compact handbook of less than a thousand pages; its data, being compiled from university calendars and similar official publications, is thus trustworthy.

The "Yearbook" is divided into sections dealing with Great Britain and Ireland, Canada, Australia, South Africa, and India respectively. Each section is preceded by a brief account of the history and the regulations of the universities of the section, after which each university is dealt with separately. A directory of the staff, arranged under departments, is given, followed by general information, including equipment of laboratories, museums, etc., degrees, residential accommodation, changes of staff during the past year, student statistics, and so on.

The appendices occupy about a third of the book and provide most valuable information, which is only available elsewhere in widely scattered publications. They cover the regulations for professional bodies, matriculation examinations, inter-university scholarships and grants for research, professional schools of the universities, and the distribution of subjects in which various universities specialise, centres of research outside the universities, and titles of theses accepted for research doctorates. There are name and general indexes.

We commend the book to all who wish for information on educational facilities of university standing. For ourselves, there are few reference books to which we turn more frequently or with more confidence.

The Symmetrical Optical System. By Dr. G. C. Steward. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 25.) Pp. viii + 102. (Cambridge: At the University Press, 1928.) 7*s*. 6*d*. net.

THIS is the latest addition to the useful series of Cambridge Tracts in Mathematics and Mathematical Physics. It enlarges upon the short section devoted to the characteristic function in the earlier book of the same series ("The Elementary Theory of the Symmetrical Optical Instrument," by J. G. Leatham), by an early use of the functions of Hamilton and Bruns. The author has made a welcome departure from the purely geometrical discussion in calculating the distribution of energy in diffraction patterns associated with the primary aberrations, a purpose for which treatments based upon the principle of optical path are naturally convenient. It is to be hoped that the end of optics completely divorced from practice has at last arrived. Had the developments made by the author and Mr. T. Smith been only a little earlier, the subject of geometrical optics might still have been included in the Tripos.

It might be suggested that the heading of Chapter v., "The Computation of Optical Systems," is a little misleading. The chapter deals with the computation of aberration of optical systems, and not with the design of systems, as the heading might lead one to suspect.

The book is, of course, addressed only to readers with the requisite mathematical equipment. Those without such an equipment can obtain many of the same results by other means.

The Story of the American Indian. By Prof. Paul Radin. Pp. xiv + 371 + 30 plates. (London: John Murray, n.d.) 21*s*. net.

IN the story of the American Indian, Dr. Radin traces the spread of offshoots of the elaborate Maya civilisation over a great part of North America. There was, according to him, one stream of an early stage of Mayan culture that evidently went by sea to the mouth of the Mississippi, spread mainly northwards to found the culture of the Mound-builders, and underwent transformation as it proceeded; eventually these immigrants were overwhelmed by the simpler peoples around them. Certain cultural traits spread over the plains, weakening as they reached the north-eastern woodlands. Another stream (of Toltec culture) flowed into Arizona and New Mexico, where it overlaid an older Mayan layer that had spread from the east; this culture was partially assimilated by the Navaho, Pawnee, and others. The capitalists of the north-west coast have closer affinities with Asia and striking resemblances to conditions met with in Melanesia. The high pre-Inca cultures of Peru are discussed in a similar way.

Dr. Radin traces these connexions in an interesting manner. The book should not be overlooked by ethnologists, but being innocent of references and an index, it is apparently written for non-specialist readers.

Lehrbuch der anorganischen Chemie. Von Karl A. Hofmann. Sechste Auflage. Pp. xv + 784 + 7 Tafeln. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1928.) 20 gold marks.

THE sixth edition of Prof. Hofmann's "Lehrbuch" follows the preceding edition after an interval of three and a half years. No drastic alterations have been made, but an important chapter of twenty-three pages has been added on the organo-metallic compounds. This is included in a part of the volume which contains chapters on explosives, structure of inorganic compounds, structure of crystals, radioactivity, and atomic structure. Those who are not acquainted with the book may therefore be assured that it deals as adequately with general questions as it does with the properties of individual elements and compounds.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Excitation of Mercury Vapour by the Resonance Line.

THE early researches of R. W. Wood (1912) showed that mercury excited by the light of the line 2537 emitted resonance radiation of the same frequency as the absorbed light.

Accompanying this resonance radiation there is radiation of longer wave-length, comprised chiefly in two broad maxima, one about λ3300, and the other giving rise to visual green fluorescence. These last radiations, which are regarded as of molecular origin, appear at higher vapour densities than are required for the resonance radiation, which has always been regarded as a purely atomic phenomenon.

F. S. Phillips in 1913 showed that the visual luminosity could be caused to move away from the place of origin if the vapour was in rapid motion. Photographing the spectrum, he concluded that the ultra-violet radiation around λ3300 and the line 2537 could also be detected in the vapour stream away from the place of origin.

I have always been puzzled by these phenomena, and the mystery has not seemed at all less since observing (see NATURE, Nov. 10, 1928) that the visible radiation could be produced by excitation lower than the resonance line, and that in this case too the secondary source was capable of being blown away from the place of excitation.

The question arises: What is the relation between the 2537 radiation and the visual radiation in Phillips's experiment ?

Although not yet prepared with a complete answer, I wish to describe some experimental results which analyse the phenomenon more closely than has yet been done.

The distillation may be carried out *in vacuo*, or with a moderate air pressure in the condenser, which results in a more dense but less rapid vapour stream. The added air does not mix with the mercury vapour under these conditions until the condenser is reached.

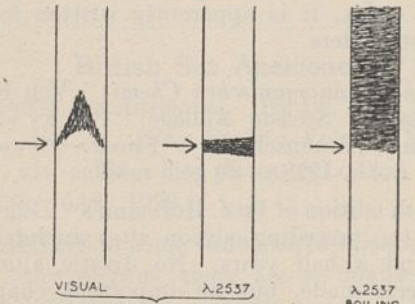

FIG. 1.

Distilling the vapour up a silica tube 1·5 cm. square section, with an air pressure of 9 mm. in the condenser, the visual glow is of the shape shown in Fig. 1A, the arrow indicating the direction of the narrow incident beam. The arched form indicates, as Wood and Pienkowski have shown, that after excitation there is a time lag before the luminosity sets in. This is most apparent in the middle of the tube, where the stream is most rapid.

On the other hand, the re-emitted ultra-violet radiation comes laterally from the cone marked out by the incident rays, undeflected by the vapour current (see Fig. 1B). This appearance is obtained by photographing through filters of chlorine and bromine in series, which transmit the line 2537 but cut out the less refrangible radiations.

Finally, on making the vapour current more rapid by completely exhausting the condenser, the visual radiation is thinned out to vanishing point, and the source of 2537 radiation moves up as well (see Fig. 1C). That this really is the radiation 2537 was checked by photographing through chlorine and bromine with addition of mercury vapour in an independent cell, of such thickness and density as to absorb about a breadth of 1 A. at this point without absorption at any other relevant part of the spectra. The luminosity in the tube was altogether cut out by this filter.

It seems therefore, so far as can be judged from the evidence yet available, that the 2537 radiation is simply Wood's resonance radiation, and that in the experiments with a blast of vapour its source can be observed as separated in space from the source of the continuous bands which are doubtless of molecular origin. But if this interpretation is accepted, the surprising thing is that the source of resonance radiation is in itself capable of moving considerable distances in a sufficiently rapid blast. This would show that the interval between excitation and emission is under some conditions enormously longer than the 10^{-7} seconds usually assigned. If so, many received views will need revision.

RAYLEIGH.

Terling Place, Chelmsford,
Mar. 14.

The Constitution of Oxygen.

W. F. GIAUQUE and H. L. Johnston in a recent letter (NATURE, Mar. 2, p. 318) state that certain observations on absorption bands are only explicable by the hypothesis that oxygen contains atoms of mass 18. Unfortunately, they do not give any indication at all of the abundance of these relative to the normal atoms.

So far as I am aware, there is no evidence obtained from positive ray analysis of any kind which would lead us to suppose oxygen other than a simple element. In my recent measurement of packing fractions the line due to O^{16} was taken as standard and, to take the cases in which the evidence is most trustworthy, the atomic weights of hydrogen, fluorine, and iodine determined in this way were found to agree with the accepted values to within one part in ten thousand. The latter are expressed in terms of the mean atomic weight of oxygen, so that this is very strong, though indirect, proof that if O^{18} exists it cannot be present even to the extent of one part in one thousand.

In order to obtain evidence of a more direct kind I have done two experiments, one with the O_2 line, the other with the H_2O line. In the first the discharge tube was run with oxygen giving a strong line O_2 at 32. Now if O^{18} exists, there would be a line due to the molecule $O^{16}O^{18}$ at 34 of a strength directly proportional to the quantity of O^{18} present. With half an hour exposure a barely visible effect at 34 was obtained. Its relative intensity was measured by photometry against other and very short exposures of line 32 and came out at 0·14 per cent. This very faint effect may, in my opinion, be due to traces of S^{34}.

In the second experiment water vapour was

employed, and the faint line at 20 compared with the strong one at 18 in the same way. Here the effect was rather greater, amounting to 0·32 per cent. In an apparatus to which air has to be frequently admitted, one would expect some effect due to A^{40++} and Ne^{20}, but I think in this case it is to be ascribed mainly to $Si^{28}C^{++}$. In any event, the presence of the line may be explained without recourse to an unknown body.

If it can be shown that the absorption band effects are compatible quantitatively with the presence of the hypothetical isotope in proportion less than one part in 500, the matter will require further investigation. Otherwise it seems more reasonable to seek for them an alternative explanation and continue for the present to regard oxygen as a simple element.

F. W. ASTON.

Cavendish Laboratory,
Cambridge, Mar. 15.

Tsetse Fly and Big Game.

REFERRING to an editorial entitled "A Threat to the Zululand Game Reserves" in NATURE of Nov. 24, 1928, whilst very much in sympathy with the object of this article in so far as it refers to preservation in reserves of the natural fauna of South Africa, I am led to express the opinion that certain of the statements made would be very difficult to substantiate on the basis of available scientific data.

The article gives the impression of having been written rather from a partisan point of view than from that of a detached scientific reviewer. The relation between certain species of tsetse fly and game is certainly a controversial subject, but it is considerably less so amongst those best acquainted with the tsetse-fly problem than some ardent advocates of indiscriminate game preservation would have the world believe. In any case one does not expect NATURE to ignore the views of the leading entomological investigators on such a question. I may also point out that the *Journal of the Society for the Preservation of the Fauna of the Empire* is scarcely the publication in which one would expect to find unbiased views on this subject.

Justification for my venturing to offer criticism is to be found in the fact that a misstatement is included concerning certain experiments stated to have been carried out in this Colony, and further in the fact that vigorous efforts are being made by my Government at the present time to arrest the spread of tsetse fly in certain areas through reduction and control of game.

The misstatement referred to is contained in the passage, "On the other hand, satisfactory and unobjectionable methods of extirpating the tsetse fly and reducing the incidence of nagana in domestic stock are known, as has been shown by experiments carried out in Southern Rhodesia, where the bush itself, the winter retreat of the tsetse fly, has been attacked." It is true that many years ago, impressed by the apparent segregation of *Glossina morsitans* in shady forest during the latter part of the dry season, I suggested that in some localities destruction of these haunts might prove a practical method of eliminating the fly. It is also true that some experiments along these lines have been attempted in the Colony. It is not, however, true that these experiments have revealed a "satisfactory and unobjectionable" method of extirpating tsetse fly. In the first place, they have never been pursued to a satisfactory conclusion, and in the second, it is more than doubtful if they can be described as "unobjectionable" either from the sentimental or practical point of view. Surely to the Nature lover large-scale destruction of many of the most conspicuous and beautiful representatives of the natural flora must be equally objectionable as destruction of the fauna. The game in any case is capable of more rapid recovery than the forest, providing, of course, that in neither case is reduction pursued to extermination. From the practical point of view there is, of course, no question concerning the objection to the destruction of useful timber.

Careful perusal of the article reveals the fact that the ultimate dependence on the game of such species of tsetse fly as *Glossina morsitans* and *G. pallidipes* is not actually called in question. I take it, therefore, that the main contention is that it is not possible or not practicable to reduce the game sufficiently to make conditions unsuited to the fly, and that attempts to do so may have untoward consequences.

With reference to the possibility of game extermination aggravating the trouble in respect to domestic animals, I may state that the experience in this Colony is that any developments of this nature following persecution of the game have been very limited and of a purely temporary nature. So far, the final event has been a marked improvement on the original position.

It is noted that no reference is made to the possibility of tsetse fly being scattered by other methods involving interference with conditions in a fly belt. Wholesale destruction of the forest in a fly belt in the Hartley district of this Colony in 1913 was certainly followed by the temporary appearance of trypanosomiasis farther afield than it had occurred for years, although the number of flies present was exceedingly small. Had this belt been heavily infested, it is at least possible that much more serious losses might have been sustained. The final event in this case was, however, also satisfactory.

With regard to the next sentence, justification appears to be lacking for the statement that "total extermination of all wild carriers of nagana which the policy demands if it is to be effective." On the contrary, experience in South Africa indicates that total extermination of game is by no means necessary to get rid of certain species of tsetse fly and the diseases they convey. The bibliography in Austen's "Monograph of the Tsetse Flies" contains notes of interest in this connexion. The late Mr. Claude Fuller has also collected a number of valuable records in the Transvaal. Dr. Schwetz has recently pointed out how tsetse fly has receded with the game around Elizabethville in the Katanga. There is a considerable amount of additional evidence in this Colony.

"It is believed that the segregation of game in reserves tends to keep the tsetse fly restricted to definite areas." Segregation of game presumably implies a game reserve surrounded by game-free country. Certainly, maintenance of a game reserve will not restrict the range of tsetse fly, if conditions are suited to its perpetuation outside the reserve. The inhibiting factor would, therefore, be found in surrounding conditions, not the reserve itself. The suggestion that it is possible to reduce the game sufficiently around a reserve to produce conditions unsuited to the fly appears scarcely in accord with what is apparently the main contention of the article.

The statement that "slaughter of big game . . . has not succeeded, and cannot succeed, in reducing the numbers of tsetse" is an assertion which ignores the whole record of tsetse fly in South Africa and the published work of investigators fully qualified to formulate an opinion on this subject. A good case can certainly be made out for the view that slaughter of big game has in the past succeeded very markedly not only in reducing the numbers of tsetse (*G. morsitans*

and *G. pallidipes*) but in eliminating these insects from considerable areas. It is also not difficult to offer a plausible explanation of how this slaughter, falling short of extermination, would tend to eradicate these flies. Whilst the case may not be considered absolutely proved, there is no justification whatsoever for unconditional denial of the possibility of controlling tsetse fly through the game, particularly in limited areas.

I have no intention of entering into the controversy as to whether the Zululand game reserve should be abolished or otherwise. My object is purely to deprecate the appearance in a leading article in NATURE of unqualified statements which are open to challenge, and the treatment of a scientific and economic problem from a less dispassionate point of view than readers of NATURE have learnt to expect.

RUPERT W. JACK
(Chief Entomologist).
Department of Agriculture,
Salisbury, Southern Rhodesia,
Feb. 4.

READERS of NATURE are familiar with the controversy which has raged round the question of coincident game and tsetse extermination, and the article referred to was obviously not a full summary of the divergent views, as was implied in the words "many competent observers hold," etc. It was meant to point to considerations which seemed to have been overlooked in the case of the Zululand Reserves. In view of the crude method of game extermination which has been widely advocated, it is regrettable that the experimental destruction of the segregation haunts of tsetse, which seems to have been based upon sound entomological observation, was not pursued to finality, as we had understood, especially as Mr. Jack admits that the less scientific wholesale destruction of a forest fly-belt had satisfactory results. The fact that some years ago "an ill-advised game drive [in the Zululand region to which the original article referred], by scattering animals over farms in the neighbourhood, undoubtedly led to the infection of the cattle of colonists by nagana and it is alleged that about 1000 head died," strongly suggests that segregation in the reserve area limited the incidence of the disease. Finally, Mr. Jack's own report of 1926 on the "Tsetse Fly in the Lomagundi District," largely quoted by the *Journal of the Society for the Preservation of the Fauna of the Empire* (1926), the impartiality of which he impugns, indicated, by its comparison between the anti-nagana results of present-day settlement and the pioneer settlements in South Africa, that the rapid retiral of big game, in fact its local extermination, and nothing short of that, was the predominant cause of the disappearance of tsetse.

THE WRITER OF THE ARTICLE.

Knock Ratings of Pure Hydrocarbons.

IN their letter on page 276 of NATURE of Feb. 23, Prof. Nash and Mr. Howes point out the value of unsaturated hydrocarbons in suppressing knocking. Their figures show that benzene and toluene, which for some time were considered the most effective anti-knock hydrocarbons, actually possess this property to a very much smaller extent than many unsaturated hydrocarbons, particularly in the aliphatic series. The statement that pseudocumene has pro-knock tendencies is, however, misleading, particularly as Edgar's octane (1 . 1 . 3-trimethylpentane) is referred to in the same paragraph as a valuable anti-knock. Pseudocumene may be pro-knock when compared with benzene, but it is certainly not pro-knock in the general meaning of the term. Compared with benzole in high concentrations, Edgar's octane is also pro-knock. The terms pro-knock and anti-knock are used rather loosely, and it must be remembered that they only have a definite meaning when a standard fuel is mentioned.

Although our own results for the hydrocarbons tested by Prof. Nash and Mr. Howes fall in approximately the same order, there is one very noticeable exception. We find that diamylene is not such a good anti-knock hydrocarbon as they indicate, and that it certainly is not better than the parent hydrocarbon, trimethylethylene, from which it is derived. If this were true, as Prof. Nash and Mr. Howes' figures indicate, it would then be desirable to polymerise the lower unsaturated hydrocarbons as Reiman does in the patent quoted, which would be contrary to all refining experience, in which it has always been found that the treatment of any unsaturated product involving polymerisation always reduces the anti-knock properties. Our own figures for diamylene prepared from trimethylethylene by polymerisation with sulphuric acid, and also for diamylene obtained by fractionating the high boiling hydrocarbons formed when commercial amyl alcohol is treated with zinc chloride, are much lower than those obtained for trimethylethylene in equivalent concentration. Furthermore, the fractions from the latter source boiling over the range containing the triamylenes after suitable purification, give even lower figures than those obtained for diamylene. This result was only to be expected.

AUDIBILITY TEST ON RICARDO E. 5 ENGINE.

	H.U.C.R.	Change in H.U.C.R.	*n*-Heptane-Benzene Equivalent. (By Volume.)	
			Per cent.	
Standard reference fuel . . .	6·3	..	44·7	55·3
Trimethylethylene .	7·2	+0·9	29·7	70·3
Diamylene from trimethylethylene .	6·96	+0·66	32·3	67·7
Diamylene from coml. amyl alcohol . .	6·90	+0·60	33·2	66·8
Triamylene b.p. 240°-250° C. . . .	6·56	+0·26	39·0	61·0

The substances were tested in 20 per cent (by weight) concentration in standard fuel. Every substance was tested over as wide a range of concentration as possible, partly to reduce experimental error, and also because the relation between concentration and anti-knock value is not necessarily linear. When comparing polymerides, it is of course essential to work in weight concentration, as polymerisation does not involve a change in weight but generally one of volume.

Results confirming the observation that polymerisation reduces the anti-knock value were also obtained for methyl*cyclo*hexene and its dimeride methyl*cyclo*hexyl-methyl*cyclo*hexene.

AUDIBILITY TESTS ON RICARDO E. 5 ENGINE.

	H.U.C.R.	Change in H.U.C.R.	*n*-Heptane-Benzene Equivalent. (By Volume.)	
			Per cent.	
Standard reference fuel . . .	6·3	..	44·7	55·3
Methyl*cyclo*hexene .	7·02	+0·72	31·7	68·3
Methyl*cyclo*hexyl-methyl*cyclo*hexene	6·50	+0·20	40·1	59·9

The substances were tested in 20 per cent concentration (by weight) in standard fuel.

While testing *cyclo*hexene a very interesting observation was made. It was found that the value in any definite concentration was determined by the history of the sample. For example, a sample which had been standing in the laboratory improved in anti-knock value when distilled over sodium. On exposure to light and air this value fell rapidly; another sample, stored in a brown bottle, did not deteriorate nearly so rapidly. Eventually this behaviour was traced to the presence of traces of *cyclo*hexene peroxide, which is readily formed under the conditions described (compare *J.A.C.S.*, **50**, 568; 1928). This peroxide appears to be quite stable in solution and to accumulate on storage. The following are the figures obtained:

AUDIBILITY AND BOUNCING PIN TESTS ON ARMSTRONG ENGINE.

		H.U.C.R.	Change in H.U.C.R.	*n*-Heptane-Benzene Equivalent. (By Volume.)	
				Per cent.	
Standard reference fuel		5·6	..	44·7	55·3
*Cyclo*hexene:					
Refluxed 48 hours over sodium. Maximum value	20% solution by weight.	6·25	+0·65	34·9	65·1
Exposed to light and air six months		5·46	−0·14	47·3	52·7
Stored in brown bottle in diffused light six months		6·07	+0·47	36·8	63·2

Not all unsaturated hydrocarbons, however, appear to form peroxides so readily; often, if they do, decomposition occurs with the deposition of gum. The sample of *cyclo*hexene left in the light for six months deposited no visible gum.

The importance of testing unsaturated hydrocarbons to make sure that no peroxides are present must be emphasised, as the values obtained may be erroneous if this precaution is not adopted. Rough analyses of the samples of *cyclo*hexene referred to above gave 0·2 gm. peroxide oxygen per litre for the sample left in the light, and 0·009 gm. per litre for the other sample. It is interesting to note that *cyclo*hexene in contact with air shows indications of the presence of peroxides after a short exposure to ultra-violet light.

The observations of Prof. Nash and Mr. Howes that the olefines, which are comparatively stable towards certain oxidising agents, are the most effective in suppressing knocking, agrees well with our own. In general, we have found that comparing isomerides, the more compact a hydrocarbon molecule is the greater is its tendency to suppress knocking. Thus trimethylethylene is better than pentene—2. This conclusion is in agreement with Dr. Edgar's observation with regard to the isomeric heptanes.

The effect of introducing a second double bond is interesting. Of the hydrocarbons examined, those containing conjugated double bonds (*e.g.* $\beta\gamma$ dimethylbutadiene, $\Delta^{1.3.}$ *cyclo*hexadiene and butadiene) have excellent anti-knock properties. A diolefine in which the double bonds are not conjugated (*e.g.* diallyl) does not possess particularly marked anti-knock properties. In this connexion the effect of introducing double bonds into a *cyclo*hexane ring is interesting.

The substances were tested in 20 per cent concentration by weight.

The difficulty of correlating engine tests with conventional formulæ at once becomes apparent.

Another point of interest is the effect of the side chain attached to a benzene ring. Although it is now well known that an increase in the length of the chain

AUDIBILITY TEST ON RICARDO E. 5 ENGINE.

	H.U.C.R.	Change in H.U.C.R.	*n*-Heptane-Benzene Equivalent. (By Volume.)	
			Per cent.	
Standard reference fuel	6·3	..	..	..
*Cyclo*hexane	6·56	+0·26	39·0	61·0
*Cyclo*hexene	6·76	+0·46	35·4	64·6
$\Delta^{1.3.}$ *cyclo*hexadiene	7·32	+1·02	28·7	71·3
Benzene	6·57	+0·27	38·8	61·2

reduces the anti-knocking properties, the opposite effect is found with side chains attached to benzene rings. For example, toluene has greater knock-suppressing tendencies than benzene, ethylbenzene than toluene, and propylbenzene than ethylbenzene. Yet xylene is inferior to ethylbenzene as an anti-knock, and pseudocumene is stated to be similarly inferior to benzene. Any theory which can explain all these facts must of necessity be very elastic.

S. F. BIRCH.
R. STANSFIELD.

Anglo-Persian Oil Co., Ltd.,
Meadhurst Laboratories,
Sunbury-on-Thames,
Mar. 7.

Swirl Opalescence.

WHEN preparing the lecithin-cholesterol suspension required for the reaction of Murata (*Jap. Zeit. für Derm. u. Urol.*, **22**, No. 11; 1922; *Sci. Reports Japanese Gov. Inst. Infect. Dis.*, vol. 2; 1923), I noticed that the most effective suspension was one which was free from visible suspended particles when freshly prepared, though the converse—that any truly colloidal suspension was suitable—was not true. The author did not note the point among his elaborate directions. He directed that the suspension should be used after standing about twenty minutes. Since at the end of this time the suspension begins to show a faint nacreous opalescence which is not removed by filtration through ordinary filter-paper, it is possible that the reaction depends in some way upon a change of state from the truly colloidal to the condition of a coarse suspension. It may be remarked that for the Wassermann antigen containing the same components an approximately colloidal state is not requisite.

It is interesting to inquire upon what the property of swirl opalescence depends. The phenomenon is well shown by so-called gold paints and similar preparations, which are suspensions of small metallic flakes formed by stamping a suitable metal. Since these preparations show a high degree of swirl effect, it might be thought that a laminar structure of the suspended solid would be a necessary condition for the manifestation of the phenomenon. It is nevertheless difficult to demonstrate the effect well with aqueous suspensions of cholesterol, although the typical crystal of cholesterol is a lamina. Blood corpuscles in urine or isotonic saline show swirl opalescence, but to a smaller degree than does a suspension of coliform organisms. Suspensions of cocci do not show the phenomenon.

Since swirling produces a local orientation of liquid into parallel planes, swirl opalescence may be taken to result from locally regular reflection of light from particles in these planes. The particles must be

opaque, and good reflectors, or possess a refractive index differing sufficiently from the refractive index of the medium. Moreover, they must have at least one dimension considerable with respect to the other one or two dimensions, in order to provide the turning moment which shall set them finally along the plane of the stream. Thus the phenomenon may be shown not only by lamellar structures, but also by bacilli and acicular crystals.

Probably the best-known example of the phenomenon is afforded by a familiar brand of household ammonia, in which minute crystals of salts of the higher fatty acids are suspended. Microscopic examination shows that the crystals are acicular, or plumose. Suspensions of benzidine in very dilute alcohol show a high degree of opalescence. Commercial solid recrystallised benzidine appears laminar to the naked eye, and if it is dissolved in alcohol and allowed to evaporate, a mass of broad thin plates, often of considerable length, is seen. Support is thereby suggested for the presence of laminæ in its opalescent suspension, but further examination did not altogether confirm that theory.

A suspension was prepared by rapidly adding 0·5 c.c. of a hot 2 per cent alcoholic solution of benzidine to about 50 c.c. of water at room temperature. Microscopic examination on a slide without a cover-glass, of a drop of the suspension, showed a number of acicular crystals, with a larger proportion of almost circular, very thin, platelets. A film formed on the surface, and the film was almost entirely composed of aggregated platelets. When the drop was examined in a covered hæmocytometer chamber, acicular crystals preponderated: the platelets appeared to be the product of slow evaporation, and were the chief forms in a film which formed on the surface of the bulk of the suspension. Two other suspensions were prepared similarly, except that for one the water was warmed to about 30°, and the other was warmed to that temperature after addition of the benzidine solution. When these clear solutions had cooled they deposited crystals just visible to the naked eye, and the opalescence differed much in degree and kind from that of the unheated suspensions. Microscopic examination showed that the crystals were almost entirely lamellar agglutinations, which, probably owing to their extreme thinness, had far less effect in producing opalescence than had the acicular forms.

To the question why a definitely acicular crystal, such as lead iodide, does not give more than an incipient swirl opalescence, the reply may be suggested that it is partly because its high specific gravity favours rapid settling, and partly because the crystals are relatively large, that is, their number in a given volume is not great enough to enable them to reflect light with sufficient regularity. The relatively large lamellar particles of gold paints each reflect an appreciable amount of light, making up in surface what they lack in numbers.

HUGH NICOL.
Pathological Laboratory,
Hospital for Epilepsy and Paralysis,
Maida Vale, London, W.9.

Rigidity in Weak Clay Suspensions.

IN the course of work necessitating the purification of quantities of the smallest soil particles (the so-called clay fraction), a striking phenomenon was observed during the flocculation and sedimentation of the material in dilute hydrochloric acid. Many industrial and laboratory processes entail flocculation and sedimentation, so an account of our own observations may be of general interest. When the concentration of the suspension exceeds a certain critical value—the significance of which will appear later—a number of sharp ramifying fissures develop containing clear liquid. The density of this being less than that of the surrounding clay-laden liquid, a circulation is set up, clear liquid rising through the fissures while the remainder sinks. Some of the fissures form against the glass walls of the vessel, so the progress of sedimentation can be watched in detail. Near the bottom of the vessel the fissures tend to close, and to enlarge progressively towards the top of the column into conical chimneys, through which the motion of the ascending liquid can be traced by the movement of floccules detached from the walls of the fissures. The circulation is completed by the deposition of these floccules in a crater or ring around the exit of the chimney. There is no doubt that the suspension has acquired rigidity. The descending surface retains the initial form impressed on it by the curvature of the meniscus and by occasional air bubbles floating on the water. Marks deliberately made on the clay surface with a rod are also retained.

Weaker concentrations settle much more rapidly;

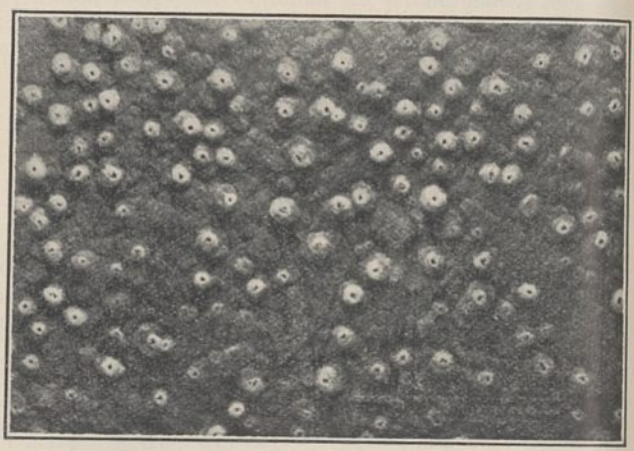

FIG. 1.

in those less than one-quarter of the critical, the floccules fall individually, whereas at half the critical value the floccules settle *en masse*, leaving a clear supernatant liquid. In the latter case the suspension subsides with a perfectly flat surface, which, when disturbed, shows no sign of rigidity. But as the flocks settle on the bottom of the vessel, a layer is built up which has a concentration great enough to show rigidity. The chimneys already described then form, and extend progressively upwards towards the descending surface. When this is still about 1 cm. above the tops of the chimneys, discrete domes, often exceeding 1 mm. in height and 1 cm. across, are formed over them, and finally each mound develops a well-defined hole at the summit. This stage is shown in the accompanying photograph (Fig. 1).

It would appear that the clay concentration in the upper layers at the moment of perforation of the mounds is the minimum at which rigidity can occur. An independent test of this point was suggested by other work in progress in this department on the plastic properties of soil and clay pastes: measurements of the rate of flow through a capillary tube under different stresses have demonstrated that departure from the Poiseuille Law occurs only above a certain critical concentration. For our suspensions this value was found to be identical, within the limits

of experimental error, with that in the immediate neighbourhood of the perforated mounds as determined directly on a sample removed with a pipette. The agreement is not affected either by removing the coarser clay particles or by the addition of fine silt, but, as would be expected, the critical concentration increases with the coarseness of the suspension. It is interesting to note that the critical concentration, even in the coarser suspensions, is only about 1·5 per cent by volume.

The above remarks apply to the case in which the minimum amount of electrolyte for flocculation was used (N/1000, HCl). Parallel experiments with strengths up to N/100 show that the amount of electrolyte present is not without influence on the phenomenon. For example, the minimum concentration for rigidity, as determined in the plastometer, is now above that at which mounds develop in sedimentation experiments. There is evidence that this is due to thixotropic gel formation, that is broken down in the preliminary shearing given to the clay in the plastometer before measurements are begun. This possibility will be followed up during further investigations of the phenomenon now in progress.

R. K. SCHOFIELD.
B. A. KEEN.

Rothamsted Experimental Station,
Harpenden, Herts.

Modes of Distribution of the Mudfish in the Philippines.

ON Luzon, the main island of the Philippine archipelago, there are only two real seasonal variations, known as the dry and the wet or rainy seasons. During the dry season, October to May, there is practically no rain. At this time the smaller bodies of water dry out, and lower fields are covered with cracks, crevices and clods running in all directions. Water remains then only in isolated deeper ditches, swamps, and larger rivers. During the rainy season, June to September, everything is flooded. Not only the swamps and ditches, but even the rice fields are full of water. This is especially true in the eastern part of the island. At this time thousands of small fish appear in the rice paddies. They are the young of the fish *Ophiocephalus striatus* Bloch, which is known in English as *mudfish* and in Tagalog as *dalag*. The young fry is known to Tagalogs either as *bulig* or as *anak nang dalag*, that is, the children of dalag.

The Tagalogs have a number of theories concerning the occurrence of this fry in the rice fields. Some hold that it originates from the mud, others that it rains down from clouds, still others, claiming some education, think that the old fish æstivates in the mud, and then when the rains come they emerge and lay the eggs. Some even think that the eggs are laid in the preceding year, remain dormant during the dry season, and hatch when the rains come. The first two notions need not be considered seriously here. The third theory, that the fish can survive in dry mud some five or six months, has no proof. The dalag, aided by its accessory respiratory apparatus, may live in water which is not fit for any other fish to live, but when it comes to a complete absence of water, the situation is changed. It may live for two or three days on a wet market table, but when it jumps out from an aquarium on the laboratory floor in evening, it never survives until the morning. During my five years' residence in that part of the Islands I have never been able to learn from the people of a case where a fish could survive in the mud during the dry season; and I have been making constant inquiries, especially from the country people. The eggs are also very sensitive to the external surroundings. Normally they hatch within two or three days, and do not live through any greater length of time without hatching.

There are three possibilities which may account for the occurrence of the young fish in the rice paddies. The old dalags may swim from rivers into flooded fields and then lay their eggs. There are many well-known instances where freshwater fishes leave the deeper waters for spawning purpose. The dalag is not very particular in this respect, but some of them do actually migrate from deeper to shallower waters, though they seldom reach the rice fields. The young fish if hatched near the rice fields may easily swim into them. They are strongly positively rheotropic, and very good swimmers. The waters receding from the rice fields give the young fish an opportunity to reach them. These two modes of distribution account for a considerable number of cases, but the most important mode of distribution is by means of the eggs themselves.

The eggs of dalag are 'pelagic' or floating eggs. They are quite large (1·25-1·5 mm.), have the germinal discs on one pole, and an oil droplet on the other. The oil being lighter than water buoys the eggs, so that it floats on the surface in such a way that the germinal disc is always submerged just under the surface of the water where the conditions for its development may be considered the best. Such eggs float very easily in any direction, depending upon the wind. During the rainy season the typhoons bring very strong winds. When the fields are flooded and the boundaries between the larger bodies of water and the rice paddies disappear, the wind carries the eggs there. In such a way the eggs may be carried into most unlikely places. After a strong typhoon in Manila, 1927, large numbers of eggs were brought to the University of the Philippines Rizal Hall, right to the door of the Zoology Laboratory. At a distance of about 300 metres on the opposite side of the campus is located a drainage tube leading indirectly to Pasig River. The drainage path itself is more than 300 metres long. The campus is dry throughout the year with the exception of a short time during the stronger typhoons, when it may be submerged for a few days. Much better means of communication are found at such times between the rice fields and the larger bodies of water; and I think that this is the most important means for the distribution of dalag in the rice fields.

P. B. SIVICKIS.

Lietuvos Universitetas,
Kaunas, Lithuania.

Major Segrave's Speed Record of 231· . . . . . m.p.h.

THERE has been much self-satisfied amusement over the five places of decimals in which Major Segrave's speed record on Mar. 21 was recorded in the Press. Truly these are merely arithmetical residues—a waste product. A lad with a healthy sense of what is the good part of an apple scoffs at saving up the skin for microscopic study—it is a waste product.

Let us take to the microscope—at the cost of knowing a little more and laughing a little less.

To the Royal Automobile Club, Sir Charles Wakefield gave not only a £1000 Trophy but also a £1000 a year for the 'world's record' holder until he is beaten. If the amount were 6*d*. the moral compulsion to enforce the letter of the law in sporting matters remains, but I quote the amounts to impress the Philistines.

Now thirty years' evolution of motor-racing has

saddled us with history, precedents and rules. In this case the rules call for :

(1) A level track of officially certified length properly surveyed—gradient tolerance, etc.
(2) Automatic timing to $\frac{1}{100}$ sec.
(3) A to-and-fro run—not only to eliminate gradient effect but also to average the wind effect (otherwise *all* attempts would be made in a following gale of wind).

Following horse-racing precedent, the *written record* itself was not a velocity in miles per hour, but a *time*. It was the average of the two times actually measured. For popular consumption a speed has been worked out from this mean time, and this, though it is *not* the speed of the vehicle, is universally taken as such, and it is now treated as the record.

(I explain that the true mean speed is the mean of the two speeds, on the runs, and not the result of dividing the length by the mean of the two times.) When a record has stood unquestioned beyond the delay for appeal, it is established and cannot be altered. This protects holders from having to fight for their title up to an indefinite date. Looking as we are through a microscope, all this is very wrong scientifically—in practice it is not very significant.

Now in doing the prescribed arithmetic there appear these wasted decimals and no provision for ignoring them. The first step to a remedy is to pass a new rule that records shall not be deemed beaten unless the new performance exceeds the last by x m.p.h., and such a resolution has been placed on the agenda of the A.I.A. (The International Association of Automobile Clubs) by the Royal Automobile Club, but I greatly doubt if it will be carried—for two reasons :

(1) Rigidly speaking, a bit of true speed should not be added to a numeral which is not a speed.
(2) In fairness to the next competitor, the existing record-holder should not be protected in his tenure of the spoils (the £1000 a year) with an excess—which he himself was not subjected to, since this partakes of altering the rules of a contest while it is in being.

Those who say that I am caring *de minimis*, do not realise how jealously these preferences, however small, are regarded. Reason (2) will not, I surmise, be raised, but it may well dominate the discussion. What will be raised is the objection to breaking the comparative position of the items in the list of records. The War has probably played havoc with the archives of the earlier records so that they could not well be written up in terms of the new method of calculation (mean of velocities in lieu of mean of times).

For the ordinary man the speeds are substantially as given: for the clever man they are still as given, and in addition they afford him the added pleasure of feeling clever. Shall we not continue to spread happiness among the wise ?

MERVYN O'GORMAN.
The Athenæum,
Pall Mall, S.W.1.

Colour and Optical Anisotropy of Organic Compounds.

I DESIRE to direct attention to a significant and very generally valid relation which emerges from an examination of the data accumulated by eight years of systematic research at Calcutta on the scattering of light. The generalisation may be stated thus : *The types of molecular structure in carbon compounds which favour the development of colour are those which exhibit an exceptionally high degree of optical anisotropy.*

When we compare a series of compounds in respect of their optical anisotropy, and their colour as indicated by the position of their absorption-bands in the spectrum, the parallelism between the development of the two characters becomes evident. Thus, the aromatic series of compounds are generally more anisotropic than the aliphatic series. We have large increases of anisotropy when we pass from pyridine to quinoline, or from benzene to naphthalene and thence to anthracene. The introduction of a chromophore like NO_2 or auxochrome like NH_2 as a substituent in the benzene molecule produces a notable increase in anisotropy. Less striking but perfectly definite increases occur when halogens of increasing atomic weight replace the hydrogen atom in the benzene ring. In the disubstituted benzene derivatives, the relative position of the groups influences the anisotropy appreciably. These and many other instances may be cited to show that an increase in optical anisotropy connotes a development of colour.

That variations of structure in carbon compounds should influence the two optical characters of anisotropy and colour in similar ways need not occasion surprise when we recollect that the element carbon in its two states, diamond and graphite, itself exhibits the same tendency. Diamond is a transparent and isotropic dielectric, while graphite is opaque, conducts electricity, and has a highly anisotropic structure as shown by X-ray analysis and by its diamagnetic behaviour.

C. V. RAMAN.
210 Bowbazar Street,
Calcutta, Feb. 28.

Magnetic Storm of Feb. 26–28, 1929.

IN the Astronomical Column of NATURE of Mar. 9, mention is made of the auroral display of Feb. 27. The display, as seen from various places in the British Isles, particularly in north-east Scotland, has been fairly fully described in the daily press. The accompanying magnetic storm was notable on account of the magnitude of the fluctuations of magnetic force. A detailed description of the storm would occupy too much space, but information on any particular point could of course be given, on application, to anyone interested.

At the Lerwick and Eskdalemuir magnetic observatories, it has been customary for some time to run additional auxiliary sets of magnetographs of lower sensitivity than the standard instruments, so that a reasonably complete record, even of the extreme fluctuations in storms, may be available. In the present case Mr. Lee of Lerwick Observatory reports that the lower limit of registration, even of the auxiliary Horizontal Force instrument, was exceeded from 28 d. 1 h. 3 m. to 8 m. The ranges of variation actually recorded at Lerwick were 3° 57′ in Declination, $>1885\gamma$ in Horizontal Force and 940γ in Vertical Force ($1\gamma = 10^{-5}$ C.G.S. units). At Eskdalemuir, as is usually the case in the great storms, the ranges were of roughly half the above order, being in fact 2° 8′·8 in Declination, 916γ in Horizontal Force, and about 690γ in Vertical Force.

The last occurrence of a storm with variations of magnetic force of the above order was on Oct. 13–16, 1926. On that occasion a magnificent auroral corona was seen from many parts of the British Isles and northern Europe. The ranges recorded at that time were, at Lerwick, 3° 41′ in Declination, $>1068\gamma$ in Horizontal Force and $>2086\gamma$ in Vertical Force ; and at Eskdalemuir $>957\gamma$ in the West Component, $>719\gamma$ in the North Component, and $>624\gamma$ in the Vertical Component.

A. H. R. GOLDIE.
Meteorological Office,
Edinburgh, Mar. 15.

The Bronze Age in Southern Africa.

By Prof. RAYMOND A. DART, University of the Witwatersrand.

IN view of the impetus which has been given to the metallurgical analysis of ancient copper and bronze objects by the initial investigations of Prof. John Sebelien of Aas, Norway (NATURE, Jan. 10, 1924), and the practical activity of the British Association Research Committee which has resulted in the important interim report embodying the recent investigations of Prof. C. H. Desch (NATURE, Dec. 8, 1928), it is ardently to be hoped that funds will not be lacking for following up Prof. Bernard W. Holman's suggestions (NATURE, Dec. 29, 1928) concerning the further collection and publication of data about the ancient mining industry and the products thereof which are available in southern Africa.

It has been the uniform experience of those who have investigated the ancient mining industry in South Africa that the work has been on so gigantic a scale as to preclude any belief that the products of the industry were consumed by a local population. Beginning with the investigations of Mr. T. G. Trevor, at that time Inspector of Mines for the Union Government, and now holding a similar post for the Rhodesian Government, several important papers by Woodburn and Baumann and others have been published in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa which established not only the above-mentioned conclusion but also the further important deduction that the early copper-, tin-, micaceous iron- and ochre-getters had the same sort of industrial implements as the ancient gold-getters of Rhodesia and the north-eastern Transvaal.

On similar lines of reasoning it was possible for me (NATURE, June 21, 1924), by gathering together information from these and other sources, as well as by my personal investigations, to put forward the thesis that the enormous ancient mining district from Katanga and Broken Hill to Pretoria, and from the Kalahari to the eastern coast, formed a single cultural unit.

In the *South African Geographical Journal* of that year I developed the same view in an article on "The Ancient Mining Industry in South Africa," and in NATURE, Mar. 21, 1925, p. 425, was enabled, through the remarkable researches of Bro. Otto, to demonstrate some of the objective proofs that are to be discovered in Bushman cave shelter paintings in the Cape Province, Natal, and Rhodesia of alien intruders wearing headgear of Babylonian and Phrygian appearance.

The great age of at least one of the mines was demonstrated by me in "The Rooiberg Cranium" (*S.A. Journal of Science*, vol. 21, 1924), when I pointed out the existence of a stalagmite fifteen feet high and eight feet thick, in its narrowest part, extending from the roof to the floor, thirty to forty feet from the entrance and in such a position as to render practically certain its formation since the period of occupation by the miners.

It was, therefore, with considerable confidence that I boldly suggested in my article on "Nickel in Ancient Bronzes" (1924), that, as Sebelien had failed to find nickel-carrying ores in the sites of ancient mines in the Arabian and Mediterranean areas, the probable source of the nickel-contaminated copper and tin for the ancient Near East was southern Africa.

At that time, although it was known that there was ample evidence of smelting operations in the Rooiberg area, and a piece of bronze slag had been discovered which had provided in the hands of Mr. Schoch the analysis revealing about 3·0 per cent of nickel which has now proved of such significance, there was no conclusive proof that bronze had been intentionally fabricated at Rooiberg.

This important corroboration of the view advanced by me was forthcoming at the Pretoria meeting of the South African Association (1926), when Dr. Percy A. Wagner (*S.A. Journal of Science*, 1926) revealed the amazing discovery of Mr. Gordon of "no fewer than thirty distinct furnaces on the farm Blaauwbank, No. 433, and alongside of some of them . . . small separate stacks of hand-cobbed tin and copper ore . . . also accumulations of nodular aluminous surface limestone and hand-cobbed iron evidently used as a flux. In the furnaces themselves were found 'slugs' and 'frills' of bronze, many of them still embedded in an iron-rich slag. The largest slug weighs 31·3 grammes."

"Here, then," as Dr. Wagner stated, "is definite proof for the first time that these ancient metallurgists had deliberately set out to make bronze, and that they were thus evidently acquainted with the properties and uses of that important alloy."

The reason for the admixture of nickel with the ores at Blaauwbank by the bronze makers was also proposed by Dr. Wagner, who pointed out that on the farm "there is, in addition to important tin and copper deposits, a nickel lode carrying at the outcrop big masses of apple-green 'nickel-bloom' or anabergite. This bears a remote resemblance to malachite, and it is probable that the ancient miners, who could not fail to have noticed this outcrop, mistook it for that mineral and thus introduced nickel into their bronze." The objects demonstrated by Dr. Wagner are now in the Social Anthropology Museum of the University of the Witwatersrand.

Irrespective of any other question, there has, therefore, been established by incontrovertible evidence the existence in South Africa of a definite Bronze Age period. Such a phase of South African prehistory has not hitherto been recognised by antiquarians, and naturally enough since the bronze objects which in other lands symbolise the existence of such a period have not been found here, but rather only the raw materials of mines, furnaces, and dumps which must have contributed to the blatant bronze cultures of more advanced cultural centres.

The second conclusion that is warranted from the facts is that the "ancient mining period" in South Africa dates back to the Bronze Age, seeing that the

methods of exploitation of the copper, tin, gold, and iron fields are culturally uniform. It can scarcely be that the whole industry was of one age: its very immensity demonstrates that it must have had several phases. The remote antiquity of at least one phase cannot, however, be questioned.

It is of the utmost importance that the Bantu peoples when first discovered did not belong to a 'bronze' but to an 'iron' culture, and there is no evidence to show that they evolved through a bronze phase to the iron phase. We are forced to conclude that the highly intricate metallurgical processes of bronze-making demonstrated by the deposits at Blaauwbank betray the actual presence there at a remote age of skilled and intelligent craftsmen from a superior cultural area. Seeing that the deposits are half-way across the continent, some estimate may also be arrived at concerning the lengthy period of South Africa's exploitation by that superior race utilising the bronze.

To the physical anthropologist who has lived in South Africa and had the opportunity of seeing and dissecting representatives of practically every tribe in the south-eastern end of the continent, there is concrete evidence in the thousands of negroid inhabitants with straight, aquiline, and hooked noses, elevated nasal bridges, reduced lip fullness, and lack of prognathism, to demonstrate beyond cavil the flood of Semitic and other Caucasian blood which flows in the veins of the Bantu peoples; just as the presence, in a more reduced proportion, of Mongoloid eye-folds, slit-like eyes, and high cheek bones of the "Snese Hottentoten" of the Eastern Province and the Bantu tribes of the eastern coast generally reveals past, but probably more recent and less widespread, contacts with the Far East.

With regard to the actual date of the Bronze Age in South Africa, it seems clear that being provoked by one or more alien races who were interested in raw bronze and being absolutely dependent upon that alien interest (as the lack of a typical and separate local bronze industry, such as those of Europe, demonstrates), there can be little question that the South African Bronze Age synchronises with the Bronze Ages of the nearest ancient cultures, namely, those of Egypt and Sumeria. The importance to South African prehistoric chronology of the further prosecution of this absorbing piece of detective work in metallurgy and the exact chronological establishment of the different ancient mining phases can scarcely be overrated.

Fifty Years of Marine Refrigeration.

THE important subject of refrigeration on shipboard has recently been dealt with in three papers by Mr. A. Greenfield, Mr. G. W. Daniels, and Mr. H. J. Ward, read respectively to the Institution of Marine Engineers, the British Association of Refrigeration, and the Institution of Mechanical Engineers.

One of the earliest contributions to a technical society on this subject was the lecture of Alexander Kirk to the Institution of Civil Engineers in 1884, while two years later J. B. Lightfoot read a paper to the Institution of Mechanical Engineers on refrigerating and ice-making machinery. Associated with the production of artificial cold were the experiments and inventions of Cullen, Leslie, Carré, Gorrie, Tellier, the Bells, Coleman, Linde, Haslam, and others. To Gorrie, an American doctor, we owe the first machine which caused compressed and cooled air to expand in working a piston in a cylinder, his patent being taken out on Aug. 22, 1850. Five years later, Gorrie died at Apalachicola, Florida, and there are memorials to him in that city and in the Statuary Hall of the Capitol, Washington, D.C. It was not, however, until about twenty years later that the matter was taken up seriously, and refrigeration on shipboard may be said to have come in definitely with the voyage of s.s. *Strathleven* in 1879, just fifty years ago. The *Strathleven* was fitted with a Bell Coleman cold-air machine, and brought home a small cargo of frozen meat from Australia. As Mr. Ward said, that marked the economic beginning of the industry. The Bell Coleman patents were then acquired by the late Sir Alfred Haslam; one of his first machines was fitted in the liner *Orient* in 1881, and in 1889 some 2,000,000 carcases of beef and mutton were brought to England, most of them in ships having Haslam's machines. Compressed air machines then began to be replaced by machines using other gases, and to-day about 80 per cent of refrigerated cargo ships use carbon dioxide and 18 per cent ammonia; the advantages and disadvantages of which were touched upon by both Mr. Ward and Mr. Greenfield.

Nearly every writer on refrigeration acknowledges the great debt this branch of engineering owes to the scientific investigator, and frequent reference is made to the well-known standard treatise, "The Mechanical Production of Cold," by Sir Alfred Ewing. Refrigeration in all its aspects is almost entirely the outcome of research, and the various investigations now being made by the Food Investigation Board, at the Low Temperature Research Station at Cambridge, and at the National Physical Laboratory, are of great value to the industry.

Fish, meat, cheese, butter, apples, oranges, bananas all require different treatment, and the refrigerating engineer is faced with many problems. Mr. Greenfield's review of the arrangement of a large refrigerated cargo ship is of especial interest. With a sectional profile of such a ship, he gave particulars of the mechanical appliances and piping. The ship he described has 54 independent insulated cargo spaces of a total capacity of 560,900 cubic feet cooled by 37 miles of brine-cooling pipe divided into numerous circuits. The temperatures used vary from 10° to 20° F. for fish and butter, to 34° to 40° F. used for vegetables and fruit. Frozen meat is kept between 16° to 24° F., and chilled meat at 29° or 30° F.

Fruit was first brought to Great Britain from the

West Indies in 1886 in the s.s. *Nonpareil*, apples were successfully carried home from Australia in 1888 in the s.s. *Oceana*, while the banana trade began in 1900 "through the enterprise of a Liverpool shipowner who sought to aid a British colony at the call of a great Colonial Secretary." This trade has grown to such an extent that in 1927 more than 18,000,000 bunches of bananas were shipped from the Gulf ports to depots in Great Britain and European countries.

Hitherto, refrigerating machinery has been driven by steam, but compressors and pumps are now sometimes connected to electric motors or to oil engines. In one of the fine new Nelson liners, the motor ship *Highland Monarch*, of 14,137 tons gross, which made her maiden voyage last autumn, the insulated spaces have a capacity of 500,000 cubic feet. The ammonia compression system of refrigeration with brine circulation is used, the ammonia compressors being driven directly by two four-cylinder Diesel engines of 300 horse-power each. Brine at four different temperatures is available for circulating through the various chambers, flow meters being used to indicate the amount flowing in each circuit. All such installations are erected according to the rules and under the direction of the surveyors of Lloyd's Register, who also periodically inspect the ships on behalf of the insurance and other interests involved. During 1927–28 installations were fitted in 62 vessels with a total insulated capacity of 5,500,000 cubic feet, while on June 30, 1928, 424 vessels held the Society's Refrigerating Machinery Certificate with a total capacity of more than 76,000,000 cubic feet of insulated space. Ships, however, are but the connecting links between the producers abroad and the distributors at home, and the extensive nature of the refrigeration industry in Great Britain and Ireland can be judged from a glance at the Ice and Cold Storage Trades Directory for 1926, a book of some 236 pages.

Evolution through Adaptation.[1]

By Dr. F. A. BATHER, F.R.S.

IT is a hundred years since Francis Egerton, Earl of Bridgewater, died, leaving a sum of money for the preparation and publication of works "On the Power, Wisdom, and Goodness of God as manifested in the Creation." At least half of the eight Bridgewater Treatises thus engendered exemplified their subject by the fitness mutually subsisting between living creatures and the outer world. The facts which by them were so easily explained have presented to us one of the fundamental problems of biology. The first question is: How far are animals and plants really fitted to their surroundings? Then, if not, why not? And again, in so far as they are fitted, how did they become so?

No living being can be considered without its surroundings; indeed, it is hard in some respects to say where the creature ends and its surroundings begin. An individual must be fitted to its surroundings, or must make some effort, conscious or unconscious, to become fitted. Thus when we observe the multifarious forms of life fitted adequately, if not always perfectly, to varied habitats and modes of living, we need feel no surprise, and we perceive no difficult problem.

Geology, however, has taught us that conditions have constantly been changing, and that the forms of life also have changed, and it has revealed to us a succession of creatures constantly becoming fitted, or as we say adapted, to diverse conditions. The problem is no longer the fitness of the individual, but the adaptation of the race or lineage. An individual is adaptable, but only up to a point, and any increased fitness of the individual is not—at any rate in the vast majority of cases open to human observation—handed on to the offspring. How then are we to explain the fact that numberless series of forms have gradually changed, and so changed as either to accommodate themselves to changing conditions or to become (in most instances) more and more fitted to diverse states of life?

Many answers to this question have been propounded, but, since controversy still continues, it is plain that none of them is wholly satisfactory.

A theory of revolutions of the earth's surface, each accompanied by a special creation of fresh forms of life, has long ceased to fit the known facts. Even if an external guiding power were admitted, one would still seek to discover the mechanism through which it worked. From such a theory it is but a step to the conception of development in definite directions, each according to some predetermined plan. Palæontologists have indeed made known to us in various groups of animals numerous series, each apparently following a trend of evolution, and some have claimed each trend as inevitable and, accident apart, predestined. But it will be realised that any line of evolution, as we look backwards, appears to have been regular and inevitable. From eolith to steel axe the ascent is straight and unbroken. It is just because the later shape proceeds so naturally and, to all appearance, inevitably out of the former shape that we can speak of an unrolling or evolution. But when we examine any such line more minutely we find that matters are not so simple. Take the evolution of either the horse or the bicycle and it will be found that there are some side-lines which failed to win approval, others that were adapted for special conditions and so diverged; or two stocks of different origin and structure may have been similarly moulded to meet a similar environment and have thus assumed a close resemblance. Clearly predetermination cannot apply to such cases, and therefore cannot be called in as a general expression of evolution.

Broadly speaking, there is a conflict between the view of evolution as essentially a process of

[1] From the Friday evening discourse, entitled "Lily-stars of the Sea: How they Fit their Surroundings," delivered at the Royal Institution on Feb. 22.

adaptation, and the view that it follows predestined courses. The essence of the latter view is that the trends do not necessarily accord with the surroundings, but may indeed run counter to them, so that the lineage ceases to be fitted and comes to an inevitable end. Now it cannot be denied that, according to our present lights, there are such examples of evolution at cross-purposes with environment. Any solution of the problem of adaptation must apply also to maladaptation.[2]

The problem may be limited and perhaps clarified if taken in connexion with another generalisation of palæontology—the irreversibility of evolution. This, which we owe to Louis Dollo, states that a structure once lost is never regained. Should the need again arise for the performance of the same function, some other organ must be modified for the purpose. This irreversibility may be extended to the history of the lineage. There is, all must admit, a curious parallelism between the development of the individual and that of the race; and, just as the individual's growth never really returns on itself, so is any true rejuvenation excluded from the history of the race. More obviously connected with irreversibility is a further generalisation, particularly associated with the name of D. Rosa, stating that a race as it progresses loses its power of adaptive change. At first it can vary in numerous directions and is not bound to any one road. But every step that it takes in one of those directions forbids its return to seek another path. Thus by degrees all roads but one are barred to it, and if that one road ceases to lead to salvation, the race must perish.

Let us combine these statements of palæontology with the geological teaching that from the beginning the surface of our planet has constantly been changing, a fact that has involved, *inter alia*, changes of climate, changes of depth and salinity in the waters, and migrations of their inhabitants. It follows that the surroundings of a race are continuously altering; the race has perpetually to catch up with the change: in so far as the external changes proceed in the same direction, so do adaptation and specialisation follow in what seems to be a definite trend. Now suppose the external change to be diverted from the normal course, then a race that by its specialisation has cut off all chances of adaptation to the new conditions will necessarily perish. Or suppose the external change merely to cease; it does not follow that the internal conditions of the organism will cease to move along the line hitherto found beneficial; thus arises the phenomenon of a trend which, beginning in harmony, has been turned to disharmony.

This seems to be a fair expression of well-known facts. It suggests to us that not only is there irreversibility and a consequent loss of adaptability, but also that there is some tendency for change of form and structure to proceed in a definite direction. In most cases the direction will accord with the environment; otherwise the world would cease to be peopled. In the remainder, and eventually in all cases, the direction becomes in disaccord; the race dies out, and its place is taken by one more adaptable. Hence special evolution of the race is replaced by that general evolution of the world-population which we call progress.

Consideration of the two chief theories of the evolutionary process in the light of modern knowledge has seemed to point to this same conception of an internal direction.

The Lamarckian theory, thus regarded, implies that a modification of the individual to meet the pressure of the environment is somehow transmitted to the germ-cells, and that these produce an altered offspring, or mutant, already in accord with the environment. It is generally agreed that characters are transmitted from parent to offspring through the chromosomes or nuclear elements of the germ-cells. Now it is known that change of outer conditions (food, light, temperature, moisture, and the like) may have such a physico-chemical action on these chromosomes as to induce some change or mutation; but if, as the Lamarckian theory demands, the mutant produced is just the one that fulfils the requirements, we still have to ask why this should be so.

In most cases that appear to exhibit a direct action of some outer physical agent, it may be that the agent merely stimulates mutation, and that among numerous mutants only those survive which harmonise with the environment. The remainder may never actually come to birth, and even fertilisation may be hindered by a change in the germ-cell due to external influences. Such instances in fact are familiar to geneticists. When the stimulus of a changed condition is continued through long ages, the probability of its producing a mutant in harmony with the requirements is enormously increased.

In so far as this is a true reading of the facts, it implies that the apparent Lamarckian effect is nothing but a special case of the Darwinian selection. But, whereas Darwin called on unstable random variations to provide the material for natural selection, Mendel, De Vries, Morgan, and others have shown that the new material really consists of stable, true-breeding mutants. So far from upsetting the Darwinian theory, that emendation makes it more workable; and if to it we add the conception of an early massacre of unsuitable mutants, the tempo of the selective process will be further accelerated.

It is possible to imagine still greater speeding up by viewing selection at a different angle. The Darwinian regards what he calls Nature—that is, the totality of environment—as the selector. But what if we lay the burden of selection on the creature? No more in this case than in the former is any conscious choice implied. An animal with defective pigment and sight will not escape its enemies unless it skulk in dark corners. A mutant that can exist only in warmer water than that supported by its parents will perish if it do not find such a habitat. Individuals that happen on suitable conditions will be saved.

[2] Examples of suicidal evolution, mostly instances of excessive calcification, are well discussed in various works of W. D. Lang, who has recently given a brief summary, "Form in Fossils," *Proc. Geol. Assoc.*, **39**, 429-44, January 1929.

A population is subject to both kinds of selection. Whether the environment of a given locality change or no, the fit among the offspring that remain in it are passively selected by Nature; those that migrate, because uncomfortable, actively, though accidentally, select a fit habitat. Thus arises divergence.

If the problem of adaptation is brought nearer to solution by these modern extensions of theory, there remain the questions of irreversibility and trends, especially those that seem to us out of harmony with the environment. Those phenomena suggest a tendency of mutation to follow the change of environment; and they do so far more than the rare and somewhat doubtful instances in which an experimenter claims to have produced a heritable modification, or a mutant conforming to some modification that he has produced by outer stimuli in the adult parent. If, then, we could find some general principle governing mutation, we might approach an explanation of the whole evolutionary process.

May I suggest a possible direction of search for such a principle? The evidence thus far available indicates that mutation depends on some physico-chemical change in the particles that make up the chromosomes of the male and female germ-cells. That chromosome particle, or gene, on which a certain structure of the adult is believed to depend, must have a chemical constitution more complicated than that of any organic compound as yet elucidated by chemists, but the changes in its composition must follow the same laws.

The ordinary chemical changes of living substance are reversible; that is a character of life; a compound broken down is at once reformed. But certain reactions are irreversible, and conspicuous among them is the whole process of growth and senile decay. If, then, some external agent produce a change in the molecular arrangement of a gene, that change may well be irreversible. Indeed, the mere removal of the external agent could not be expected to cause a reversal of the reaction. Again, just as other irreversible changes in an organism proceed in definite directions, so a succession of changes initiated in a gene would be likely to follow a single line. Whether a chemical change consist in the loss of a molecule or in a rearrangement of molecules, it seems that the number of possible changes would become increasingly limited. This limitation would, in course of ages, apply to each of the genes.

If the changes in the genes were merely random, then the organism would be just as likely to vary in a negative as in a positive direction. But if the evidence convinces us that variation is more in a positive direction, then the changes in the genes cannot be random, but must be produced or controlled by some factor external to them.

How, precisely, external influences are conveyed to the chromosome particles is another question. Some researchers, as J. T. Cunningham, rely on the action of hormones, internal secretions conveyed by the blood to the germ-cells. But what happens when the hormones get there? The chromosomes lie in the plasma of the germ-cell, and it has long been recognised that this is not without effect on inheritance. Now Hirata has recently described a chemical mechanism by which a change in this plasma acts to some extent on the gene. At first the influence is manifested in the adult offspring as a non-heritable modification, but it is suggested that a continuance and intensification of the stimulus might be so firmly impressed on the gene that the change would be passed on to the offspring. Thus the modification would become a mutant, and our problem would to that extent be solved.

I have attempted to keep my speculations consistent with recent work in genetics and biochemistry. If some such physico-chemical structure be admitted as the basis of variation, and if the irreversibility of the chemical changes in it be allowed, then it seems to provide that fundamental premise from which, in combination with a varying environment, one can deduce irreversibility of evolution, reduction of variation, and orthogenetic trends. The decisive principle is still natural selection, but the material on which selection acts is not supplied at random; it is subject to certain laws, and those laws assist the progress of that evolution of life which is revealed to us by palæontology.

Obituary.

Dr. H. Brauns.

HANS HEINRICH JUSTUS CARL ERNST BRAUNS, who died on Feb. 3 at his residence in Willowmore, Cape Province, at the age of seventy-two years, was born in Hannover, Germany, and spent his school-days in Mecklenburg, where he also entered the University, obtaining the Ph.D. degree. He studied medicine at several places, including Göttingen and Leipzig, from which latter university he obtained the M.D. degree. The honorary degree of D.Sc. was conferred upon him in 1928 by the University of Stellenbosch in recognition of his services to entomology in South Africa. He was a member of the Royal Society of South Africa, and shortly before his death was elected an honorary member of the Société des Sciences Naturelles, Musée du Congo Belge, Tervueren.

On the completion of his medical studies, Brauns travelled in the East, India, and North, Central, and South America. In 1895 he went to South Africa, settling eventually at Willowmore in the Karoo, where he worked until 1925.

Brauns collected insects all over South Africa, but mostly from the Karoo. His chief interest was centred in Hymenoptera, his collection of which is now in the Transvaal Museum, Pretoria. He published numerous papers, memoirs, and monographs on South African Hymenoptera, especially on the Apidæ, Sphegidæ, Masandæ, and Chrysididæ, and his systematic work on genera such as

Cerceris, *Crocisa*, *Epeolus*, etc., is important. He was a keen observer and first-class field naturalist, and his many observations on the habits, development, nest-building, prey parasites, food plants, and general bionomics of Hymenoptera have earned for him a prominent position as an entomologist. He also contributed to our knowledge of termitophilous and myrmecophilous insects. His indefatigable spirit prompted him to collect even up to the last, and shortly before his death he published descriptions of new Chrysididæ.

THOMAS OWEN BOSWORTH, who died in London on Jan. 18 last, was born at Spratton, Northamptonshire, on Mar. 28, 1882. He was educated at St. John's College, Cambridge, and was on the staff of the Geological Survey of Scotland in the years 1908 and 1909. The remainder of his life was mainly spent abroad as an oilfield geologist. In this capacity he travelled extensively in America, ranging from Peru to within the Arctic circle. His published works include "The Keuper Marls around Charnwood" (Leicester, 1912), "Geology of the Mid Continent Oilfields, Kansas, Oklahoma, and North Texas" (New York, 1920), "Geology of the Tertiary and Quaternary Periods in the North-West Part of Peru" (London, 1922), and several papers in the *Geological Magazine*. In the work on Peru, Bosworth gives a fascinating account of the later geological history of the region, and his description of the present conditions and processes in the desert is full of interest to both geologists and geographers. By his death at the early age of forty-six years, geology has lost a very able investigator.

News and Views.

THE Soviet Government has now completed the first part of an extensive electrification scheme which was begun almost immediately after the Revolution. A large 80,000 h.p. hydro-electric station has been built on the River Volkhov about 80 miles east of Leningrad. The power is supplied to Leningrad by overhead lines at 120 kilovolts. The Swedish General Electric Co. (Asea) supplied most of the equipment and assisted in the planning of the station. Metropolitan-Vickers Electrical Company of Manchester also supplied some of the equipment. In the communication between the generating and distributing station, the transmission lines are used as part of the circuit. The communication between the machine room and the control room is by ship's telegraphs. According to Reuter (Moscow), the Soviet Government has also started broadcasting, the control of which has been put in the hands of the Commissariat of Posts and Telegraphs. In addition to radio-technical and agricultural courses, a university has been opened the lectures in which are all given by radio. By means of telephone lines, broadcasting is being extended to isolated villages. A very rapid increase in the number of radio listeners is expected. According to the estimates of the Commissariat, the number of listeners will have increased by a million before the end of this year. Radio theatres have been opened in both Moscow and Leningrad and experiments are being made with radio-films. On Aug. 1 next, a new radio station with a power of 75 kilowatts will be opened in Moscow.

IN January this year, Dr. T. A. Jaggar, Director of the Hawaiian Volcano Observatory, predicted that an eruption of either Kilauea or Mauna Loa was to be expected during 1929. The prediction, based on the cyclic behaviour of the Hawaiian volcanoes first recognised by Dana, was made good in spectacular fashion on Feb. 20. On that day, Washington received the following radiogram: "Kilauea flashed into magnificent eruption at 1:00 A.M. Hawaii time this morning." We learn from a *Daily Science News Bulletin* issued by Science Service of Washington, D.C., on Feb. 21, that the opening phase began with vast fountains of lava, spurting to heights of two hundred feet from a long crack in the floor of Halemaumau Pit. In twelve hours the pit was filled with a lava-lake to the depth of sixty feet. By that time the fountains were still playing to a height of a hundred feet, and the level of the lava-lake was rising at the rate of five feet per hour. Driblet cones formed above the effervescent lava, and from the higher jets liquid drops were blown off to fall, at first as pumice but later as clear brown glass relatively poor in gas bubbles. Quantities of the fine-spun glassy threads known as 'Pelé's hair' have been formed by wind action from the crests of the waves of molten rock. The seismograph at Volcano House records a constant tremor, and an inclination from the vertical away from Halemaumau Pit. Since the eruption started, constant additions have been pouring into the cauldron as a result of landslides of volcanic detritus from the steep slopes of the sides. It is anticipated that the present phase of intense activity will continue for several weeks.

MR. R. A. WATSON WATT delivered the Symons Memorial Lecture of the Royal Meteorological Society on Mar. 20, taking as his subject "Weather and Wireless." Mr. Watson Watt stated that wireless as a means of communication is essential in modern meteorology because it alone is capable of giving sufficiently rapid interchanges of data over wide areas. The results of observations made all over Great Britain are in the hands of the central forecaster within an hour, the majority of the data for Europe are received within an hour and a half, and that for the whole Northern Hemisphere within six hours. It was announced that an experimental transmission from Daventry of daily weather charts is to commence shortly. Wireless has a 'climate' and a 'weather' of its own. The weakening of signals over different kinds of country, according to time of day and season, and the dependence of atmospheric disturbance on latitude, place, and time, are climatological in scope. The quick-period changes, the erratic phenomena of fading, are part of the 'weather' of wireless—atmospherics are its 'rainfall.'

MR. WATSON WATT stated that the average atmospheric is a hundred thousand times as strong as a readable signal. They have been known to disturb broadcast reception up to four thousand miles from their place of origin. They originate in thunderstorms and the predominant source of the world's supply of atmospherics at any moment usually lies in a land where it is summer afternoon. The average atmospheric received in England is of such strength as would be sent out by a thunderstorm 2000 miles away. Speaking of the alleged effects of wireless on weather, Mr. Watson Watt stated that the average rainfall of England requires for its production the expenditure of energy at the rate of a third of a million horse-power per square mile, night and day throughout the year. The total rate of emission of energy from all the broadcasting stations of Great Britain and Northern Ireland, in the limited periods during which they work, is less than 55 horse-power. Any effect of broadcasting on weather would therefore be due to 'sub-homeopathic doses' of less than one in a thousand million. The lecture was illustrated by the reception of current weather maps and written forecasts on the Fultograph system, and by demonstrations of the cathode ray direction finder, a visual direct-reading instrument used for locating wireless transmitters and thunderstorms.

IN his Friday evening discourse, delivered on Mar. 22 at the Royal Institution, Sir Ernest Rutherford dealt with "Penetrating Radiations." There exists in our atmosphere a type of ultra-penetrating rays, often called the cosmic rays, of about a hundred times the penetrating power of gamma rays. The frequency of vibration of these cosmic rays is from a hundred to a thousand million times greater than that of ordinary light. For ordinary X-rays, the quantum of radiation, in passing through the atoms of matter, occasionally interacts with one of the component electrons and the whole wave-energy of the quantum is given to the electron, which is set in rapid motion and ionises the matter in its path. The chance of such a conversion of the energy of the radiation, called the photoelectric effect, increases rapidly with the weight of the atom and falls off markedly as the frequency of the radiation is raised. Another process, called scatterings, is also always present. The effect is small for ordinary X-rays, but becomes predominant for very high frequency rays. In this process, called the Compton effect, the radiation is scattered and at the same time the electron is set in motion. The scattered radiation is degraded in frequency in amount depending on the angle of scattering. In very penetrating rays, the average frequency of the scattered wave is reduced to about one-half for each scattering collision, when about half the energy in the average is given to the recoil electron. Consequently, when a very penetrating radiation passes through matter, recoil electrons of high speed, and degraded radiations, are always present. The experimental information is at present too scanty to fix with certainty the origin and nature of these penetrating rays. It has been suggested that they come from outer space, and represent radiations which arise in the destruction or creation of atoms. The energy of the quantum in the most penetrating radiation measured by Millikan is of the order of 1000 million volts. It may prove significant that radiation of this energy may be expected to arise if the proton can be converted into radiation by a single catastrophic process.

THE Medical Research Council has lately issued three important monographs in the Special Report Series (H.M. Stationery Office). No. 124, by E. G. D. Murray, gives a critical account of the general biology of the meningococcus, the causative micro-organism of cerebro-spinal fever. No. 125, by Hugh Cairns, is a study of intra-cranial surgery, based upon a year's residence as assistant surgeon in Dr. Harvey Cushing's clinic at Boston, U.S.A. The medical reader, even, will be astonished at what can now be accomplished in this branch of surgery, and it is remarked that, apart from the difficulties of diagnosis and surgical approach, the brain is just as amenable to surgery as are the peripheral nerves. No. 126 contains a summary of reports for 1927 from research centres in Great Britain and Ireland on the medical uses of radium. There can now be no doubt that radium is a valuable adjunct, properly applied, in the treatment of cancers. Some inoperable cases are apparently cured, and even when this happy result does not ensue, life is frequently prolonged and the last days of the patient are rendered more comfortable. Much, however, remains to be elucidated as to the proper dosage, and the best method of application, of radium.

THE value of the work carried out at what are termed forest products laboratories is now beyond cavil. The first was established in the United States in Madison, Wisconsin. An important branch of the Research Institute at Dehra Dun, India, is occupied with similar researches; as also a section of the Bureau of Science at Manila in the Philippines. The Forest Products Research Laboratory at Princes Risborough in Great Britain has already been alluded to in NATURE. A pamphlet (No. 9, Melbourne, 1928) has been recently issued in which Mr. A. J. Gibson, a conservator of forests in India, lent to Australia for the purpose of the inquiry, discusses the question of "A Forest Products Laboratory for Australia." Mr. Gibson arrived in Australia in August 1927 and spent four months in visiting all the States of the Commonwealth, his report being based on the results of his investigations. In publishing the report the Council for Scientific and Industrial Research, under the auspices of which the investigation was carried out, states that its publication does not assume "that the opinions expressed therein are its adopted views nor that it is intended to follow, in their entirety, the recommendations made."

As a result of his investigations and tours, in which Mr. Gibson acknowledges his indebtedness to the forest and research officers of the various States, he expresses the opinion that the establishment of a central Forest Products Laboratory for the Commonwealth of Australia is advisable. One of the reasons given is a common one, and yet not the less important for that reason. In the past, he says, there has been much overlapping of research work and waste of

money owing to the absence of co-ordination between the various States and the Federal Government in this matter. He recommends the setting up of a central laboratory, and estimates the rough cost as follows: A capital expenditure for erection of buildings and equipment of £49,000; an annual expenditure of £10,400 for the personal staff; and another £8600 for maintenance: or a total for personnel and maintenance of £19,000 per annum.

VOLUME 2 of the *Bulletin of the Hill Museum* (1928) has recently come to hand. The first volume of this publication was completed in 1924, and it is announced that with the commencement of Vol. 2 a part will be issued each quarter. The journal is devoted to the publication of original papers on Lepidoptera based upon the splendid private collections of Mr. J. J. Joicey, housed in the Hill Museum at Wormley, Surrey. Contributions from outside sources are also accepted, provided they deal with collections made for the Hill Museum or are based upon studies carried out there. Among the various papers included in this volume, Prof. E. L. Bouvier's finely illustrated account of the Saturniid moths from the East Indies is important on account of the new species and varieties described. Mr. Arthur Hall's revision of the genus *Phyciodes* and papers by Mr. G. Talbot (and others) on material from Matto Grosso, Brazil, and the Great Atlas Mountains, are also noteworthy. The *Bulletin* is admirably printed, and is illustrated by well-executed coloured and other plates. The subscription price is 30s. per volume, payable to Mr. G. Talbot at the Hill Museum: it is also announced that the *Bulletin* will be sent in exchange for other publications on Lepidoptera.

A SEVERE earthquake, that must have shaken a wide area in British Columbia and southern Alaska, occurred on Mar. 1 at 2.31 A.M. (Eastern Standard Time). The epicentre is placed by the seismological section of the U.S. Coast and Geodetic Survey in lat. 53° N., long. 122° W., or in the strait between Queen Charlotte Island and the mainland. An after-shock, almost as strong as the first, occurred in the same place a little more than an hour later (*Daily Science News Bulletin*, Science Service, Washington, D.C. The epicentre of both shocks lies about 160 miles south-east of that of the Alaskan earthquake of Oct. 24, 1927, which was probably situated near Wrangell and Juneau in the narrow sounds of the Alexander Archipelago (NATURE, vol. 120, p. 667). The central areas of the two earthquakes thus seem to occupy a submarine band parallel and close to the western coast of North America.

UNTIL comparatively recent years, earthworms have been regarded as entirely useful animals, as they benefit the agriculturist by opening up the subsoil and improving the general condition of the land, and also they provide a prolific source of bait for inland fishing. Under modern conditions, however, they are a nuisance on lawns and golf courses on account of the mounds of earth they build up at the entrance to their burrows, which are unsightly and interfere with play in golf. W. R. Walton (*Farmers Bull.*, No. 1569, U.S. Dept. Agric.) epitomises our present knowledge of the life history and habits of earthworms, indicating the chief species that are of economic importance. Earthworms are a favourite food of wild song-birds and domestic poultry. In the latter connexion it should be noted that the eggs or larvæ of the gape-worm are swallowed by earthworms, and if in their turn these are eaten by chickens, the latter may contract the disease of gapes, for which the mortality is very high among young birds. The collection, storing, and rearing of earthworms for sale is a regular industry in fishing areas, and methods used in connexion therewith are described. When it is desirable to reduce earthworms, as on lawns and golf courses, various vermicides may be utilised, including corrosive sublimate, ammonium sulphate, powdered arsenate of lead, and mowrah meal. In flower-pots and flower-beds saturated limewater applied freely to the soil will destroy earthworms and not injure the plants.

AT the end of the third volume of the *Quarterly Review of Biology* (December 1928) the editor, Prof. Raymond Pearl, reports on the cost of the biological books received during the year 1928. These books are classified by origin—United States, Germany, English-American (that is, published in England and imported by a branch in America), England, France, other countries. In the last-named group two expensive books with many plates should be omitted before taking the average price. Leaving these two books out of the reckoning, Germany heads the list—the price per page working out at 1·48 cents, the English-American at 1·46, British Government publications 1·26, United States 1·14, England 1·09, France 0·45, and United States Government publications 0·21 cents per page. Prof. Pearl states that the sample of British Government publications was small and does not give an entirely fair representation of the case. He points out the low cost of the U.S. Government publications, and that French scientific books are still marvellously cheap as compared with the commercially published books of the rest of the world. There has been a slight fall (4·4 per cent) in the cost of biological books produced in England as compared with 1927, but the German books received were 23·3 per cent higher in cost in 1928 than in 1927, and 35·8 per cent higher than in 1926. The corresponding increases in the price of French biological books were 25·0 and 28·6 per cent, but the absolute price is so low that the increases are scarcely significant. Prof. Pearl interprets the feelings of many biologists in Great Britain when he states that it is a question whether the German "publishers are not dangerously close to the point in their pricing of scientific books where they will bring into operation that other sad economic law of which the effect is that absolute returns diminish. There can be no great profit in publishing books at such high prices that nobody buys them."

IN accordance with the recommendations of the recent Committee on the organisation of a Colonial Agricultural Service and of the Colonial Veterinary Services Committee, the Secretary of State for the

Colonies has appointed the following Colonial Advisory Council of Agriculture and Animal Health: Mr. W. Ormsby-Gore (temporarily chairman), Mr. F. A. Stockdale (vice-chairman), Lieutenant-General Sir William Furse, Dr. A. W. Hill, Dr. G. K. Marshall, Dr. E. J. Butler, Prof. T. B. Wood, Dr. W. H. Andrews, Dr. A. T. Stanton, and Mr. R. V. Vernon. The Lawes Trust Committee and the Joint Committee on Research in Animal Nutrition of the University of Aberdeen and the North of Scotland College of Agriculture, respectively, have been invited to give their consent to Sir John Russell and Dr. J. B. Orr serving on the Council. Mr. G. H. Creasy, of the Colonial Office, has been appointed secretary to the Council. No terms of reference have been given, but the Council's functions will be generally those recommended by the Committees named above.

THE International Council for the Exploration of the Sea will hold its annual meeting this year in London on April 8-15. Fifteen countries are now represented on it, namely, Belgium, Denmark, France, Finland, Germany, Great Britain, Holland, Irish Free State, Italy, Latvia, Norway, Poland, Portugal, Spain, and Sweden. The headquarters of the Council are in Copenhagen, and it is there that the annual meetings are normally held. The Council last met in London in 1920, when it first reassembled after the War. On April 12 and 13 special meetings will be held, by the courtesy of the Zoological Society of London, in the Society's meeting-rooms, for the discussion of the fluctuations of fisheries and methods of measuring currents. On April 17 a joint meeting with the Challenger Society will be held at the station of the Marine Biological Association at Plymouth.

A SECTIONAL meeting of the World Power Conference on the "Complete Utilisation of Water Power Resources" will be held at Barcelona on May 15–23, at the same time as the Barcelona Fair. It will be followed by visits to places of interest in Spain. The meeting is being organised by the Spanish National Committee of the World Power Conference, with the official co-operation of the Spanish Government. The subjects to be dealt with are: general hydrological problems; technical problems of water power utilisation; economic and financial problems; legal problems; protective measures and defence works of undertakings. Copies of the technical programme (in English, Spanish, French, and German) with forms of application for membership, can be obtained from The Secretary, International Executive Council, Central Office, World Power Conference, 63 Lincoln's Inn Fields, London, W.C.2.

THE unique collection made by Mr. and Mrs. A. C. Bossom of the crafts of the Indians of British Columbia has been loaned to the Imperial Institute, South Kensington, S.W.7, for display during the period Mar. 27–May 20. The British Columbia Indian or Siwash is a mixture of the Mongoloids and Red Indians, and this heredity appears in his art, as some of it is similar to that of the Chinese and Japanese. His artistic instinct is more highly developed than that of the Red Indian, because he is a house-dweller and not nomadic. The exhibits consist of about 1500 articles, illustrating workmanship in wood, metal, bone, ivory, leather, basketry, etc. It is a curious fact that these Indians had no pottery. The exhibition is open daily on week days from 10 A.M. to 5 P.M., and from 2.30 to 6 P.M. on Sundays. Admission is free.

THE proceeds of the Daniel-Pidgeon Fund for the year 1929 of the Geological Society of London have been awarded to Mr. J. Selwyn Turner, who proposes to investigate the faunal succession in the Coomhoola Grits and Carboniferous Slate of County Cork.

AT the annual general meeting of the Geological Society of London, the following officers were elected: *President:* Prof. J. W. Gregory; *Vice-Presidents:* Dr. F. A. Bather, Prof. E. J. Garwood, Dr. E. Greenly, and Mr. H. W. Monckton; *Secretaries:* Mr. W. Campbell Smith and Prof. W. T. Gordon; *Foreign Secretary:* Sir Arthur Smith Woodward; *Treasurer:* Mr. F. N. Ashcroft.

MOTIONS on the subject of nomenclature for consideration by the fifth International Botanical Congress, to be held at Cambridge in 1930, should be in the hand of the rapporteur général, Dr. John Briquet, before Sept. 30 next. Further information on the programme of work on nomenclature can be obtained from Dr. Briquet, Conservatoire botanique, Geneva, Switzerland.

THE Ministry of Agriculture and Fisheries has issued anew the Leaflet (No. 138) on fowl pox, which has been re-written. It gives a complete summary of the features of the disease, and its treatment, with illustrations. The Ministry also carries out veterinary tests for poultry diseases, a charge of 3*s.* being made for a post-mortem examination, and 10*s.* for a complete examination in outbreaks of bacillary white diarrhœa.

IN our issue of Dec. 1, 1928, p. 860, an account was given of the Kimberley meeting of the South African Association for the Advancement of Science held on June 29–July 4, 1928. The full report of the meeting has now been issued (Johannesburg: South African Association for the Advancement of Science. 30*s.* net). In addition to the presidential addresses, the volume contains all the papers recommended for publication after presentation at the meeting. There are author and subject indexes.

EVERY scientific worker must have had the experience of being asked to recommend for popular reading a book in some branch of his own science, and of being hard put to it to find a satisfactory answer. The Committee of the Leeds Public Libraries has got over the difficulty by inviting experts to compile, with suitable comments, lists of works dealing with all the aspects of various subjects of popular appeal. The lists are published as small booklets at a price of 3*d.* each, and are suggestive library guides. In the scientific series the latest to appear are "What to Read in Zoology" by Prof. J. Arthur Thomson, and "What to Read in Biology" by Prof. W. J. Dakin.

MESSRS. W. Heffer and Sons, Ltd., Cambridge, have just issued a catalogue (No. 323) of some 1800 works dealing with agriculture, botany, zoology and biology, chemistry and chemical technology, medicine and physiology, mathematics and physics, including long runs of publications of the learned and scientific societies. The list can be had free from the publishers.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A temporary zoological assistant for work on the zoological collections of the *Discovery*—The Secretary, *Discovery* Committee, Colonial Office, Whitehall, S.W.1 (April 7). A full-time lecturer on electrical engineering at the Leicester College of Technology—The Registrar, College of Technology, Leicester (April 8). A demonstrator in the department of chemistry as applied to hygiene, at the London School of Hygiene and Tropical Medicine—The Secretary of the School, Malet Street, W.C.1 (April 10). A physics tutor at the University Correspondence College—The U.C.C., Burlington House, Cambridge (April 12). A junior assistant under the Air Ministry, with good general technical knowledge of wireless ground stations, directional wireless and wireless in aircraft, and of development of short wave wireless telegraphy and telephony especially in its use in aircraft—The Secretary, Air Ministry (S.1.), Adastral House, Kingsway, W.C.2 (April 15). An assistant curator in the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (April 15). A principal of the Shoreditch Technical Institute—The Education Officer (T.1a), The County Hall, Westminster Bridge, S.E.1 (April 16). A principal of the Hackney Technical Institute—The Education Officer (T.1a), The County Hall, Westminster Bridge, S.E.1 (April 16). An inspector of ancient monuments for Wales—The Chief Inspector of Ancient Monuments, H.M. Office of Works, Westminster, S.W.1 (April 21). A chief inspector of the West Riding of Yorkshire Rivers Board—H. F. Atter, 71 Northgate, Wakefield (April 30). An independent lecturer in economics at the University College of North Wales—The Registrar, University College of North Wales, Bangor (May 13). An advisory dairy bacteriologist at the Harper Adams Agricultural College—The Principal, Harper Adams Agricultural College, Newport, Salop.

Our Astronomical Column.

AURORAL ARCS ON MAR. 14 AND 16.—Auroral arcs were seen on Mar. 14 and 16 at 7 P.M. by Prof. H. Bassett and Mr. R. G. Durrant and by several other spectators at Reading. On both occasions the phenomenon presented itself in precisely the same position, but it was fainter on Mar. 16, the moon's light being stronger. The altitude of the brighter part of the arc was approximately 30° above the horizon and its breadth about half a degree. The arc stretched over an expanse from south-south-east to north-north-west or 180°. It passed below Venus, the moon, and Jupiter on one side, and between two bright stars at a considerable distance on the other. Mr. Durrant refers to the event as being an apparition of the zodiacal light, but the aspect of the latter is usually that of a glow in the shape of a cone. He alludes to Sir John Herschel's suggestion that the zodiacal light represents a denser region of planetary material consisting of the tails of comets, while Lord Kelvin considered it as the reflected light from a cloud of meteors revolving round the sun. There is very little if any distinction between these views. Mr. Durrant remarks that if the theory just mentioned still meets with acceptance, this solar crape ring must circulate just within the path of Venus, but the object witnessed in the sky at the middle of March seems to have been consistent with that of an aurora.

RECENT SOLAR ACTIVITY.—A large metallic prominence was observed by Mr. Newbegin at Worthing on Mar. 18 at the sun's west limb. He states that the prominence consisted of delicate filaments in a series of interlacing arches culminating in a dense mass at the top which was 105″ in height. This part was dense in helium (D_3). The observation is of interest because it seems likely that this prominence was connected with the disturbed area embracing the large sunspot described as No. 4 in NATURE of Mar. 16, p. 425 (for Mar. 5—date when first seen—read Mar. 4). On Mar. 11–13 a considerable magnetic disturbance took place, the measured ranges at the Greenwich station at Abinger being 47′ in declination and 300γ in horizontal force. The storm began with a very pronounced 'sudden-commencement' at 13·9 hr. on Mar. 11; the large leader spot crossed the sun's central meridian about 20 hours earlier.

ANOTHER MINIATURE MAGELLANIC CLOUD.—Dr. W. Baade contributes to *Astr. Nach.*, 5612, a note on the nebulous object N.G.C. II. 1613, the position of which for 1900·0 is $0^h\ 58{\cdot}0^m + 1°\ 25'$, near 26 Ceti. It was found by Prof. M. Wolf from photographs with the Bruce teleseope, and described by him in *Mon. Not. Roy. Ast. Soc.*, **69**, p. 91, as a faint nebulous cloud, 30′ by 40′ in size, with brighter condensations embedded in it. He suggested that it was a cluster of small planetary nebulæ. An exposure by Prof. H. D. Curtis with the Crossley reflector did not lead to any decisive result. Dr. Baade has now taken several photographs with the Bergedorf reflector, with exposures ranging from 50^m to 120^m. He describes it as a star-cloud of the type of the Magellanic clouds; the longer exposure gives its dimensions as $14' \times 12'$; the brightest stars in it are of mag. 17 to 18. It appears to resemble N.G.C. 6822; a photograph of this by Dr. E. P. Hubble is reproduced in "Astronomy," by Russell, Dugan, and Stewart, p. 804 (1927).

THE LIGHT CURVE OF NOVA TAURI, 1927.—*Astr. Nach.*, 5613, contains a table and diagram showing the changes in the light of this star, which was discovered at Bergedorf on Nov. 18, 1927, by Prof. Schwassmann and Dr. Wachmann, being then of mag. 9·5.

The Harvard plates enabled the history of the star to be carried two months further back. It was invisible (fainter than $11^m{\cdot}7$) on Sept. 11; $8^m{\cdot}2$ on Sept. 25; $6^m{\cdot}0$ (maximum) on Sept. 30; it sank fairly rapidly to $13^m{\cdot}5$ at the end of the year; there was then a slight revival to 12·5 in March 1928. 13·5 was again reached in mid April, after which the star was lost in the sunlight. An exposure on Aug. 28, 1928, with 30 minutes exposure, gave the magnitude 14·4.

The light curve gives no evidence of the rapid oscillations of brightness which were such a conspicuous feature in Nova Persei 1901 a few weeks after the maximum.

Research Items.

NAGA CUSTOMS.—Owing to head-hunting troubles in 1923 it became necessary for Mr. J. H. Hutton to make two tours to parts of the Naga Hills not hitherto visited by white men. One journey was made in April, the second in October. Mr. Hutton has published a diary of the two tours as No. 1, vol. 11, of the *Memoirs of the Asiatic Society of Bengal*. Many types of implements, utensils, and weapons entirely new to the author were recorded, also new data relating to the burial and head customs, forms of tatoo, etc., as well as much information supplementary to that noted by the authors of the various monographs on the Naga tribes published by the Assam Government. In connexion with the Yungya custom of disposing of the dead in trees, the head being afterwards removed, the sacred tree in question is the *Ficus*, for which some veneration is consistently shown among the Nagas. Among the Wa of Burma and the Dusun of Borneo it is the head tree. The Mafulu of New Guinea use it much as the Yungya, and the Papuan tribes reverenced it. Women in southern India who desire children pay reverence to it, and the Akikuyu of East Africa regard it as the abode of the souls of the dead. It is, therefore, suggested that the beliefs about, and veneration for, the fig tree may be a negroid cult spread all over the Indian Ocean which has grown up into Hinduism from below. Similarly, a negroid belief may survive in the custom of hanging the combs of bees and wasps in the entrance of houses, a custom witnessed everywhere on the first tour. A similar custom is recorded in the Andaman Islands and in the Malay Peninsula. Its occurrence in the Andaman Islands certainly suggests a negrito origin.

THE PURPOSES OF THE PECTEN IN THE EYE OF BIRDS.—In the Doyne Memorial Lecture for 1928, Prof. Arthur Thomson discussed the functions of the pecten in the light of certain experiments carried out by him. He suggests that this curious structure serves other purposes than the nutrition of the vitreous humour and retina and possibly the regulation of inter-ocular pressure. Its pigmentation, position, and structure, all suggest that it may act as a dark mirror which reflects as well as absorbs light. Rays of light, which in the normal position of a bird's head fall upon the pecten from the zenith, have been shown by experiment to be reflected from it, and can be projected upon some sentient part of the fundus, with the great advantage that, so reflected from a dark mirror, they are deprived of the dazzle and glare of bright sunshine and produce a more defined and detailed image. The biological advantage of such a device is obvious, for it means that a bird of prey hovering overhead can be seen even against the sun, and the position of the pecten is such that the threatened victim can fly in another direction whilst still 'keeping an eye' on the source of danger. The projection of *two* images upon the fundus may enable birds to estimate distance more accurately, a valuable power where dense foliage has to be traversed at speed. Though the pecten in birds is built upon a general plan, it shows remarkable variations in size and form, and these are characteristic of different species.

BIOLOGY OF THE BAY OF PETER THE GREAT (SEA OF JAPAN).—The curious peculiarity of the Bay, according to G. U. Lindenberg (*Priroda*, No. 11), is the fact that its fauna is similar in its character to the terrestrial fauna of the Ussuri region. Even the first explorers of Ussuri noted the mixture of such typically northern forms as the fir and cedar, the sable and the arctic deer, with such typical southern forms as the American vine and the Manchurian walnut, tiger and the racoon-like dog. This is analogous with the aquatic fauna of Peter the Great Bay. The conditions which gave rise to this peculiarity are not the same in the cases of the terrestrial and the aquatic fauna. The climatic conditions of the great ice age played an important part in determining the character of the terrestrial flora and fauna, whilst the aquatic fauna is greatly influenced by the hydrological regime of the Sea of Japan. The occurrence of series of southern forms in the bay during the last three years may be partly explained by hydrological changes of the regime of the bay. It cannot be denied, however, that the southern forms were overlooked by previous explorers. Such typical representatives of the northern fauna as cod (*Gadus callarias macrocephalus*) and dorse (*Eleginus navaga gracilis*) are found among the fishes of the bay. At the same time, many of the southern forms, such as the herring, *Chirocentrus dorab*, *Sphyrna zygæna*, *Alectis ciliaris*, *Priacenthus hamrus*, and others are found in the bay. The sword fish, *Trichiurus Japonicus*, the flying fish, *Cypselurus agoo*, *Stromateoides echinogaster*, *Hemirhamphidæ*, *Scombresociolæ*, *Belsnidæ*, *Mugilidæ*, *Scombridæ*, *Monacanthidæ*, *Tetrodontidæ*, *Triglidæ*, *Echeneidæ*, *Gobiidæ*, and other representatives of southern seas are numerous. So far as is known at present, the fish fauna of the Bay of Peter the Great consists of 233 species, belonging to 53 families. Quantitatively, the fish fauna is richer than that of other Russian seas, such as the Black Sea, the Baltic, the Arctic Ocean, etc. The character of the fish fauna of the Bay of Peter the Great is nearer to that of northern Japan and Korea than to the Okhotsk and the Bering seas.

TWO NEW HYDROIDS.—A. E. Briggs describes (*Records Australian Mus.*, **16**, 1928) two new species of the hydroid genus *Myriothela* collected near Sydney, New South Wales. Six species of the genus are known from northern seas and one from antarctic or subantarctic waters. The discovery of these two new species considerably extends the known range of distribution of the genus. *M. australis* was found attached to seaweed thrown up on the beach and may prove to be a shallow water species. The specimens range in length from 4 mm. to 30 mm. *M. harrisoni* was found on the under surface of rocks below the level of low spring tides. A large number of capitate tentacles is present—up to 1500 in *australis* and up to 600 in *harrisoni*. In both species the gonophores borne by one individual are of the same sex. Both male and female gonophores have an apical opening representing the velar aperture. The salient structural features of *M. australis* are described.

LEAF-FALL IN FROST.—It is well known that frost may cause a premature leaf-fall, but the relation of this phenomenon to the normal process, in which leaf-fall is preceded by the differentiation of a special abscis layer, has seldom been followed in detail. Studies of this nature have recently been carried out by Dr. Anton Mühldorf, who, in addition to observations in the field in the autumn, exposed plants at various stages of development to freezing temperatures which were produced artificially. An account of this work appears in the *Bulletinul Facultatii de Stiinte din Cernauti*, vol. 2, pp. 267-304; 1928. Briefly, his conclusion is that this leaf-fall is a special case of the normal process of leaf abscission, in which the actual separation of the leaf is accelerated as the

result of the changes set in motion by freezing. For example, sap is released into the intercellular spaces where its subsequent expansion on freezing facilitates the separation of the cell walls in the region where abscission takes place. If, however, leaves have not yet commenced to differentiate the usual specialised abscission layer at the time when they are exposed to frost, they die and decay on the plant and do not fall off before decaying. Dr. Mühldorf notes that the vacuole sap released by the cell at the moment of death by freezing has a weakly acid reaction, and this may favour the subsequent hydrolysis of the middle lamella, but this factor alone is quite inoperative in producing leaf-fall unless the usual absciss zone is already differentiated. This paper contains a very full discussion of the general phenomena of leaf-fall accompanied by an extensive bibliography in which, however, British and American work is not cited.

COAL IN SOUTH AFRICA.—The Geological Survey of the Union of South Africa has published the third volume of "The Coal Resources of the Union of South Africa" as *Memoir* No. 19 of the Survey. The first volume contained descriptions of the coalfields of Witbank, Springs, and Heidelberg, and of the Orange Free State, the second volume described the inland coalfields of Natal, and the present volume deals with such of the coal-bearing areas of the Transvaal as were not described in Vol. 1, together with the coalfields of the Cape Province. The Transvaal area here described comprises the Eastern Witbank coalfield, the Bethal coalfield, the Ermelo and Middelburg-Belfast coalfields, the Piet Retief-Wakkerstroom coalfield, and a number of less important fields, such as Springbok Flats, Northern Waterberg, Zoutpansberg, and Komatipoort. The Cape coalfields appear to be of but little importance; the only area in which coal has been worked to any extent is the Stormberg area, but even here the coal is of inferior quality and the seams are thin and much intermixed with shale bands, so that competition with the Transvaal and Natal coalfields is practically out of the question, and the author of the memoir, W. J. Wybergh, states that although there are actually many million tons of coal in existence in the Stormberg coalfield, it is highly improbable that it will ever be economically possible to work it apart from very unimportant local requirements. The important Transvaal coalfields are fully described, the quantities of coal reserves are carefully estimated and numerous analyses are given, so that the present volume may be looked upon as satisfactorily completing the information contained in the two previous volumes on South African coal resources.

PALÆOZOIC INSECTS.—The meagre but interesting fauna of the Rhynie chert found in the Old Red Sandstone of Aberdeenshire comprises a minute branchiopod crustacean (*Lepidocaris*) allied to the *Anostraca* (NATURE, **118**, p. 89; 1926), some arachnids, including the only true mite known in the Palæozoic, and the remains of some minute insects—the only insects known in rocks of earlier date than the Upper Carboniferous. These insects, which were first described by Hirst and Maulik, have been re-examined by Dr. R. J. Tillyard (*Trans. Entomol. Soc. London*, p. 65; 1928), who notes the resemblance of the mandible and antenna to those characteristic of the order Collembola, especially to the family Poduridæ, and concludes that they either belong to that order or are ancestral to it. From comparative morphology it is inferred that the primitive Thysanura must also have been in existence in Devonian times. The specimens consist of four more or less perfect heads for which the genus *Rhyniella* was established by Hirst and Maulik, and some jaw-like structures for which the generic name *Rhyniognatha* is used. In part 10 of his series of papers on Kansas Permian insects, Dr. Tillyard (*Amer. Jour. Sci.* (5), **16**, p. 185; 1928) gives a detailed account of the genus *Lemmatophora*; this has hitherto been referred to the order Protorthoptera, but is now shown to be related to the recent order Perlaria (stone-flies), and is taken as the type of a new order, the Protoperlaria. The wing of a damselfly (genus *Permagrion*) from the Upper Permian of the Falkland Islands has been studied by Dr. Tillyard (*Trans. Entomol. Soc.*, p. 55; 1928). It is the oldest known type which can be definitely referred to the sub-order Zygoptera of the order Odonata (dragonflies), and is allied to the more primitive form *Kennedya* from the Lower Permian of Kansas. The evolution of the order Odonata in Palæozoic times is discussed by Dr. Tillyard (*Rec. Indian Mus.*, **30**, 151; 1928). The characters of the two related orders Protodonata and Odonata are analysed, and it is concluded that the common ancestor is to be found in the Westphalian genus *Brodia* of the order Megasecoptera. The evolution of the Odonata in Mesozoic and Tertiary times will be dealt with in the second part of the paper.

ULTRASONIC RADIATION.—In the February issue of the *Journal of the American Chemical Society*, Schmitt, Johnson, and Olson describe further experiments on the chemical action of very intense sound waves. Iodine is liberated from a solution of potassium iodide, probably owing to the intermediate formation of hydrogen peroxide, since a reaction was obtained when a titanium sulphate solution was irradiated. Solutions containing hydrogen sulphide and air become strongly opalescent after exposure for a few minutes, owing to liberation of sulphur.

EARTH CURRENT REGISTRATION.—Dr. S. K. Banerji, Director of the Bombay Observatory, informs us in a recent communication that he has succeeded in registering earth currents with lines only 250 yards long, whereas usually lines of some miles in length are employed, in order to minimise polarisation effects at the electrodes. He overcomes polarisation difficulties by making the electrodes neutral with respect to the soil, each electrode being a combination of electropositive and electronegative metals, the actual composition being found by trial, and varying with the soil. The neutrality is not maintained indefinitely, and to avoid frequent removal and scraping of the electrodes, small separate electrodes of the positive and negative metals are sunk, and one or other of these is joined to the main as and when found necessary to correct for any small polarisation current that may develop. Such installations have been set up at Colaba and Alibag, which are about 15 miles apart, and about 5 and 18 miles respectively from the centre of the Bombay electric railway network. Photographic records of the earth-currents show the leakage from this network; the oscillations are in excellent agreement with the voltage record at the power station. The amplitude of the oscillations of the leakage current is about 110 microamperes at Colaba, and only 5 at Alibag; the reduction in amplitude agrees roughly with that corresponding to laminar flow. A plane current-sheet of even 5 microamperes is sufficient to disturb the magnetic registers very appreciably. Besides the leakage currents, the earth-current records show the natural diurnal current-variation, and disturbance currents during magnetic storms.

CHEMOTHERAPY WITH LEAD COMPOUNDS.—It is now some years since Prof. Blair Bell first published in the

Lancet an account of the use of lead in the treatment of malignant tumours, and his work has attracted a considerable amount of attention. Another question which has also been discussed recently is that of the toxicity of organic compounds of lead, for example, lead tetraethyl. These two fields of inquiry have lately been combined in an investigation which has been carried out on the chemical side by Dr. Erich Krause, of the Technische Hochschule, Berlin, who contributes a paper to the January number of the *Berichte* (vol. 62, pp. 135-137), and on the pathological side by Dr. W. A. Collier. Various organic compounds of lead (and also of tin) are worked into emulsions with a gum arabic solution, and are injected into the necks of mice. The tolerated dose of substances applied in this way varies considerably, and does not appear to depend on the solubility. Thus triphenyl lead fluoride or triphenyl tin bromide is fifty times as poisonous as diphenyl lead dibromide. Aliphatic and hydroaromatic lead compounds are among the less toxic substances, and are therefore used in the treatment of experimental cancer. A carcinoma emulsion is injected into mice, after which half the animals are treated once with lead compounds as above. The results indicate definite curative effects, the treatment either preventing the development of tumours, or causing tumours to heal after partial development. The most effective substances are found to be tri-normal-propyl lead fluoride, or the less toxic tri-iso-butyl lead bromide, and lead tetraphenyl and tri-cyclohexyl.

AUTOMATIC RECTIFIER SUBSTATIONS. — Recent statistics show that the owners of railway and tramway systems and lighting and power networks are adopting the policy of making their substations completely automatic. This movement began in America, where the need of highly efficient plant is felt very acutely. In Europe the economic conditions involve the factors of high labour costs, the eight-hour day, and the necessity of safeguarding the workman in the best possible way. In the *Brown Boveri Review* for February, a full account is given of the automatic substations this firm has installed for the Brno tramway company in Czechoslovakia. Instead of using rotary converters and complicated combinations of standard relays, mercury arc rectifiers are used. These are of robust construction. In order to connect the rectifier set with the network, it is merely necessary to close two switches. When working with rotary converters it is necessary to synchronise the machines and also verify that the polarity has not been reversed after every operation. The vacuum in a rectifier is maintained by a pump set which is started working or shut down according to the value of the vapour pressure in the rectifier. A time switch automatically closes the circuit breakers. This is the first step in operating the substation. By means of a remote-controlled switch in the distant central power station, the plant is started up or shut down. Should the load become excessive, a thermal relay automatically puts the reserve set into operation. All the control gear is kept in cases which are sealed and completely dust-tight. The average daily efficiency of the rectifier substations is stated to be 92·3 per cent. This compares with an efficiency of 87·6 per cent for a rotary converter station. A brief inspection of these plants is made once a week and their working is controlled in detail every month.

PHOTO-CELLS.—Great progress has been made recently in the development of photoelectric cells or, as they are now more commonly called, photo-cells. Compared with selenium cells, they are much more trustworthy and consistent; unlike them, their response to variations on the light falling on them is practically instantaneous. They have numerous practical applications. Most systems of 'talking films,' for example, use these cells, so as to convert varying light impulses into electrical currents which are applied and reproduced as synchronised sound in loud speakers in the cinema. Another application of importance commercially is to picture telegraphy. Variations of light falling on the photo-cell cause electric currents which can be transmitted by land lines and cables and radio, and are then converted into varying light impulses which are recorded on sensitised photographic paper. In the February number of the *Osram G.E.C. Bulletin*, the principles of the action of this new development are given. The action of the valve depends on the emission of electrons from a suitably prepared metallic surface when light falls on it. The photoelectric currents are extremely small, being of the order of one microampere even with strong sources of illumination. They have the invaluable property, however, of being proportional to the incident light. They can thus be used for most forms of light measurement. They can be made sensitive to particular colours, and this enables them to be usefully applied in practical photometry. It seems certain that within the next year or two practical photometric measurements will be made by their use. Baird uses them in his system of television. A special cell can be made which only responds to infra-red light invisible to the human eye. This can be used as a burglar alarm.

A NEW EQUATION OF STATE.—Paper 5 of Volume 63 of the *Proceedings of the American Academy of Arts and Sciences* gives an account of a new equation of state for fluids introduced by Drs. J. A. Beattie and O. C. Bridgeman of the Research Laboratory of Physical Chemistry of the Massachusetts Institute of Technology. It is $pV^2 = RT(1-\epsilon)(V+B) - A_0(1-a/V)$ where $B = B_0(1-6/V)$ and $\epsilon = c/VT$, a, b, c are constants and the other symbols have the usual meanings. The terms involving A_0 and B_0 represent the effects of the interactions of the molecules of the fluid, while ϵ represents the effects of temperature and density on the time of encounter of the molecules. For this equation $(\delta^2 p/\delta T^2)_v$ is always negative but approaches zero at high temperatures and volumes ; p approaches RT/V as V increases and $(\delta pV/\delta p)_T$ at low pressures is negative for low and positive for higher temperatures. The five available constants of the equation are all readily determined from observed data, and comparisons are made between calculated and observed pressures at 1777 points for ten gases and the average difference only amounts to 0·18 per cent.

TANTALUM.—An interesting account by G. M. Dyson of the metallurgy, properties, and uses of tantalum appeared in the issue of *The Chemical Age* for Mar. 2. Since its replacement by tungsten for the manufacture of lamp filaments, tantalum has been utilised as a substitute for platinum. It is unattacked by acids, with the exception of hydrofluoric acid, but reacts with fused alkalis. Hence, tantalum cannot always be employed instead of platinum for making chemical apparatus, especially as it is unsuitable for use above red-heat, when a superficial oxide film is formed and nitrogen is absorbed. Tantalum will absorb all the common gases when heated to a high temperature, and is therefore used in some radio valves since it functions as its own 'getter' and hardens any vacuum in which it is heated. Other uses of tantalum are for the manufacture of surgical instruments and for electrodes in electrolytic rectifiers for alternating current.

Ultra-Microscopic Viruses infecting Animals and Plants.

IN opening the discussion on ultra-microscopic viruses infecting animals and plants, held at the Royal Society on Feb. 28 and continued on Mar. 14, Sir Charles Martin pointed out that the first virus, that of tobacco mosaic, was discovered by Iwanowski, a Russian botanist, in 1892. Five years later, Lœffler and Frosch ascertained that foot-and-mouth disease of cattle was due to a filter-passing contagium, and since that time numerous virus diseases of plants, mammals, birds, insects, and even bacteria have become known. These show no common clinical or epidemiological features, and simply form a heterogeneous collection of contagia, all filterable with an infective filtrate and with at present no proved microbial connexion. In certain cases distinctive intracellular bodies occur which may be used in diagnosis.

Filterability, which gives entry to the group, depends upon numerous and obscure factors. Viruses may be good or bad filterers, and this is not simply a question of size. That viruses are invisible is merely due to the fact that the finest filters stop particles of about 0·1μ, whilst the limit of microscopic resolution is about 0·2μ. The dimensions of virus, probably not less than collargol (20$\mu\mu$), raise the question of the minimum size of living organisms and have suggested the alternative hypothesis that viruses are propagating catalysts. Viruses, however, show the characters of living things and there are no essential distinctions save those of size and cultivability. Even the latter may be due to a size limitation of their powers of assimilation which renders them obligate parasites, a view supported by the absence of any evidence of saprophytic viruses. The study of virus diseases is certainly one of the most important and difficult fields of biology to-day.

Dr. Henderson Smith was prevented by influenza from opening the discussion from the plant side. In his communication he emphasised the fact that viruses causing disease in plants are of the same nature as those causing it in animals. Some plant viruses attack numerous hosts, whilst others are more narrowly adapted. Many viruses can be transmitted by juice or tissue, and these are filterable and highly infective. Others can only be transmitted by grafting, and their filterability cannot be determined. Probably, in the field, all plant viruses are normally transmitted by insects; in certain cases the relation between a vector and a particular virus is highly specific, and in a few it has been definitely proved that the insect becomes infective only after a period has elapsed since feeding upon a diseased host. Such relationships suggest that viruses are some kind of living parasite. The intracellular inclusions in certain plant virus diseases give protein reactions but themselves do not seem to be alive. The claim that virus disease can be originated *de novo* by inoculation of normal tobacco with normal potato has not been confirmed.

Prof. P. A. Murphy emphasised the strong family resemblance between the virus diseases of plants and the difficulties introduced into their study by the fact that many diseases can only be transmitted by grafting or an appropriate insect vector. Viruses are not found outside the plant, and there is no good evidence of their culture *in vitro*. Fungal and bacterial diseases of plants are local, and the fact that virus diseases are systemic possibly indicates that virus is different in nature from bacteria or fungi. Viruses can be attenuated temporarily or permanently; diseases caused are permanent; as a general rule there is no recovery and an attack does not confer immunity. Cases of apparent recovery are probably due to the occurrence of carriers, a widespread phenomenon in plant virus diseases.

Foot-and-mouth disease was discussed by Dr. J. A. Arkwright, who said it is notable for its easy filterability and high virulence in dilution. The virus is not infectible to other animal species until adapted by passage. Infection confers a short immunity, and susceptibility reappears in the same order as the natural susceptibility of different regions in the normal animal. During the immune period the blood contains antibodies. Foot-and-mouth vaccine inactivated by formalin confers immunity in guinea-pigs and resembles the vaccine of killed bacteria in that the action is proportionate to the dosage. The immunity is specific for the three types of foot-and-mouth and also for the formolised vaccine. The properties of the virus do not exclude its bacterial nature, and there is nothing in the available evidence to contradict the idea of its likeness to bacteria. The alternative idea of a metabolic product seems unlikely.

Mr. J. E. Barnard described some of his efforts to improve microscopic technique, and emphasised the increasing difficulties of observational study as the limits of microscopic resolution are approached. His aim is to use light of shorter wave-length, which should make it possible to see characteristics of a body smaller than can be seen by visual light. A recent development is a dark-ground illuminator for ultra-violet rays, whereby it is hoped to reduce the exposures to workable limits. Mr. Barnard showed a number of lantern slides obtained by this method, and in one of bovine pleuropneumonia granules of 0·08μ were clearly revealed. He finds that the virus of pleuropneumonia, which consists of vesicles, shows two methods of reproduction, a normal bacillary type and a type quite distinct. In his work on this virus he has cultivated two saprophytes of ultramicroscopic dimensions.

Experiments on insect transmission of plant viruses were described by Dr. Kenneth Smith. He thought that the incubation period which had been found in certain vectors might be the time taken for the passage of the virus from the mouth to the salivary juices. The virus has no effect on the insect, the period for which vectors remain infective varies with the disease, and two years' experiments have given no evidence of inheritance. Lantern slides illustrated his studies of the transmission of potato mosaic to tobacco, and the extraordinary splitting of the virus into a 'needle disease' and an 'aphis disease,' of which the former, but not the latter, may be made lethal to potatoes by rapid transference. As an explanation of these 'two' diseases, Dr. Kenneth Smith suggests that the sap of tobacco contains a substance which reacts with the saliva of the aphis and so modifies the disease.

Dr. W. E. Gye gave an account of his researches on the Rous fowl sarcoma, from which a filter-passing virus may easily be obtained capable of producing true tumours giving further infective filtrates. There is a group of such filterable tumours of diverse structure showing this power of giving rise to unlimited growth. Each gives a filtrate of specific nature. The virus shows the properties of other viruses, and its susceptibility to various antiseptics shows the same general range as other organisms, *e.g.* bacteria. In its susceptibility to acriflavine it is similar to pleuropneumonia virus, and it seems of the same order as this virus and also of the same order as visible bacteria.

Prof. J. C. Ledingham opened the second day's

discussion by summing up the impression left on him by the previous contributions, namely, that viruses appear to be like bacteria in most characters save dimensions, that we have not yet exhausted the possibilities of ordinary microscopic vision in the study of viruses, and that one of the most valuable lines of research is the question of virus attenuation in relation to immunisation. The importance of the latter is shown in vaccinia and variola, where passage makes feasible vaccination which confers a prolonged immunity. With foot-and-mouth and certain other viruses, the killed virus gives a vaccine conferring a brief immunity but the possibilities of virus attenuation have not been sufficiently exploited in these fields. In its attenuation behaviour vaccinia shows inhibitions no different from those of experimental erysipelas, which suggests that the virus resembles visual bacteria. No definite opinion can yet be given regarding the nature of the included bodies, which are of uniform size (0·2μ) and behave like staphylococci inoculated under similar conditions. Woodruffe and Goodpasture were able to isolate a single body of fowlpox and found it to consist of innumerable elementary bodies. Regarding the question of concomitant bacteria, for example, *B. sui-pestis* and swine fever, the action seems to be one of activation of the bacterium by the virus in pigs carrying disease.

The more general principles of plant viruses as illustrated in potato mosaic were dealt with by Dr. R. N. Salaman. He has been unable to confirm the American results that virus disease may be caused by physiological disturbance due to the introduction of foreign protoplasm into a plant, and thinks that the original results are due to the use of carrier plants. Questions of carrying and tolerance underlie all plant studies. By inoculation into varieties having different tolerance, it is possible to distinguish viruses producing identical symptoms such as crinkle *A* and *B*. Certain viruses, for example, crinkle, are not altered by passage.

Prof. F. W. Twort considered that, according to the theory of evolution, we should expect forms of life much more primitive than bacteria, and that such primordial stages might be represented by the viruses. Present research methods may not be suitable for the study of such organisms, and entirely new methods are desirable. For example, rays below the infra-red may be essential to the growth of viruses, and work he has carried out with rays of 21-31 metres wavelength has given very promising results.

The differences between bacteria and viruses from the immunological point of view were emphasised by Dr. C. H. Andrewes. The main character of virus immunity is its solid or absolute character, the condition often lasting throughout life and being related, probably, to the persistence of the virus in the tissues. Although viruses inactivated by formalin, etc., confer immunity, it is not possible to immunise or to produce antibodies by heat-killed virus. In the former case the serum of immune animals contains antibodies different from other known antibodies, and the body's defence against viruses is different from that against visible bacteria.

Capt. S. R. Douglas described the electrical behaviour of viruses. In all cataphoretic experiments the virus passes to the positive pole. The distribution of the virus in the blood in the several stages of certain virus diseases was also referred to briefly.

Dr. E. Hindle gave an account of his experiments on the virus of yellow fever. This normally passes moderately coarse filters, but in the mosquito it is arrested even by those of coarsest grain, which suggests the occurrence of an evolutionary process inside the insect's body. Dr. Hindle thought that the undoubted variability shown by viruses indicated an organismal nature, but the character of the immunity conferred was so different from that in bacterial diseases that virus could not be considered as merely very minute bacteria.

Dr. W. B. Brierley emphasised the fact that plant workers give far less value to the character of filterability than do zoological students. In many plant viruses filterability cannot be tested, as the diseases are, under known conditions, not juice-transmissible and can only be transferred by grafting or insect vectors. Plant viruses exist as numerous strains the virulence of which can in many cases be increased or attenuated. Two or more viruses may act in conjunction, producing characteristic diseases which can be analysed and resynthesised experimentally. In insect transmitted diseases one insect may carry different viruses or one virus may be carried by different insects, but in certain cases the relationship between virus and insect is amazingly specific, and in at least one case there is a prolonged 'incubation' period. The systemic character of virus diseases is not distinctive, certain fungal and possibly bacterial plant diseases being systemic. Virus intracellular inclusions have been found in numerous diseased plants, and evidence is accumulating that they are characteristic of particular host-virus relationships. In spite of certain difficult points such as dimensions, and in the case of animals, immunological characters, a survey of the evidence makes it difficult to visualise the viruses as propagating catalysts or as other than organisms of the same order of life as bacteria.

Prof. A. E. Boycott discussed the nature of viruses and briefly summarised views which were published more fully in NATURE of Jan. 19. He considered that in many ways viruses show the character of ordinary bacteria, whilst in other ways they more resemble the unorganised growth-promoting substances and that, as it is all a matter of analogy, which view one accepts depends upon which side one's personal bias tips the scale.

A discussion on 'viruses' is rather like what one would expect a discussion on 'insects' or 'bacteria' to be; something large and fine, but not a little scattered and diffuse. Apart perhaps, from 'the nature of virus,' no coherent thread ran through the contributions. The meetings were valuable, however, in bringing together workers from all the fields of virus research and letting them hear and see each other in the flesh.

The Chemical Society in the Industrial North.

FOLLOWING the precedent established in 1926, when the annual general meeting and anniversary dinner were held in Manchester, the Chemical Society this year visited Leeds on Mar. 21. The proposal to hold such meetings away from London at frequent intervals was one which was immediately commended; the present plan gives many fellows of the Society who for a variety of reasons may find it impossible to travel to London an opportunity of identifying themselves with the activities of the Society, and it also lends an occasion for the greater emphasis, in variously engaged communities, of the part which chemistry plays in modern industry, health, and education, in the modern State, and above all in the world-wide development and maintenance of a friendly rivalry in the service of mankind.

The official business of the Society was first transacted at a meeting held in the Colour Chemistry Department of the University of Leeds. Afterwards, fellows and others assembled in the Great Hall of the University to receive the presidential address. A cordial welcome was extended to the Society by the Vice-Chancellor (Dr. J. B. Baillie) and by the Lord Mayor of Leeds.

In his presidential address, entitled "Co-operation in Science and Industry," Prof. J. F. Thorpe takes stock of the position in which we find ourselves as a result of the stimulus applied by the War in the direction of scientific achievement, of the developments leading to co-operation in various desirable forms, and of the way in which this stimulus and co-operation are being applied to increase the prosperity of Great Britain. It is, as Prof. Thorpe says, chiefly to the chemical and allied industries that the country turns to increase its productive capacity, its capacity to render available the potential wealth of the nation in a suitable form, whereby alone a universally higher standard of living can be made possible. He is convinced that it is organised industry, relying for its political and financial strength on co-operation—those who hold the keys of national prosperity—who will in the future (if they do not already) call the major chords of the political tune, which is not unreasonable, unjust, or even unlikely, seeing that organised industry both makes it possible to pay the piper and fashions his instrument. By organised industry we suppose Prof. Thorpe to mean the body corporate, composed of capital, and management, and 'labour' (that much abused term, by which we will propose to describe every kind of human service except those accounted for as management and capital)—that body corporate which keeps in the closest possible touch with all sources of new knowledge, with all applications of knowledge both old and new, with human needs, and with national policy. Four kinds of co-operation, Prof. Thorpe reminds us, are essential to strength: internal co-operation, co-operation with pure science, co-operation with Government, and co-operation with labour. Leaving aside the last, not because of any lack of importance (indeed, this form was described as being "above all" necessary), but merely because the occasion was unsuitable for its discussion, he presents us with an analysis of ways and means, of results and expectations in the domain of the other opportunities for co-operation.

As a concrete example of internal co-operation he selects the common use of hydrogen in three industrial processes: the production of methyl alcohol, of liquid fuels from coal, and of ammonia. Close association of engineers with chemists has been indispensable in order to render possible the establishment of a group of industries so largely dependent on the inauguration and control of reactions under pressure, and on the still empirical employment of chemical 'lubricants,' as catalysts have, not inaptly, been described. There remain, even in the single field of the hydrocarbon industry, vast areas awaiting co-operative exploration. The co-operation required, however, is not exclusively of the strictly scientific kind. Let us suppose that there is a country in the throes of a crisis in its coal-mining industry, yet importing vast quantities of liquid fuel. It is obviously to the advantage of that country literally to liquefy its assets. Science and industry show us that one promising method of producing oils and numerous other valuable raw materials from coal is afforded by the low-temperature carbonisation process; but, says Prof. Thorpe, albeit in other and more polished phrases, to the unscientific citizens of that country who still burn raw coal on their domestic hearths: no coke, no oil. Again, we are asked to consider the enormous waste of natural gas—millions of cubic feet each day in Canada: twenty-five million cubic feet daily in Persia—and to reflect on what co-operative research might do to utilise it.

Co-operation with pure science is a matter of special moment to our universities, where the human material acquires its knowledge, its impulse, and its outlook, and where opportunities for useful contribution to industrial and national prosperity abound, if only they are made available by support from industrial and national resources. It is, of course, the primary function of the university to attend to fundamentals, both in training and in research; to produce men who are capable of applying their minds with intelligent understanding, with wise vision, with human sympathy, and with appreciation of moral values to the world and its affairs. Prof. Thorpe has special opportunities both to study the inevitable problems and to reach sound conclusions concerning their solution. Discussing the contribution of the universities, so far as co-operation between science and industry are concerned, Prof. Thorpe speaks with experience of the training of the men, pointing out the necessity for research training in order to discover the potential value of a student, and recommending that a higher standard be required of candidates for entry into the honours school. In his remarks on the fundamental research which can be, and is, successfully carried out in the universities, he pays tribute to the far-sighted policy of leading industrial organisations, particularly of Imperial Chemical Industries, Ltd., in affording financial support to enable such studies to be prosecuted under the direction of specialists in various branches of research.

The Government's part in co-operating in science and industry is being exercised in the two most profitable directions in which, in Prof. Thorpe's view, support could be given, namely, on one hand by protection of young and struggling industries, and on the other hand by the promotion of research by means of the establishment of specific inquiry, of financial assistance to industrial groups, and of the provision of research studentships and fellowships. With the present policy of the Department of Scientific and Industrial Research in reducing the number of maintenance grants for students in training Prof. Thorpe expresses dissatisfaction. In fact, he uses words which indicate considerable disquietude: "the outlook is serious"; "it is essential that the State should provide the means for helping to meet this very real national difficulty"; "it is to be hoped that the diminution is merely a temporary expedient." Prof. Thorpe is right in saying that a policy which has provided a steady stream of research workers not otherwise available ought not in any measure to be laid aside while there remains a national need for the best type of research worker. He would be a brave man who would risk his reputation or his roubles in the attempt to prove that the need neither exists in Great Britain to-day, nor is likely to be intensified to-morrow.

In the evening, the anniversary dinner of the Society was held in the Town Hall, the principal guest being Viscount Lascelles, who, in his speech welcoming the Society to the West Riding of Yorkshire, mentioned the special degree to which the prosperity of that part of the country is dependent on co-operation between science and industry. The Lord Mayor of Leeds urged the development of a spirit of collective enterprise, in addition to, rather than instead of, that of private enterprise. The Vice-Chancellor of the University said that the theme of the

address was one which was constantly under discussion in that area; it seemed to him that the practical application of science was often more difficult than the fundamental theoretical considerations, and he described chemistry as a blend of patience, poetry, and penetration. Prof. E. Biilmann declared that national feeling is not incompatible with an international spirit in science, which is the quintessence of internationality, while Prof. Max Bodenstein spoke of the common work and the friendship of the workers.

Electrical Conductivity in Strong Magnetic Fields.

P. KAPITZA has contributed to the *Proceedings of the Royal Society*, dated Mar. 6, two important papers on the change of the electrical conductivity of metals in strong magnetic fields. The first paper is experimental and gives the results of experiments on some thirty-five different kinds of metals, all of which were subjected to enormous magnetic stresses.

In ordinary commercial magnetic testing we rarely go to magnetising forces so high as 50 gauss. In Kapitza's experiments the magnetising forces are taken up to 300,000 gauss. In order to get consistent results, it was found necessary to obtain metals of the greatest purity and to make certain that the metals were all in their normal physical state at the commencement of the experiment. Most of the metals were studied at three temperatures: at room temperature, about 17° C. (290° Kelvin); at a temperature of 193° K., when the Dewar flask containing the metal under test was filled with a mixture of solid carbon dioxide and ether; and finally, at a temperature of 88° K., when the flask was filled with liquid nitrogen. Most of the metals were subjected to both transverse and parallel (longitudinal) magnetic fields.

It was found that in all the metals the change of resistance follows the same law, which can be expressed by a formula which gives good agreement with the experimental results. It shows that in weak fields the resistivity of the metals increases in proportion to the square of the magnetic field, but in stronger fields, up to 300 kilogauss, the increase of resistance is in direct proportion to the magnetic field. It is shown that the physical change produced by hardening or annealing the metals has a great effect on the phenomenon of change of resistance in a magnetic field.

The experimental results indicate that the resistance can be considered as made up of two components, an ideal resistance which is a property of the metal, and an additional resistance which is attributed to internal disturbances. The ideal resistivity has a constant value for each metal at a given temperature, but the additional resistance appears to be independent of the temperature.

Kapitza's researches have a direct bearing on the theory of metallic conduction. He has proved that both in a transverse and in a parallel magnetic field the increase in the resistance of the metal conductor due to the field is directly proportional to the first power of the applied field. His pioneering experiments on the resistance of metals in very intense fields bring this out clearly. Modern theories are based on the assumption that the paths of the free electrons are deflected in their motion by the magnetic field. They lead to the conclusion that the effect must follow a square law. As this is not true, the phenomenon cannot be merely due to the obstruction of the paths of the electrons. Kapitza gives a theory which assumes that the change of resistance follows a linear law with the increasing field. This effect is masked in weak fields by disturbances existing in the metal which are equivalent to that produced by an inside magnetic field. He obtains formulæ which agree with the experimental facts and permit the separation of the ideal resistance and the additive resistance which is produced by internal disturbances.

It has been observed by Kamerlingh Onnes and others that close to the absolute zero of temperature there is a 'residual resistance.' This resistance is the 'additive resistance,' which is independent of the temperature.

The other component of the total resistance, which Kapitza calls the ideal resistance, has a constant value for a given temperature in each metal, and is independent of the chemical and physical state of the metal. Mercury, thallium, tin, lead, and indium, which are supra-conductors, were very carefully examined, but no exception to the general law in their change of resistance in magnetic fields was observed. The experiments definitely indicate that the phenomenon of supra-conductivity consists in the disappearance of the additive resistance. The resistance of the conductor is then equal to its ideal resistance. It follows that supra-conductivity is not a phenomenon confined to a few metals, but probably exists in all metals. The temperature, however, has to be reduced sufficiently low to make the additive resistance disappear.

University and Educational Intelligence.

BRISTOL.—One or more research studentships in experimental physics are being offered for the session 1929–30. The emoluments will be from £200 to £300, and the studentships may be renewed for a second or a third year. Further particulars may be obtained from Prof. Tyndall, to whom applications should be sent before May 25.

A studentship in theoretical physics is also offered for the session 1929–30, of the value of from £200 to £300, and the studentship may be renewed for a second or a third year. Further particulars may be obtained from Prof. Lennard-Jones, to whom applications should be sent before May 25.

CAMBRIDGE.—The Amy Mary Preston Read scholarship, of value £150, for research in a scientific subject, has been awarded to H. D. Ursell, scholar of Trinity College. B. H. C. Matthews, Beit Memorial Fellow 1928, has been elected a fellow of King's College.

EDINBURGH.—At a graduation ceremonial on Mar. 21 the degree of doctor of science was conferred on Gwendoline Hilda Faulkner for a thesis on "The Anatomy and the Histology of Bud-Formation in the Serpulid *Filograna implexa*"; on Mr. J. M. Gulland for a thesis on "The Morphine and Aporphine Alkaloids"; and on Mr. T. A. Sprague for a thesis on "Taxonomic Studies in *Loranthus* and other Phanerogamic Genera."

LONDON.—Dr. Paul Dienes, senior lecturer in mathematics at University College, Swansea, has been appointed as from Aug. 1 to the University readership in mathematics tenable at Birkbeck College. Dr. Dienes was educated at the Presbyterian College of Debrecen, Hungary, and the University of Budapest, where he obtained his doctorate in 1905. On graduation he was appointed lecturer in mathematics at Budapest. In 1908 he was given two years' leave of absence to study in Paris and obtained the doctorate of the University

of Paris in 1909. From 1918–19 he acted as adviser to the Commissioner for the re-organisation of the University of Budapest, and in 1919 he organised the Faculty of Science in the new Calvinistic University of Debrecen, Hungary. His publications include "Leçon sur les singularités des fonctions analytiques" (Gauthier-Villars, 1913), "Taylor Series: an Introduction to the Theory of Functions of a Complex Variable" (Oxford Univ. Press, in the press), and numerous papers in French, Hungarian, and Italian scientific journals.

The degree of D.Sc. in anatomy has been conferred on Mr. W. B. Crow (East London College), for a thesis entitled "Contributions to the Principles of Morphology."

An Academic Diploma in Public Health is to be instituted.

OXFORD.—The fifth Annual Report of the Lewis Evans Collection of Scientific Instruments was presented to Congregation on Mar. 19. It contains an interesting note on the original carved panels on either side of the east window of the Old Ashmolean Museum. The carving represents marine shells and exotic fruits, having a direct reference to the use of the Museum for illustrating the natural productions of lands oversea; an object, as Mr. R. T. Gunther, the curator, points out, always uppermost in the minds of the Tradescants and of Elias Ashmole. The report also records a long list of accessions, and speaks with appreciation of the encouragement derived from the inauguration during the year of a "Society of Friends of the Old Ashmolean."

The electors to the professorship of engineering science propose to proceed to the election of a professor in the course of the ensuing Trinity Term. Applications must reach the Registrar not later than April 27.

THERE will be an election to Beit Memorial junior fellowships in medical research in July next. Forms of application and all information can be obtained on request by letter addressed to Sir James K. Fowler, 35 Clarges Street, W.1. The latest date for the return of application forms is June 1.

APPLICATIONS for a Ramsay Memorial Fellowship for Chemical Research, the annual value of which is £250, with the possible addition of not more than £50 for expenses, should reach the Secretary of the Ramsay Memorial Fellowships Trust, University College, Gower Street, W.C.1, by, at latest, June 5.

APPLICATIONS are invited for scholarships for the promotion of research in sanitary science which have been established by the Grocers Company. The annual value of each scholarship is £300, plus an allowance for expenses, and the tenure is for a year, with a possible extension for a further year or two years. Application forms, returnable before the end of April, may be obtained from the Clerk to the Grocers Company, Grocers' Hall, E.C.2.

THE Board of Regents of the University of the Philippines has established a Baker Memorial Professorship in the College of Agriculture. This professorship, which is in memory of Charles Fuller Baker, who was dean of the College of Agriculture from 1917 until his death in July 1927, provides for the services in the College of a man from abroad who shall be in residence and teaching in the College eight months at least, and it is proposed to secure men who are specialists in the different sciences allied to agriculture.

Calendar of Patent Records.

April 1, 1614.—On April 1, 1614, there was granted to William Ellyott and Mathias Meysey an English patent for the first cementation process for converting iron into steel, and steel was successfully produced by the inventors and by Sir Basil Brooke, to whom the patent was transferred in 1618. A second patent containing extended privileges was granted to Ellyott and Meysey, but a clause in it prohibiting the importation of steel created international complications and the patent was revoked.

April 1, 1773.—It is not often that an invention is considered worthy of a public monument within a year or two of its birth. But this happened in the case of David Hartley's invention for securing buildings against fire by means of thin iron plates laid under each floor and in the ceilings, which was patented on April 1, 1773. The invention was adopted in a number of buildings and received extraordinary support from the Corporation of the City of London, which not only attended officially at a full-scale trial of the invention, but erected an obelisk, which still stands, on Wimbledon Common, and made Hartley a freeman of the City. Parliament, too, was not far behind. It voted £2500 to enable the inventor to carry on his experiments, and extended the duration of the patent for thirty-one years from 1777.

April 2, 1712.—The first specification of an invention to be enrolled in the High Court of Chancery pursuant to a definite proviso in the patent grant was enrolled on April 2, 1712, in connexion with John Nasmith's patent, No. 387, for "the preparing and fermenting of wash from sugar molasses and grain." The wording of the grant shows that the insertion of the proviso, which later became a regular requirement of the Crown, was the suggestion of Nasmith himself. (Cf. this Calendar, Feb. 29 and Mar. 13.)

April 3, 1449.—The patent granted by Henry VI. to John of Utynam on April 3, 1449, for the exclusive right of making coloured glass, is the earliest known example of an industrial monopoly patent in England or any other country. John of Utynam came from Flanders at the King's command to make windows for colleges at Eton and Cambridge, and the grant recites that because the said art had never been used in England, and John intends to instruct divers lieges of the King in its practice, no subject of the King is to use it for a term of twenty years, against the will and consent of John, under a penalty of £200.

April 4, 1785.—One of the outstanding inventions of the eighteenth century—the power loom—was patented by the Rev. Edmund Cartwright on April 4, 1785. Neither this nor his other patents brought much reward to the inventor, but he received a special parliamentary grant in 1809 in recognition of his services to industry.

April 5, 1839.—Josiah Marshall Heath's patent, dated April 5, 1839, for the first practical process for the manufacture of manganese steel, gave rise to one of the hardest fought law-suits in the annals of British patent law. During the protracted proceedings the case at one time or another came before no fewer than 18 different judges—of whom 7 decided in favour of the patentee and 10 against—as well as the Privy Council and the House of Lords, and the final verdict of the latter was not delivered until 1855, thirteen years after the commencement of the suit and after the death of Heath himself. The value of the invention to industry was not in question, and the Privy Council recommended the extension of the grant for seven years, but this decision was rendered nugatory and the case brought to a close by the final judgment of the House of Lords against the inventor.

Societies and Academies.

LONDON.

Geological Society, Mar. 6.—**Mrs. M. M. Ogilvie Gordon**: Structure of the Western Dolomites. She described briefly the stratigraphical succession of the Permian and Triassic rocks which mainly compose the mountain lands of the Western Dolomites, and showed their character in a number of photographic slides. Special attention was given to the outbreaks of volcanic action which took place in the Upper Buchenstein and Wengen periods at the close of the Alpine Middle Trias. The leading structural features were described, with the aid of the geological map of the Gröden and Fassa district published by the lecturer in 1927.

Institute of Metals, Mar. 14.—**W. Rosenhain** and **W. E. Prytherch**: An improved form of electric resistance furnace. Higher available working temperatures (up to 1400° C.), durability, and freedom from oxidation of the carbon resistor are claimed. The heating element consists of carbon or graphite pellets, or short rods placed end to end in a refractory sheathing tube which fits easily over them. Heating occurs by contact resistance. The sheathing tube prevents the access of air sufficiently to avoid any appreciable burning of the carbon.—**C. Sykes**: Alloys of zirconium (2). Measurements of electrical and magnetic properties of copper-zirconium, iron-zirconium, and nickel-zirconium alloys show that zirconium gives no material improvement in the properties of the metals, and in certain cases is detrimental. Two further partial series of binary alloys are described—aluminium-zirconium and silver-zirconium. The systems exhibit little solubility in the solid state at room temperatures and intermetallic compounds are formed. In the low-percentage alloys (10 per cent) the compounds crystallise in the form of long, fine needles, and consequently the structure of the alloys is very coarse.—**J. Newton Friend** and **W. E. Thorneycroft**: The resistance of zinc to indentation (a preliminary account). A machine is described for determining the rate of indentation of zinc by a steel conical die acting under small gravity loads.—**J. Newton Friend**: The solution of plain and amalgamated zincs in electric batteries. For use in electric batteries with dilute sulphuric acid or with saturated ammonium chloride solutions, plain high-grade 99·9 per cent zinc cannot satisfactorily replace the amalgamated metal or amalgamated pure zinc.—**J. Newton Friend** and **W. E. Thorneycroft**: The silver contents of specimens of ancient and medieval lead. Twenty specimens of ancient, Roman, and medieval lead have been analysed. Spartan lead votive figurines, c. 700–500 B.C., contain 0·0568 per cent silver, or 18½ oz. silver per ton. The pre-Roman lead does not appear to have undergone any treatment for desilverisation.

CAMBRIDGE.

Philosophical Society, Mar. 11.—**N. F. Mott**: The quantum theory of electronic scattering in helium. Born's calculation of the electron scattering in atomic hydrogen is extended to the case of helium. The results agree well with experiments of Dymond and Watson.—**H. M. Cave**: Note on the number of high velocity β-rays. By a simple magnetic field method, it is shown that, for radium B + C, the number of β-rays having energies greater than 12,000 $H\rho$ must be less than 1 per 500 disintegrations, and is probably less than 1 per 1000 disintegrations.—**J. L. Hamshere**: The mobility distribution and rate of formation of negative ions in air. The Rutherford-Frank-Lattey 'alternating field' method of measuring ionic mobilities in a gas has been modified. Negative ions in dry air have a continuous mobility distribution between the limits 2·15, 1·15, with a peak value about 1·8. At pressures below 50 mm. (Hg) the current is resolved into ions and free electrons. The ratios of the ion and electron currents show that the electron makes in air a mean number of $9{\cdot}4 \times 10^4$ collisions before capture, independent of electron velocity over a range 2 to 7×10^5 cm./sec.

DUBLIN.

Royal Irish Academy, Feb. 25.—**Miss M. C. Knowles**: The lichens of Ireland. In the arrangement of the list, Praeger's topographical divisions are used and the classification and nomenclature of the "Monograph of British Lichens." 801 species are recorded; among them 7 new to science and 5 to the lichen flora of the British Isles.—**Rev. R. J. Doyle** and **H. Ryan**: Periodic precipitation in the presence and absence of colloids. The equation of Jablczynski giving the relation between the distances of bands formed during periodic precipitation in the presence of colloids, and also the equation of Morse and Pierce, hold approximately for the banded precipitation of calcium hydrogen phosphate in the absence of colloids. The presence of the colloid cannot therefore be the main factor in the phenomenon. It was also shown by means of indicators in gels that the diffusing reagent is far in advance of a point at which a band begins to form. The colour changes of the indicators showed clearly that band formation does not occur in the diffusing wave front as some theories of periodic precipitation appear to assume.

PARIS.

Academy of Sciences, Feb. 18.—**L. Lecornu**: The Clapeyron cycle in the case of saturated vapours.—**H. Douvillé**: The Western Pyrenees at the commencement of the Eocene and the formation of the chain.—**V. Grignard** and **Tchéoufaki**: The additive properties of the α-diacetylenic hydrocarbons. Oxidation with weak (1-2 per cent) potassium permanganate solution in acid solution gives a product of hydration and not of oxidation: stronger solutions (5-6 per cent) give oxidation products. The addition of water (sulphuric acid, mercuric chloride) gives always a β-diketone. Shaking with oxygen gives partial hydration.—**T. Nagell**: The rings of algebraic integers.—**A. Khintchine**: A generalisation of some classical formulæ.—**L. Lusternik** and **L. Schnirelmann**: The existence of three geodesics closed on the whole surface of genus 0.—**Th. Anghelutza**: A new class of nuclei for a Fredholm equation.—**Vladimir Bernstein**: The singular points of functions represented by Dirichlet's series.—**Jacob**: The application of Fourier's generalised integrals to the calculus of probabilities.—**N. Neronoff**: A continuous irrotational movement in two dimensions of an indefinite fluid in the presence of a fixed cylindrical obstacle.—**Pierre Dupin**: A new method of measuring the velocity of fluids based on the use of valve oscillators. A description with illustrations of an apparatus showing the velocity of a fluid by a direct reading on a graduated scale. It is based on the modification of the wave-length of an oscillating circuit produced either by a variation of capacity or by a variation of the self-induction of the circuit under the influence of the velocity of the fluid. The condenser readings are a linear function of the velocity.—**Benjamin Jekhowsky**: The corrections of the ephemerids of the minor planets.—**A. Véronnet**: The origin of the planets and the formation of the world.—**Y. Rocard**: Hydrodynamics and the kinetic theory of gases. The wall limiting the fluid absorbs molecules

and sends them out according to a law of distribution of velocities other than that of Maxwell. Near the wall of the vessel the gas or liquid is no longer a fluid and the equations of hydrodynamics are not satisfied. At distances greater than three or four times the mean free path, the ordinary laws of fluids hold.—**Jean J. Trillat**: The orientation of organic compounds by cylindrical glass surfaces and the superficial orientation of the glass.—**Ballay**: The cathode yield in the deposition of nickel with high current densities. The influence of oxidising agents and of the hydrogen ion concentration.—**Pierre Bonnet**: The tectonic structure of southern Transcaucasia.—**Kadlec-Fleck**: The synthesis of cyanamide by combinations of carbon and calcium nitride. Calcium nitride reacts with carbon at a red heat, giving cyanamide and calcium carbide. Between 800° C. and 1100° C. the rapidity of the reaction increases with the temperature. Above 1000° some calcium cyanide is also produced.—**Luigi Umberto de Nardo**: A new method of colorimetric estimation of nitrates in soils and waters. This method is based on the use of pyrogallolsulphonic acid as reagent.—**Aug. Chevalier** and **W. Russell**: The subfamily of Erisma.—**P. Mazé**: The mean temperature of the leaves of maize exposed to sunlight.—**Lucien Daniel**: The heredity of the ligneous transformations in the descendants of grafted Jerusalem artichoke and sunflower.—**Raymond Poisson**: The presence in the south of France of an American Hemipter-homopter of the family of the Membracidæ, *Ceresa bubalus*, and its biology. This insect, which seriously affects certain cultivated plants, was noted in France (Eastern Pyrenees) in 1927, and its possible extension must be watched.—**F. Maignon** and **A. Painvin**: The influence of the seasons on the respiratory combustions of the dog.—**Pierre Marié**: The arthropods inhabiting the burrows of the Alpine marmots.—**E. Aubel**: The relation between the production of lactic acid and the growth of yeast.—**M. Javillier** and **Mlles. S. Rousseau** and **L. Emerique**: The chemical composition of the tissues in A-avitaminosis: phosphorus, lipoid extract, cholesterol.—**Mlle. A. Michaux**: The total albumens (seroalbumen or serine and serumglobulin) of the serum of guinea-pigs suffering from scurvy. The presence of albumen and hæmoglobin in the urine of animals at the end of the disease.—**E. Wollmann** and **Ach. Urbain**: The reaction of fixation in grafted tumours of mice.—**R. Douris**, **Ch. Mondain** and **Mlle. M. Plessis**: The differentiation of normal and pathological sera. The oxidisability of the sera. The diluted sera were oxidised by a chromic-sulphuric acid mixture under comparable conditions. The oxidation coefficient, expressed as oxygen absorbed, was least for cancerous sera, higher for syphilitic sera, and highest for normal sera. The coefficients overlap to an extent which deprives the method of diagnostic value.

SYDNEY.

Royal Society of New South Wales, Dec. 5.—**A. R. Penfold** and **F. R. Morrison**: The chemistry of the exudation from the wood of *Pentaspodon Motleyii*. This tree occurs in New Guinea and is identified as close to *Pentaspodon Motleyii*. The crude oil was non-volatile in steam and could not be distilled without decomposition at 1 mm. It contained 90-95 per cent of a new monocarboxylic acid of molecular formula $C_{24}H_{36}O_4$. The silver and copper salts are the only two derivatives which have so far been prepared.—**A. R. Penfold**: The essential oil from a pinnate leaf *Boronia* from Frazer Island, Queensland. The oil contains 75-80 per cent safrol, limonene, etc. It differs in composition from all other pinnate leaf *Boronias* so far described, and on account of the inability of botanists to separate it from *B. thujona* it is known tentatively as *B. thujona, var. A*.—**M. B. Welch**: Examination of defective oregon. An investigation was made on portion of an electric crane which broke suddenly in Sydney. The wood used was oregon, and mechanical tests showed that the wood was extremely brittle and unable to absorb energy due to sudden shocks. Usually wood is far stronger in tension than in compression, but with the timber in question there was little difference in this respect. It seems possible that, due to continual reversal of the stresses in the member, the wood had become fatigued.—**W. R. Browne**: The probable Tertiary age of certain New South Wales soils. It is agreed that accumulation of residual sedentary soils is favoured by low physiographic relief; consequently, when such deposits are found in regions of high relief, they may be regarded as relics from the latest stages of the cycle of erosion immediately preceding. Some soils occurring around Sydney, on the Blue Mountains, and elsewhere on the highlands, are believed to have been produced during the Tertiary peneplanation; one indication of this is found in the ironstone gravel or hardpan which is so frequent in these soils and must have been formed under physiographic and climatic conditions very different from those prevailing at the present day.—**A. R. Penfold**: The essential oil of a new species of Anemone leaf *Boronia*, rich in ocimene.—**W. R. Browne**: On some aspects of differential erosion. Examples are given from New South Wales illustrating the effect. An explanation is developed of anomalous behaviour of rock-masses in regard to erosion, whereby rocks like granite, really resistant to mechanical wear, are eroded more quickly than less resistant ones. These masses may, during the last phases of the preceding cycle of erosion, have suffered deep and thorough decay, so that on the uplift of the region they succumbed very quickly to river-attack.—**E. Cheel**: Further notes on the genus *Boronia*. Some of the specimens dealt with were collected about eighty years ago by Allan Cunningham and other explorers who considered them to be good species, but several of these were reduced to mere forms or varieties by Bentham. Seven of the earlier names are worthy of rehabilitation to specific rank, and two are proposed as new species.—**W. R. Browne** and **H. P. White**: Alkalisation and other deuteric phenomena in the saddleback trachybasalt at Port Kembla. The changes were produced partly by residual solutions, but mainly by post-volcanic solutions, which have given rise to zones of progressive alteration roughly parallel to the intrusive contact, the greatest changes being in the intrusive rock. These solutions introduced much soda and potash, the former entering into replacive ablite and the latter partly into sericite, but there is chemical evidence that most of the potash is contained in the albite. The term 'alkalisation' is proposed to cover cases of magmatic alteration wherein both alkalis are introduced, or in which either base appears in more than one deuteric mineral.—**G. L. Windred**: Notes on some organisms of tomato pulp. Counts of micro-organisms occurring in commercial tomato pulp revealed the presence of large numbers of various species of moulds, yeasts, and bacteria. An organism causing sliminess of the pulp was isolated; it resembled *Bacillus ruminatus* Gottheil, but there are marked differences. Gas production in sealed metal cans causing the bursting of the containers is due to: (1) production of gas from carbohydrates by the organisms, (2) and the action of the acid produced by them on the metal of the container.—**M. B. Welch**: Notes on some Australian timbers of the Monimiaceæ. The genera described are *Doryphora*, *Atherosperma*, *Daphnandra*, *Mollinedia*, and *Hedycarya*. The vessels show scalariform end per-

forations, and are usually very long. The wood fibres have more or less bordered pits, and reach a maximum length of almost 3·0 mm. in *Doryphora sassafras*. A key is given for the identification of the woods, based on the microscopical characters.—C. Chilton: Note on a fossil shrimp from the Hawkesbury Sandstones.

Official Publications Received.

BRITISH.

Journal of the Manchester Egyptian and Oriental Society. No. 14. Pp. 72. (Manchester: Manchester University Press.) 7*s*. 6*d*. net.

University of Leeds. Twenty-fourth Report, 1927–28. Pp. 164. (Leeds.)

Government of India: Department of Industries and Labour (Public Works Branch.) Triennial Review of Irrigation in India, 1924–27. Pp. ii+58. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1*s*. 9*d*.

Transactions of the Royal Society of Edinburgh. Vol. 56, Part 1, No. 6: A Contribution to Actinian Morphology; The Genera *Phellia* and *Sagartia*. By Dr. T. A. Stephenson. Pp. 121-139+2 plates. 4*s*. Vol. 56, Part 1, No. 7: A Gravitational Survey over the Buried Kelvin Valley at Drumry, near Glasgow. By Dr. W. F. P. McLintock and Dr. J. Phemister. Pp. 141-155+2 plates. 3*s*. 6*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 54, Part 1, January. Pp. 252+lxxxiv+xxiv+94 plates. (London.) 7*s*. 6*d*.

Association of Technical Institutions. Agenda Paper and Report of Council (1928) for the Annual General Meeting to be held on Friday, February 22nd, and Saturday, February 23rd, 1929, at the Grocers' Hall, London, E.C.2. Pp. 46. Draft of Paper to be read at the Annual General Meeting, February 22nd and 23rd, 1929, on "The Relation of Broadcasting to Further Education." By C. A. Siepmann. Pp. 18. Draft of Paper to be read at the Annual General Meeting, February 22nd and 23rd, 1929, on "Technical Training for Women." By Miss Ethel E. Cox. Pp. 10. Draft of Paper to be read at the Annual General Meeting, February 22nd and 23rd, 1929, on "Industrial Safety." By Sir Gerald Bellhouse. Pp. 10. (London.)

Teachers and World Peace: a Memorandum for the Guidance of Teachers who desire to explain the Aims and Work of the League of Nations in Schools. Second edition. Pp. 96. (London: League of Nations Union.) 6*d*.

The Carnegie Trust for the Universities of Scotland. Twenty-seventh Annual Report (for the Year 1927–28) submitted by the Executive Committee to the Trustees on 13th February 1929. Pp. iv+168. (Edinburgh.)

The Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 67, No. 386, February. Pp. 217-316+xxxvi. (London: E. and F. N. Spon, Ltd.). 10*s*. 6*d*.

The South-Eastern Naturalist and Antiquary: being the Thirty-third volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Thirty-third Annual Congress, held at Rochester, 1927. Edited by A. F. Ravenshear. Pp. lxxv+148. (London.)

The Imperial Forestry Institute, University of Oxford. Fourth Annual Report, 1927–28, and Prospectus. Pp. 19. (Oxford.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 38: The Chemical Composition of Wool, with Special Reference to the Protein of Wool-fibre (Keratin). By Hedley R. Marston. Pp. 36. Bulletin No. 39: The Utilization of Sulphur by Animals, with Especial Reference to Wool Production. By Hedley R. Marston and Prof. T. Brailsford Robertson. Pp. 51. (Melbourne: H. J. Green.)

The Engineer Directory and Buyers Guide, 1929. Pp. 256. (London: *The Engineer*.)

Canada. Department of Mines: Geological Survey. Economic Geology Series, No. 5: Oil and Gas in Western Canada. By G. S. Hume. (No. 2138.) Pp. v+152. 25 cents. Summary Report, 1927, Part C. (No. 2171.) Pp. 124C. National Museum of Canada, Bulletin No. 50: Annual Report for 1926. Pp. 126+19 plates. (Ottawa: F. A. Acland.)

Report of the Canadian Arctic Expedition, 1913–18. Vol. 15: Eskimo Language and Technology. Part A: Comparative Vocabulary of the Western Eskimo Dialects. By D. Jenness. (Southern Party, 1913–16.) Pp. 134. (Ottawa: F. A. Acland.)

Agricultural Research Council. Reports on the Work of Research Institutes in Great Britain, 1927–1928. (Council Paper No. 90.) Pp. 128. (London: Ministry of Agriculture and Fisheries.)

Nigeria. Seventh Annual Bulletin of the Agricultural Department, 1st August 1928. Pp. 225. (Lagos: Government Printing Office; London: The Crown Agents for the Colonies.) 5*s*.

Royal Society of Arts, John Street, Adelphi, London, W.C. Fund for the Preservation of Ancient Cottages: First Annual Report presented at a General Meeting held on February 27th, 1929. Pp. 24. (London.)

India: Meteorological Department. Scientific Notes, Vol. 1, No. 1: A Comparison of Upper and Gradient Winds at Agra and Bangalore. By Mohammad Ishaque. Pp. 11+7 plates. 1.3 rupees; 2*s*. Scientific Notes, Vol. 1, No. 2: An Analysis of the Madras Hourly Rainfall Records for the Years 1865 to 1875 and 1901 to 1917. By V. Doraiswamy Iyer. Pp. 13-24 +1 plate. 9 annas; 1*s*. Scientific Notes, Vol. 1, No. 3: Thunderstorms of Calcutta, 1900–1926. By V. V. Sohoni. Pp. 25-36+4 plates. 14 annas; 1*s*. 3*d*. (Calcutta: Government of India Central Publication Branch.)

War Office. Report on the Health of the Army for the Year 1927. (Vol. 63.) Pp. iv+144. (London: H.M. Stationery Office.) 4*s*. 6*d*. net.

The Costing of Chemical Manufacturing Processes. By L. Staniforth. Pp. 24. (London: The Institute of Chemistry.)

Department of Agriculture, Madras. Bulletin No. 91: A Soil Survey of the Malabar District. By B. Viswa Nath and T. S. Ramasubramanyan. Pp. 9+18 maps. (Madras: Government Press.) 1.6 rupees.

The British Chemical Plant Manufacturers' Association. Official Directory of Members, 1929; with a Classified List of their Manufactures and Services. Pp. 119. (London.)

Transactions of the Geological Society of South Africa. Vol. 31, January–December 1928. Pp. 166+24 plates. 42*s*. Proceedings of the Geological Society of South Africa: containing the Minutes of Meetings and the Discussions on Papers read during 1928; to accompany Vol. 31 of the Transactions, January–December 1928. Pp. iii+lvi. (Johannesburg.)

Transactions of the Optical Society. Vol. 30, 1928–29, No. 1. Pp. 48. (London.) 10*s*.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1169 (Ae. 333): The Distribution of Pressure over the Hull and Fins of a Model of the Rigid Airship R.101, and a Determination of the Hinge Moments on the Control Surfaces. By Dr. R. Jones and A. H. Bell. (T. 2305.) Pp. 37+13 plates. 1*s*. 9*d*. net. No. 1184 (Ae. 347): Experiments on a Model of a Single Seater Fighter Aeroplane in connection with Spinning. By H. B. Irving and A. S. Batson. (T. 2611.) Pp. 19+12 plates. 1*s*. net. No. 1187 (Ae. 349): On the Use of a Follow up Mechanism in Aerodynamic Servo Control Systems. By H. M. Garner and K. V. Wright. (T. 2637.) Pp. 8+2 plates. 6*d*. net. (London: H.M. Stationery Office.)

Department of Scientific and Industrial Research. Third Report of the Gas Cylinders Research Committee (Alloy Steel Light Cylinders). Pp. iii+74+13 plates. 2*s*. 6*d*. net. Fourth Report of the Gas Cylinders Research Committee (Cylinders for Liquefiable Gases). Pp. v+151. 4*s*. net. (London: H.M. Stationery Office.)

Memorandum showing the Progress and Development in the Colonial Empire and in the Machinery for dealing with Colonial Questions from November 1924 to November 1928. (Cmd. 3268.) Pp. 81. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

The Journal of the Institute of Metals. Vol. 40. Edited by G. Shaw Scott. Pp. xii+877+38 plates. (London.) 31*s*. 6*d*. net.

Aeronautics. Technical Report of the Aeronautical Research Committee for the Year 1927–1928 (with Appendices). Vol. 1: Aerodynamics (Model and Full Scale). Pp. viii+431+ix-xxiii+182 plates. 15*s*. net. Vol. 2: Stability and Control, Autogiros, Materials, Engines, etc. Pp. viii+433-946+ix-xv+187 plates. 20*s*. net. (London: H.M. Stationery Office.)

Proceedings of the Royal Physical Society for the Promotion of Zoology and other Branches of Natural History, Session 1927–28. Vol. 21, Part 4. Pp. 159-216. (Edinburgh.) 6*s*.; to Fellows, 5*s*.

Department of Agriculture, Tanganyika Territory. Pamphlet No. 2: A Planters' Guide to the Production of Arabian Coffee. By A. E. Haarer. Pp. 31. (Dar-es-Salaam.)

The Daylight Transmission of Wireless Waves over Sea Water. By R. O. Cherry. Pp. 8. (Melbourne: Broadcasting Co. of Australia.)

Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 4, No. 10: The Composite Stellar and Nebular Spectrum of Z Andromedae. By H. H. Plaskett. Pp. ii+119-160. Vol. 4, No. 11: The Orbits of A Persei and H. R. 8210. By W. E. Harper. Pp. 161-168. (Ottawa: F. A. Acland.)

Records of the Indian Museum. Vol. 30, Part 3, October 1928. Pp. 217-373+plates 8-11. 2.12 rupees; 5*s*. Vol. 30, Part 4, December 1928. Pp. 375-468+plates 12-14. 2.12 rupees; 5*s*. (Calcutta: Zoological Survey of India.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1172 (Ae. 336): The Effect of Wind, Weight and Atmospheric Conditions (including Semi-Tropical Conditions) on the Distance to Take-off and Land an Aircraft. By Flight Sergt. B. H. Rolles and H. L. Stevens. (T. 2620: T. 2640 and a.) Pp. 14+7 plates. (London: H.M. Stationery Office.) 9*d*. net.

University College of Wales, Aberystwyth. New Varieties and Strains from the Welsh Plant Breeding Station. No. 1: Pure Lines of Hen Gymro Wheat. Selections made by T. J. Jenkin. (Leaflet Series S, No. 1.) Pp. 16+6 plates. (Aberystwyth.) 1*s*.

University of Bristol: Lewis Fry Memorial Lectures, 1928–29. Science and Drama. Lectures delivered by Prof. C. Lloyd Morgan on November 15th and 16th, 1928, in the Great Hall of the University. Pp. 38. (Bristol.)

Armstrong College, Newcastle-upon-Tyne: Standing Committee for Research. Report for 1927–1928. Pp. 28 (Newcastle-upon-Tyne.)

Proceedings of the Royal Irish Academy. Vol. 38, Section A, Nos. 4, 5: Recombination of Ions in Atmospheric Air. Part 1: Investigation of the Decay Coefficient by Schweidler's Method, by Dr. P. J. Nolan and Cilian O'Brolchain; Part 2: The Law of Recombination of Ions and Nuclei, by Dr. P. J. Nolan. Pp. 40-59. 6*d*. Vol. 38, Section B, No. 9: The Pre-Glacial Topography of the Liffey Basin. By Anthony Farrington. Pp. 148-170+plates 6-7. 1*s*. Vol. 38, Section B, Nos. 10, 11: The Condensation of Aldehydes with Nitro-Diacetoresorcinol, by Dr. Joseph Algar and Nora M. MacDonnell; Dichalkones derived from Diacetoresorcinol, by Dr. Joseph Algar and Patrick J. Hanlon. Pp. 171-178. 6*d*. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

The Textile Institute. List of Members and Lists of Fellows and Associates as at 31st January 1929. Pp. 64. (Manchester.)

Proceedings of the Royal Society. Series A, Vol. 123, No. A791, March 6, 1929. Pp. 372. (London: Harrison and Sons, Ltd.) 12*s*.

Journal of the Royal Statistical Society. New Series, Vol. 92, Part 1. Pp. 162+xii. (London.) 7*s*. 6*d*.

Final Report of the Committee on Industry and Trade. (Cmd. 3282.) Pp. vi+338. (London: H.M. Stationery Office.) 5*s*. 6*d*. net.

FOREIGN.

Report of the Danish Biological Station to the Board of Agriculture. No. 34, 1928. Pp. 125. (Copenhagen: C. A. Reitzel.)

Carnegie Institution of Washington. Year Book No. 27, July 1, 1927, to June 30, 1928; with Administrative Reports through December 14, 1928. Pp. xix+438. (Washington, D.C.: Smithsonian Institution.)

Bulletin of the American Museum of Natural History. Vol. 56, Art. 7: Critical Observations upon Siwalik Mammals. By W. D. Matthew. Pp. 437-560. (New York City.)

Bulletin of the Interior: Bureau of Education. Bulletin, 1928, No. 13: Major Trends of Education in other Countries. By James F. Abel. Pp. 48. (Washington, D.C.: Government Printing Office.) 10 cents.

State of Illinois. Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 17, Art. 5: Some Properties of Oil Emulsions influencing Insecticidal Efficiency. By L. L. English. Pp. 233-259. Bulletin, Vol. 17, Art. 6: Some Causes of Cat-facing in Peaches. By B. A. Porter, S. C. Chandler, R. F. Sazama. Pp. 261-275. Bulletin, Vol. 17, Art. 7: The Biological Survey of a River System—Its Objects, Methods and Results. By Stephen A. Forbes. Pp. 277-284. Bulletin, Vol. 17, Art. 8: The "Knothead" Carp of the Illinois River. By David H. Thompson. Pp. 285-320. Bulletin, Vol. 17, Art. 9: Methods and Principles for Interpreting the Phenology of Crop Pests. By L. R. Tehon. Pp. 321-346. Bulletin, Vol. 17, Art. 10: An Account of Changes in the Earthworm Fauna of Illinois and a Description of one new Species. By Frank Smith. Pp. 347-362. Bulletin, Vol. 17, Art. 11: The Hessian Fly and the Illinois Wheat Crop. By W. P. Flint and W. H. Larrimer. Pp. 363-385. (Urbana, Ill.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 171: Researches on Hypoglycenia producing Substances. 1: Syntheses of certain Guanidine Derivatives. By Taizo Kumagai, Sin-iti Kawai, Yoshio Shikinami and Tatsuo Hosono. Pp. 271-275. 15 sen. No. 173: On the Potentiometric Titration of Gallium. By Sunao Ato. Pp. 5. 15 sen. No. 174: On the Oxidation of Stannous Chloride in Sulphuric Acid Solution by Air, and the Dissolution Velocity of Oxygen into Sulphuric Acid Solution. By Susumu Miyamoto. Pp. 7-17. 20 sen. No. 175: The Residual Thermoelectricity of Mercury Filament. By Toshimasa Tsutsui. Pp. 19-32. 25 sen. (Tōkyō: Iwanami Shoten.)

Bernice P. Bishop Museum. Bulletin 55: Fringing and Fossil Coral Reefs of Oahu. By James B. Pollock. Pp. 56+6 plates. (Honolulu.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 80. The Distribution and Habits of the Birds of the Republic of Haiti, by James Bond; On the Birds of Dominica, St. Lucia, St. Vincent, and Barbados, B.W.I., by James Bond. Pp. 483-545. (Philadelphia, Pa.)

Collection des travaux chimiques de Tchécoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský sous le patronage de la Regia Societas Scientiarum Bohemica. Année 1, No. 2, Février. Pp. 65-136. (Prague.)

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 21: Requirements for High-School Graduation. By Carl A. Jessen. Pp. v+24. 5 cents. Report of the Commissioner of Education for the Year ended June 30, 1928. Pp. iii+42. 5 cents. (Washington, D.C.: Government Printing Office.)

Department of Commerce: U.S. Coast and Geodetic Survey. Special Publication No. 151: Comparison of Old and New Triangulation in California. By William Bowie. Pp. iii+50. (Washington, D.C.: Government Printing Office.) 15 cents.

Supplement 33rd to the Bulletin of Applied Botany, of Genetics and Plant-Breeding. Agricultural Afghanistan. (Composed on the Basis of the Data and Materials of the Expedition of the Institute of Applied Botany to Afghanistan.) By Prof. N. I. Vavilov and D. D. Bukinich. Pp. iii+610+xxxii+28 plates. (Leningrad.) In Russian, with summary in English.

Bulletin of the Pacific Ocean Scientific Fishery Research Station. Vol. 2, Part 1: Physico-chemical Characteristic of Breeding Migration Fast of Keta Salmon. By Prof. B. P. Pentegoff, U. N. Mentoff and E. F. Kurnaeff. Pp. 69. In Russian, with summary in English. Vol. 2, Part 2: Algae maris Japonensis; Chlorophyceae. By E. S. Sinova. Pp. 52. In Russian, with résumé in French. (Vladivostock.)

University of Illinois: Engineering Experiment Station. Bulletin No. 188: Investigation of Warm-Air Furnaces and Heating Systems, Part 3. Conducted by the Engineering Experiment Station, University of Illinois, in cooperation with the National Warm-Air Heating Association. By Prof. Arthur C. Willard, Prof. Alonzo P. Kratz and Prof. Vincent S. Day. Pp. 82. (Urbana, Ill.) 45 cents.

Bulletin of the Peking Society of Natural History. Vol. 2, Part 3: Enumeration of Plants collected by the late Mr. Nathaniel Harrington Cowdry in Chihli Province (and Chefoo); (including Contributions made by Dr. Bernard E. Read, Mr. Joseph Hers, Mrs. A. B. D. Fortuyn and Mr. J. C. Liu to the Herbarium of the Peking Union Medical College). By Liu Ju-Ch'iang. Pp. x+47-194. 2 dollars. Vol. 3, Part 2: A Compendium of Minerals and Stones used in Chinese Medicine from the Pen T'sao Kang Mu, Li Shih Chen, 1597 A.D. Compiled by B. E. Read and C. Pak. Pp. vii+120. 1.50 dollars. (Peking.)

Astronomische Abhandlungen der Hamburger Sternwarte in Bergedorf. Band 4, No. 1: Beitrag zur Geschichte und Theorie der astronomischen Instrumente mit rotierendem Planspiegel und fester Reflexrichtung (Heliostat, Siderostat, Zölostat, Uranostat.) Von Wilhelm Hartmann. Pp. 36. (Bergedorf.)

Report of the Aeronautical Research Institute, Tōkyō Imperial University. No. 46: Hûtô no Kabe ga Mokei no Yôryokû-keisû ni oyobosu Eikyô ni tuite (On the Effect of the Wall of a Wind Tunnel upon the Lift Coefficient of a Model.) By Tatudirô Sasaki. Pp. 149-193. 0.42 yen. No. 47: Directional Observations of the Radio-Atmospheric Disturbances. By Jûichi Obata, Yukio Munetomo and Yahei Yosida. Pp. 195-212+12 plates. 0.60 yen. (Tōkyō: Kôseikai Publishing House.)

Publications du Laboratoire d'Astronomie et de Géodésie de l'Université de Louvain. Vol. 4, 1927. Pp. 258. (Louvain.)

Buletinul Facultății de științe din Cernăuți. Vol. 2, Fasc. 2, 1928. Pp. iv+267-487. (Cernăuai, Roumania.)

Berichte über die Verhandlungen der Sächsischen Akademie der Wissenschaften zu Leipzig: Mathematisch-physische Klasse. Band 80, No. 5. Pp. 273-356. (Leipzig: S. Hirzel.) 3 gold marks.

Abhandlungen der Mathematisch-physiche Klasse der Sächsischen Akademie der Wissenschaften. Band 40, No. 3: Beziehungen zwischen Lichtbrechung, Dichte und chemischer Zusammensetzung in der Granatgruppe. Von H. v. Philipsborn. Pp. iii+43. 2.50 gold marks. Band 40, No. 4: Über jungdiluviale und alluviale Torflager in der Grube Marga bei Senftenberg (Niederlausitz). Von F. Firbas und R. Grahmann. Pp. iii+63+2 Tafeln. 3.60 gold marks. (Leipzig: S. Hirzel.)

Columbia University in the City of New York. Bulletin of Information, 29th Series, No. 18: Professional Courses in Optometry, 1929–1930. Pp. 30+3 plates. (New York City.)

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 22: Bibliography of Research Studies in Education, 1926–1927. Pp. vii+162. (Washington, D.C.: Government Printing Office.) 25 cents.

Ministry of Agriculture, Egypt: Technical and Scientific Service: Bulletin No. 79: The Temperature of Cultivated Soil at Giza. By W. S. Gray and A. A. Nassar. Pp. ii+12+17 plates. 5 P.T. Bulletin No. 80: Sand-Sowing in Cotton-Breeding. By Gadallah Aboulela. Pp. 19. 5 P.T. (Cairo: Government Publications Office.)

Bulletin of the American Museum of Natural History. Vol. 56, Art. 8: Pleistocene Mammalian Fauna of the Seminole Field, Pinellas County, Florida. By George Gaylord Simpson. Pp. 561-599. Vol. 56, Art. 9: A Revision of the Tertiary Multituberculata. By Walter Granger and George Gaylord Simpson. Pp. 601-676. (New York City.)

Department of Commerce: Bureau of Standards. Miscellaneous Publication No. 86: Tables of Spectral Energy Distribution and Luminosity for Use in Computing Light Transmissions and relative Brightnesses from Spectrophotometric Data. By J. F. Skogland. Pp. 23. (Washington, D.C.: Government Printing Office.) 10 cents.

Occasional Papers of the Bingham Oceanographic Collection, Peabody Museum of Natural History, Yale University. No. 2: A Contribution to the Osteology and Classification of the Orders Iniomi and Xenoberyces; with Description of a new Genus and Species of the Family Scopelarchidae from the Western Coast of Mexico; and some Notes on the Visceral Anatomy of Rondeletia. By Albert Eide Parr. Pp. 45. (New Haven, Conn.)

Zentralanstalt für Meteorologie und Geodynamik. Publikation Nr. 132: Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1925, Neue Folge, Band 62. Pp. xx+A42+B54+C42+D11. (Wien.)

Field Museum of Natural History. Zoological Series, Vol. 15, Part 3: The Marine Fishes of Panama. By Seth E. Meek and Samuel F. Hildebrand. (Publication No. 249.) Pp. xxiii-xxxi+709-1045+plates 72-102. Zoological Series, Vol. 12, No. 15: A new Genus of Aquatic Rodents from Abyssinia. By Wilfrid H. Osgood. (Publication No. 250.) Pp. 183-189+plate 15. Zoological Series, Vol. 12, No. 16: Reptiles collected in Salvador for the California Institute of Technology. By Karl P. Schmidt. (Publication No. 251.) Pp. 191-201. Zoological Series, Vol. 12, No. 17: Notes on South American Caimans. By Karl P. Schmidt. Reports on Results of the Captain Marshall Field Expeditions. (Publication No. 252.) Pp. 203-231+plates 16-21. (Chicago.)

Field Museum and the Child: an Outline of the Work carried on by Field Museum of Natural History among School Children of Chicago through the N. W. Harris Public School Extension and the James Nelson and Anna Louise Raymond Public School and Children's Lectures. Pp. 34+8 plates. (Chicago.)

Library of Congress. Report of the Librarian of Congress for the Fiscal Year ending June 30, 1928. Pp. vi+362+4 plates. (Washington, D.C.: Government Printing Office.)

Department of Commerce: Bureau of Standards. Research Paper No. 39: Reflecting Power of Beryllium, Chromium and several other Metals. By W. W. Coblentz and R. Stair. Pp. 343-354. 5 cents. Research Paper No. 43: Least Retinal Illumination by Spectral Light required to evoke the "Blue Arcs of the Retina." By Deane B. Judd. Pp. 441-451. 5 cents. (Washington, D.C.: Government Printing Office.)

Scientific Papers of the Institute of Physical and Chemical Research. No. 176: A Band Absorption Spectrum of Iodine in an Extreme Ultra-Violet Region. By Masamichi Kimura and Michika Miyanishi. Pp. 33-42. 20 sen. Supplement, No. 8: The approximate Content of Gallium in the Green Kaolin from Tanokami: On the Existence of Gallium in the Solar Chromosphere. By Satoyasu Iimori. Pp. 4. 10 sen. (Tōkyō: Iwanami Shoten.)

Diary of Societies.

SATURDAY, MARCH 30.

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (at Museum, Leicester), at 8.—Annual General Meeting.

TUESDAY, APRIL 2.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Hull Photographic Society, Park Street, Hull), at 7.45.—H. E. Copp: The Future of the Gas Industry.

WEDNESDAY, APRIL 3.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. L. H. Lampitt, E. B. Hughes, and H. S. Rooke: Furfural and Diastase in Heated Honey.—J. W. H. Johnson: Further Notes on Methods of Sewage and Water Analysis; Anti-Oxidation, and Stabilisation of Pollution.—B. J. F. Dorrington and Dr. A. M. Ward: Potassium Cyanate as a Reagent for the Detection of Cobalt.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, APRIL 4.

LINNEAN SOCIETY OF LONDON, at 5.—G. M. Graham: The Natural History of the Victoria Nyanza.—Dr. G. P. Bidder: On the Classification of Sponges.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Misuse of Language.

FRIDAY, APRIL 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—E. W. Hill: Some Technical Considerations concerning Power Factor in Relation to Tariffs.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—Technical Film showing the Production of Graham-Paige Cars in America.

SATURDAY, APRIL 6.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Leeds), at 2.30.—Resumed Discussion on the Address by W. J. Hadfield on The Local Government Bill and the Municipal Engineer, with Particular Reference to the Compensation Clauses.