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The Yield of Coal Seams.

An important paper on the yield of coal seams was read by Messrs. Bocking and Bailey before the South Staffordshire and Warwickshire Institute of Mining Engineers in February last, and a separate copy has just reached us. The main object of the paper appears to be to point out that the generally adopted basis of calculation of the yield of coal seams, namely, 1200 tons per foot thickness per acre (or, as it is often put, 100 tons per inch thickness per acre), is too low and that it would be safe to substitute a higher figure. The authors explain that by the thickness of a coal seam they mean not the true thickness as measured between roof and floor at right angles to the seam itself, but the vertical thickness of the coal seam. This method of calculation is of course quite sound and has the advantage that the dip of the coal seam need not enter into the calculation. The generally accepted figure is one that has been used for a very long time ; among the interesting manuscripts in the library of the North of England Institute of Mining and Mechanical Engineers, one of the most interesting is the journal of John Watson, a local mining engineer of considerable reputation and eminence in the latter part of the eighteenth century. This journal contains the following entry under date of July 19, 1746 :

" An Acre of Coal or the Coal that lies under An Acre of Land in a Six foot Seam will Produce 143 Tens of Coal at 22 Waggons to a Ten and 19 Bolls to a Waggon and 36 Gallons to a Boll according to the best computation."

Apparently a 'ten' of coal varied somewhat in weight, but was about 50 tons, so that the above quoted figures come out at about 1200 tons per foot per acre, and apparently mining engineers have been content to use this ancient figure without inquiring too closely whether it applies to present-day conditions or not. There is, however, an important point which has not been brought out either in the above paper or the interesting discussion that followed it, namely, as to what precisely is meant by the yield per acre. The authors and all the speakers who took part in the discussion appear to have taken this phrase to mean the amount of coal got from an acre actually worked out. The other sense, in which the above phrase is more generally employed, is as a basis for the calculation of the amount of coal that may be expected from an estate of a given acreage, underlain by coal seams of a given total vertical thickness, before mining operations have commenced on

the estate in question. In other words, the estimate of 100 tons per inch per acre refers to the amount of coal that can be expected to be produced by an estate of given size, making due allowance for all possible faults, dykes, and 'wants' of any kind due to geological conditions as well as for the coal necessarily left behind in pillars, barriers, etc. It must also be remembered that this estimate apparently originated in the Great Northern Coalfield where bord-and-pillar working is customary and where it is not unusual for 'stooks' of coal to be left behind surrounded by goaf, which are usually too badly crushed to be worth getting. Furthermore, this calculation also makes allowance for the shaft pillars, that is, for the coal left to support the shafts and the buildings and machinery round about the shafts; theoretically, all the coal in these pillars should be won before the colliery is finally abandoned, but it often happens that a good deal of it is too badly crushed to be worth winning when the time for getting it ultimately arrives.

Messrs. Bocking and Bailey point out quite correctly that the real amount of coal contained in a coal seam is of the order of 1500 to 1600 tons per foot per acre, and quote examples to show that such amounts have repeatedly been won by the getting of a definite area of coal. Obviously, this statement, which is undoubtedly perfectly true and is amply proved by the evidence which the authors bring forward, is not necessarily in contradiction with the above-named preliminary estimate, as the latter would only mean that the mining engineer in making his calculation makes an allowance of 20-25 per cent of the total coal that might be present, which he expects either to lose in the course of mining operations or not to find at all owing to the natural causes above indicated. Probably the authors are right in suggesting that such an estimate errs on the side of caution, but most mining engineers will plead that it is well to be on the safe side in drawing up preliminary estimates when there are so many unknown factors, the majority of which will tend to diminish rather than to increase the quantity of coal that a given area will actually yield. It may, however, be fairly conceded that the suggestion that under present-day practice, where the geological features of the coalfields are so much better known than they were, and where modern methods of working restrict far more severely the waste of coal that used to obtain in the past, the percentage allowed is too high and that it might be reduced with advantage.

As to the view that mining engineers working a coal seam should do their utmost to get the maximum possible yield from that seam, no mining engineer will dissent from it, and in fact this may be said to be the invariable practice to-day, only qualified by the consideration that the working of a colliery is an economic proposition, and that as soon as the extraction of the last portions of a coal seam cost more than the coal thus saved is worth, it is sound practice not to attempt to save it, but to stop the operations at the most economic point. It may be urged that such a practice represents a definite loss of national resources, and this is undoubtedly true except from the point of view that coal which costs more to market than it will fetch in the market is a national liability and not a national asset.

A Text-book of Medical Entomology.

Insects, Ticks, Mites, and Venomous Animals of Medical and Veterinary Importance. Part 1: *Medical.* By Prof. Walter Scott Patton and Dr. Alwen M. Evans. Pp. x+785+61 plates. (Liverpool: Department of Entomology, Liverpool School of Tropical Medicine, 1929.) 20*s*.

SOME realisation of the importance which entomology has assumed in the service of modern medicine will be obtained by scanning the pages of this up-to-date book, the joint authors of which have each in their respective fields gained considerable reputations as medical entomologists. This is the first of four volumes which, when all have been published, will cover the field of entomology in its bearing upon human medicine, public health, tropical hygiene, and veterinary medicine. It has been prepared to meet the needs of medical graduates qualifying for the diploma in tropical medicine at Liverpool.

A striking feature is the departure from the idea of a conventional scientific text-book; for the usual chapter subdivisions there has been substituted an arrangement of the subject into twenty-eight lecture-meetings, each of which occupies approximately one hour and is followed by one hour's instruction in the laboratory, where the student examines a series of prepared demonstration specimens illustrating the lecture. The book is really an exposition of a method of teaching which, unfortunately, has entirely missed the viewpoint of the non-Liverpool student, and it will not be an easy matter for the latter to interpret the sketchy, synoptic lecture-notes, that require amplification in the actual lecture. The following example taken

from the synopsis of lecture 6 on p. 276 dealing with the *Aëdes* group of mosquitoes will serve to illustrate the difficulties the average reader encounters:

"Important species.—*Stegomyia fasciata* (*calopus*, *argenteus*, *ægypti*). Distinguishing characters. Bionomics. Domesticity. Feeding habits. Breeding places, typical and atypical. Importance of resistance of egg to desiccation. Duration of early stages. Length of life of ♀. Distribution, *see* map 1. Relation to Disease, *see* notes on Lecture 4. *S. albopicta* (*scutellaris*). Distinguishing characters. Bionomics. Breeding places. Distribution, *see* notes on specimen 200. Relation to Disease, *see* notes on Lecture 20." . . .

Specimen 200 referred to in the quotation is one of 558, which are examined by the student in the course of his laboratory practice of twenty-eight hours. This works out at three minutes per specimen, which seems barely sufficient for the beginning student faced with a mass of new detail and an unfamiliar terminology. As the book has been largely written around these demonstration specimens, the result has been to restrict its usefulness to the Liverpool student.

An analysis of the contents shows that the initial 180 pages are devoted to minute structural anatomy. Here the authors have made extensive use of the technique of double embedding in celloidin and paraffin for the sectioning of densely chitinised structures such as insect mouth-parts, which are not readily cut by the single-embedding method. They have thus been able to demonstrate clearly the exact relations to each other of the intricate piercing parts of many of the smaller blood-sucking species. Strict attention to morphological detail is, indeed, the keynote of the whole work, and the representation of the mouth-parts of a female *Ceratophyllus fasciatus* in Fig. 275, p. 514, reflects the accuracy of the authors' methods in preparing minute objects for microscopic study. On the other hand, the reader will find that the physiological aspects of entomology have been overlooked, and that little consideration is given to the insect as a living organism capable of responding to changes in its ecological conditions. This neglect of physiology is regrettable when one remembers that the whole superstructure of the control of insect pests rests on our knowledge of their habits and behaviour. Nevertheless, it must not be forgotten that it is only by careful anatomical studies that the presence of the larvæ of heteroxenous helminthes in insects can be revealed. Thus a reawakening of interest in the study of internal insect anatomy might lead indirectly to a much-desired extension of our knowledge of this important group of helminthes. Incidentally, there is here an opportunity for valuable co-operation between the entomologist and helminthologist, which up to the present has been largely neglected.

The remainder of the book is devoted to the blood-sucking Nematocera (180 pages), for which the junior author is mainly responsible, Brachycera (104 pages), Cyclorrhapha (178 pages), Siphonaptera (47 pages), Anopleura (60 pages), Acarina (89 pages), and venomous animals (16 pages). The penultimate lecture deals with the dissection of the mosquito and with routine methods of collecting, preserving, and mounting insects (29 pages). General principles of insect control and the specific control of mosquitoes and tsetse flies form the substance of the final lecture (35 pages).

Whatever criticism may be advanced against the book in other directions, very little exception will be taken to the profuse illustrations, which have achieved a high standard of excellence. Anything finer than the wash drawings of Mrs. Patton and Mr. Terzi could not be readily imagined, whilst the line drawings of the junior author, Dr. Evans, are notable because of their meticulously careful workmanship. The photographic reproductions contributed by Miss Brown could scarcely be surpassed, and Plate XXIII., representing the mature larva of *Gasterophilus intestinalis*, is a typical example of the wealth of detail that her technique can produce. In the circumstances, it is unfortunate that the arrangement of the plates in reference to the text should appear to be haphazard. Plate XXIII., for example, is to be found facing p. 278 in the section of the book which deals with mosquitoes, whilst the Gasterophilinæ are discussed on pp. 327, 336-341, and 466-467. Further, it is curious to find that no description of the mature larva of *G. intestinalis* has been furnished, and no reference to the plate is made in the text. Despite the space, too, devoted to the sub-family, the reader is advised in the summary of Lecture 8, p. 341, that "medical officers are not expected to recognise any stage of the Gasterophilinæ".

Attention must be directed to one or two liberties that have been taken with the classification of the Diptera. It is generally recognised that changes have to be made in existing schemes of classification when advancing knowledge has revealed new facts of phylogeny. All such changes must, of course, be supported by sound reasons. Bearing this in mind, the summary elimination by the authors of the section Aschiza of the Cyclorrhapha cannot be

defended merely on the pretext that it is difficult for the teacher to demonstrate the presence or absence of the ptilinal suture " with a pocket lens magnifying 10 diameters ". The question then arises as to the position of the Syrphidæ, a family which is of minor medical importance, because of the occasional recorded occurrence of the rat-tailed maggot in the human intestine. This difficulty has been evaded by the degradation of the family to the rank of a sub-family Syrphinæ, which is then included with others in the family Muscidæ Calypteratæ. Again, the family Œstridæ has been relegated to the scrap-heap and replaced by four new sub-families, Gasterophilinæ, Œstrinæ, Hypodermatinæ, and Cutiterebrinæ, which are added to the Muscidæ Calypteratæ. We are not enlightened as to the authors' reasons for this treatment of the Œstridæ, good as they may be. Finally, the sub-order Pupipara has been rejected and its component genera elevated to sub-families. In the illustrated synoptic table at the end of the book we find one of them, the Hippoboscinæ, included under the Muscidæ Calypteratæ, which has become a rather unwieldy assemblage. It would almost seem as if the authors had fallen into the trap, which they thought to avoid. The making of artificial changes in a natural group is the negation of scientific method, and where taxonomy is concerned a judicious use of the axe is recommended. On the basis of our present knowledge, the Pupipara should be maintained as a separate sub-order. Although its association with the Glossininæ in the Muscidæ may appear to be justifiable on the grounds of similarity of mode of reproduction, the two are sufficiently divergent structurally to warrant their maintenance as separate entities.

It is regrettable that a scientific text-book intended for the use of post-graduate medical students should contain several mis-statements of fact. Among others, we note on p. 109 that the ovarian tubules are wrongly designated ovarian follicles. The larvæ of *Wuchereria bancrofti* (p. 199), *Loa loa* (p. 296), *Habronema muscæ*, and *H. megastoma* in their respective, intermediate, insect-hosts are erroneously referred to as embryos. *Ctenocephalus* (p. 527) is said to have " eight, rarely seven, genal combs ", whereas species of this genus have but a single genal comb composed of seven or eight spines. Typographical errors are fairly numerous both in the text and in the index. In the latter, we note on referring to leeches that the reader is recommended to see Hirudinea, only to find that no mention is made of the Hirudinea in the index !

It has been the worthy ambition of the authors to furnish a reasonably priced book, which would serve the needs of both the beginner and the medical graduate doing research work in the tropics. The beginner, on one hand, is swamped by the mass of detail, whilst the research worker will find the omission of a bibliography a serious defect. By the exercise of a stricter discrimination in the choice of material, the authors could have condensed the book considerably, and thereby enhanced its value. The lack of a definite plan of arrangement makes it difficult for the beginner to get readily a concise, connected account of the various stages and life-history of any particular, medically important species. In place of this single volume combining the systematic and practical parts of the subject, the authors would have made a wider appeal by publishing a more conventional text-book and, separately, a practical laboratory guide.

Statistical Mechanics without Tears.

Introduction to Statistical Mechanics : for Students of Physics and Physical Chemistry. By Prof. James Rice. Pp. x + 333. (London : Constable and Co., Ltd., 1930.) 18*s*. net.

ABSTRACT dynamical theory, classical or quantum-mechanical, deals always in the first instance with comparatively simple systems such as planetary systems or atoms, finding even there complications sufficient to require our utmost skill to unravel. Chemists and physical chemists always, physicists more often than not, and sometimes even astronomers, study large aggregates of such ' simple ' systems and are then interested only in the properties which they exhibit in the mass. It is the province of statistical mechanics to derive from the properties of individual ' molecular ' systems the observable properties of these large aggregates. As such, statistical mechanics is a key subject, of which the principles at least should be familiar to all students of these branches of science. It is therefore all the more distressing that there has never before been available, at least in English, a really good, clear, really elementary book on statistical mechanics. The difficulty of writing such a book for the proper audience is of course obvious.

The subject requires inevitably considerable mathematics, and is apt to develop the more happily the more mathematics is allowed. The problem, then, is to write a book which shall give a real account of statistical mechanics without shirking, but with the minimum of mathematics, and with

every *mathematical* process of more than ordinary difficulty carefully led up to by the discussion of simple examples. For such a book we have had long to wait, but our long wait has been amply rewarded by Prof. Rice, whose book now under review must be recorded both in form and execution to be as nearly as possible all that such a book should be.

A student of physics or chemistry, who has mastered this book but gone no further, should at the least have gained a clear idea of the fundamental connexion between his more usual subject matter and the theories and facts of atomic physics, and of the methods by which this connexion must be further explored. The majority of serious students ought to be able to master it, for it is admirably free from complications of merely mathematical technique. A student who can master it with ease will find it an admirable introduction to more advanced works on statistical mechanics and (generally) the properties of matter in bulk, in which a more educated mathematical outlook is assumed in the reader. The book should be widely read and pass rapidly to a second edition.

In these circumstances, it seems worth while to mention certain minor features which perhaps might be altered, or at least reconsidered, with a view to improving the second edition.

In the first place, it seems a pity to preserve in Chapter ix., presumably for historical reasons, the erroneous account of van der Waals's equation in which the effect of the 'clustering' of the molecules is ignored; that is, the effect of the Boltzmann distribution factor. The account given is, of course, van der Waals's own account, but since it involves an incorrect working out of his own initial hypotheses about the constituent molecules, and since the correct working out is only slightly more complicated, might not the old form now be dropped? The author gives an excellent accurate account of his own in the later part of the chapter.

Secondly, is it not time to jettison also once for all Planck's second quantum theory? It never was much of a theory; always plagued with an internal irreversibility which was really utterly destructive from the first, though of course not at first so appreciated. Planck himself, though he would not readily abandon it, finally admitted himself beaten by the Stern-Gerlach experiment.

Thirdly, some typographical trivialities: It would be pleasant to have the possessive of van der Waals correctly printed, and in numbers of places *o* is wrongly printed for 0. Is there not also some confusion between the work function and the true free energy?

Fourthly, it might perhaps be argued that the specific heats of gases are rather inadequately discussed. One would have liked more details about hydrogen, for example; Why not, in fact, an account of the complete and successful theory of Dennison? And why not a fairly complete account of some other gas at higher temperatures? It is a pity not to discuss the specific heat of the rigid rotator as given by what is now known to be the correct quantum mechanical formula, but to waste time discussing a partition function now of little theoretical interest.

This leads one naturally on to a final more general point. The weak point of the book seems to be an absence of detailed numerical comparisons between theory and experiment. Specific heats and chemical constants are the natural places for such comparisons, but comparisons except in general statements are almost entirely lacking. To include some such comparisons would make the book longer, for there is little if any space to be saved; to prepare them is a most unpleasant task, as the reviewer knows to his cost; but they would be very well worth while.

These are small points, utterly negligible compared with the general excellence of the book, on which the author is to be most heartily congratulated.

R. H. F.

Outlook of Higher Education.

Education at the Crossroads. By Lord Eustace Percy. Pp. iv+104. (London: Evans Bros., Ltd., n.d.) 5*s.* net.

LORD EUSTACE PERCY'S appointment as Minister of Education in the last government no doubt seemed to most people to have no particular significance. The new Minister, however, soon evinced unusual signs of wanting to see things for himself and of both forming opinions of his own and expressing them. This he did in an arresting manner, and with such an unusual avoidance of the customary rotund qualifying phrases of a cabinet-haunted Minister that there was on the part of some much fear, and on the part of others a good deal of hope, that he might end in some first-class indiscretion. Now Lord Eustace has written a book; yet his adversaries (if he still has any) can scarcely rejoice, for if it is coloured by any political cast of thought, the candour, the large-mindedness, and the courage exhibited in the book must surely disarm them.

In about a hundred pages of clear print and in excellent English, Lord Eustace gives us a comprehensive survey of the region of education on which the greatest questions in our national system wait for solution. There are six chapters dealing respectively with the universities and technical colleges; the universities and the schools—recent tendencies; the universities and the schools—a plea for a university policy; technical education; the idea of a local college; and universities and local colleges as partners. In these chapters the difficulties of the present situation are set forth with extraordinary clarity and the measures are indicated which, according to the author's belief, would afford a practicable solution of these difficulties.

The book is so terse (the author modestly terms it an essay), so closely packed with matters of interest, that it is difficult to proceed with a further indication of its contents and character without wholesale quotation. It is perhaps most noteworthy, and also most praiseworthy, in exhibiting the author's full sense of the responsibilities of universities, both old and new, in relation to our whole educational system and national needs. While frankly calling them to account, he shows a complete understanding of their rights and privileges, and he has conceived no idea of imperilling their souls by any measures of regimentation. Lord Eustace addresses himself, evidently with equal first-hand knowledge, to the complex questions surrounding technical colleges, and here again he writes alike with firmness and sympathy of their failings and their future. Particularly noticeable in this connexion is his proposal to bring adult education of the Workers' Educational Association type into organic relation with the institutions now called technical, and so to create a distinct all-round local college.

Incidentally, the author has emphatic comments to make on undue specialisation in school years and on narrowness in all regions of education. He shows a real appreciation of the position of science in our national life—and more sympathy than perhaps would be expected with efforts to make science what men of that calling think it should be.

In concluding this notice the reviewer would like to say that his recommendation of the book is based on the conviction that at the present day there is, and for some time to come there will be, a strong call on men of science, especially those with university responsibility, to give more time to the subject of our national education in its widest aspects. Everyone admits that the times are critical, everyone says that education is of fundamental consequence, but few make any really serious study of it. Uninformed educational talk is one of the more wearying of afflictions, and the *obiter dicta* of emphatic people who say this, that, or the other is the one remedy for all educational ills, are very distressing. It is not said here that Lord Eustace Percy has given us a gospel, but he has with a merciful economy of words stated a most important case.

At the outset he says: "it is a safe rule that an ex-minister should in general refrain from writing books about the department for which he has been responsible". Whilst violating the letter he hopes that he does not violate the spirit. Of this readers will, we are sure, fully acquit him, and be grateful for a temperate discussion of great questions by one who has had and may continue to have a chief responsibility in settling them.

ARTHUR SMITHELLS.

Our Bookshelf.

Dr. H. G. Bronns Klassen und Ordnungen des Tierreichs wissenschaftlich dargestellt in Wort und Bild. Band 5, Abteilung 4, Buch 3: *Tardigrada.* Bearbeitet von Ernst Marcus. Pp. viii + 608. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1929.) 84 gold marks.

THIS monograph is divisible into two almost equal parts; the first on structure, physiology, and ecology, and the second on systematics. A brief statement of the distinguishing characters of the Tardigrada prefaces the first part. The small size of these animals is sufficiently evident from the fact that in only two of the nineteen genera does the length reach 1·2 mm., and the majority of the genera contain forms less than half this length. The author gives in 90 pages careful systematic descriptions, aided by excellent figures, of the external features and internal anatomy, and then proceeds in the next 30 pages to an account of the egg-laying habits and of the development based chiefly on that of the genus *Hypsibius*.

The chapter on the physiology includes many interesting details of the powers which Tardigrades possess of withstanding drying and even repeated drying. According to recent investigations, the Macrobiotes can remain viable in the so-called barrel form, in dry air at 15° C., for six and a half years, but after eight years in this dry state they cannot be revived. In the examples which had been dry for six and a half years movement was first observed about four hours after moisture had been supplied. The account of encystation is also thoroughly adequate. The section on ecology refers among other matters to the adaptations met with in shore-dwelling species and in those living among mosses. A useful account is given of methods of collecting and examining Tardigrades, and is followed by a

short history of our knowledge of the group from the first observation of 'small water-bears' by J. A. E. Goeze in 1773.

The systematic part contains clear descriptions of nineteen genera and subgenera, and of 274 species, 107 of which are regarded as doubtful. The bibliography contains a list of 188 publications, and there is an excellent index. The author, who is a keen investigator of the Tardigrada, has expended much thought and care on the preparation of this monograph, which maintains the high standard of the great series of which it forms a worthy part.

The Immunology of Parasitic Infections. By Prof. William H. Taliaferro. (The Century Biological Series.) Pp. xv + 414. (New York and London: The Century Co., 1929.) 6 dollars.

THIS book, which is dedicated to Theobald Smith, a pioneer in many fields of biological inquiry, is the first of its kind to present to the reader a collation and analysis of practically all the papers of any importance which have been written on the subject of immunity processes in protozoal, helminthic, and other non-bacterial infections. Immunological inquiry in this field has been by no means barren in practical and theoretical results. The demonstration of specific antibodies in the sera of persons suffering from helminth infection, hydatid disease, and schistosomiasis particularly, has greatly assisted diagnosis. So also have the many allergic skin reactions capable of being elicited when extracts of protozoa, helminths, etc., are introduced into the dermis.

Such applications of immunology to practical diagnosis are, however, excelled in interest by the light which these studies are likely to throw on problems of normal resistance and susceptibility to parasitic infections. The antigenic constitution of the protozoal or helminthic unit is now receiving the attention it deserves, and specialists in this field will be grateful to Prof. Taliaferro for his admirable survey of the relevant literature. As well over a thousand papers are cited with their full titles, the work forms a most valuable book of reference. J. C. G. L.

Jahrbuch des Forschungs-Instituts der Allgemeinen Elektricitäts-Gesellschaft. Band 1: 1928–1929. Pp. 240. (Berlin: Julius Springer, 1930.)

THIS volume is the first issued by the Research Institution of the Allgemeine Elektricitäts-Gesellschaft. It contains a wonderful record of research work in both applied and pure science of the highest class. Brief historical introductions are given to the various subjects. The book opens with a section on acoustics. The A.E.G. method of connecting up tone (talkie) films is first described and then the experimental groundwork on which it is based is given. The line diagrams are very clear and the photographs of the apparatus are instructive. The advanced mathematics of the vibrations of membranes are given and very striking examples of nodal figures are drawn.

The section on electrotechnics is very brief. Photographs are given of the A.E.G. relays suitable for long-distance communication. The sections on atom and electron physics record a great deal of valuable research. Corpuscular waves and their application for analysing crystal structures are well described. Instructive data are given about the contact potential between two similar metals. Under electro-optics two useful papers on the polarisation of canal rays are given. The volume finishes up with an article by C. Ramsauer pointing out the importance of technical research laboratories and emphasising the connexion between prosperity and research.

Annals of the Pickett-Thomson Research Laboratory. Vol. 5: *The Pathogenic Streptococci, their Rôle in Human and Animal Disease* (*continued*). Pp. xi + 392 + 46 plates. (London: Baillière, Tindall and Cox; Baltimore, Md.: Williams and Wilkins Co., 1929.) 42*s.* net.

VOL. 5 of the Annals of the Pickett-Thomson Research Laboratory continues the photographic register of streptococcal growths from oral, dental, tonsillar, and puerperal sources. It contains 46 plates of excellent photographs and a letterpress of nearly 400 pages devoted to lengthy excerpts from a curiously unselected mass of literature on streptococci and their many activities. The work fully merits the authors' own estimate of 'gigantic', but it is not science. To the authors a streptococcus is known by the appearance of its colony on a particular medium, and on this basis there is little room left for variation. It is difficult to see why it should be thought worth while to spend money on the production of these expensive volumes. It is of some interest, perhaps, that the first two plates illustrate the alteration in the flora of the gums following the use of a proprietary tooth-paste containing a streptococcal vaccine prepared by the authors.

The Kinetics of Chemical Change in Gaseous Systems. By C. N. Hinshelwood. Second edition. Pp. vi + 266. (Oxford: Clarendon Press; London: Oxford University Press, 1929.) 12*s.* 6*d.* net.

IN order that the progress made in the past three years in the study of the kinetics of chemical change in gaseous systems may be adequately recorded, Mr. Hinshelwood has prepared a second edition of his book. For this purpose the chapters on energy of activation and on unimolecular reactions have been completely rewritten and a chapter on chain reactions has been added. This new chapter contains the interesting suggestion that 'intensive drying' is efficient only in a limited range of chemical actions, which proceed either instantaneously or not at all, and that the trace of water, which makes it possible to propagate these actions, provides centres from which branching chains proceed. A sharp distinction is drawn between changes of this type and reactions which proceed with stable and measurable velocities, and it is contended that observations made with one group of changes cannot logically be extended to the other.

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.*]

Infra-red Spectrum of Diamond by Infra-red Spectrometer and Raman Methods.

FROM the data given by specific heat, melting-point, and photoelectric effect, Einstein, Nernst, and Lindemann have deduced that diamond should have a frequency varying according to the method of calculation from 7·7 to 11μ.

Spectrum obtained by Infra-red Spectrometer.

The infra-red spectrum of diamond has been examined by the spectrometer by Ångström, Julius, and Reinkober, but without obtaining a complete statement of the bands and without any attempt to determine their relationships. Reinkober reported transparency where Julius found absorption. We have also found and are investigating such an abnormal diamond as that of Reinkober. For seven normal diamonds, however, we find a band system in which there are apparently three fundamental frequencies and one combination band. The wave-numbers (cm.$^{-1}$) for these bands have the following approximate values: $\nu_1 = 1246$ cm.$^{-1}$ $= 8{\cdot}02\mu$; $\nu_2 = 2086$ cm.$^{-1}$ $= 4{\cdot}8\mu$; $\nu_3 = 2438$ cm.$^{-1}$ $= 4{\cdot}10\mu$; and $\nu_1 + \nu_2 = 3353$ cm.$^{-1}$ $= 2{\cdot}98\mu$. On inspecting these frequencies, it appeared at first that ν_3 might be a first harmonic of ν_1, but further consideration makes it much more likely to be one of the fundamentals required for the structure of diamond, which as Bragg has shown contains a six-sided ring analogous to the benzene ring. Three directions in this ring starting from a given carbon atom correspond to the ortho, the meta, and the para linkings of the organic chemist.

From the geometry of the puckered hexagonal ring of Bragg the ratios of lengths of these linkings are as follows:

$$1 : 1{\cdot}63 : 1{\cdot}91.$$

It is to be remarked that the ratios of the frequencies given above come out as follows:

$$1 : 1{\cdot}67 : 1{\cdot}96.$$

Spectrum obtained by Raman's method.

We have also subjected diamonds to radiation by the Raman method in which the line λ4358 is selected in the manner suggested by Wood and have examined the spectrum. Here we find a sharp line at λ4629 nearly. The difference in wave-numbers between this and the originating line is 1342 cm.$^{-1}$, which is just inside the farthest out band at 8μ but not in the centre of this wide band. We have also observed two diffuse bands, but these require further investigation.

ROBERT ROBERTSON.
J. J. FOX.

Government Laboratory,
May 1.

Raman Effect in Diamond.

FROM many points of view diamond is a crystal of supreme interest, and it is remarkable that, though more than two years have elapsed since the discovery of the Raman effect, no attempt appears to have been made so far to study the scattering of light in this substance. I have found that quite a small diamond (half carat size) suffices to photograph the Raman spectrum of crystalline carbon. Each of the mercury lines 4046·6 A. and 4358·3 A. excites a single Raman line of remarkable sharpness and intensity (Fig. 1, marked with arrows); the wave-number shifts are 1331 cm.$^{-1}$ and 1333 cm.$^{-1}$ respectively, in pleasing agreement with the wave-number 1333 cm.$^{-1}$ of the *Rest-strahlen* frequency of diamond (Nernst and Lindemann; *Z. Electro-Chemie*, **17**, 822; 1911). The sharpness of the line is to be expected in view of the known perfection of the crystal, according to the ideas of Sir C. V. Raman (Faraday Society's Discussion, Bristol meeting). The brightness of the line is also not surprising in view of the ease with which organic substances generally give the Raman effect. Experiment shows that the line is strongly polarised.

The appearance of the Raman effect in diamond is specially significant in view of the fact that its crystal structure is not a molecular lattice but a continuously linked assemblage of similar atoms. Other cubic crystals with a relatively simple structure, as, for example, sodium chloride, and sodium and lithium fluorides, which have been previously examined, have failed to exhibit any Raman lines. Whether the difference between diamond and rock-salt is due to the difference in their crystal structure, or due to the essential dissimilarity in the nature of the forces holding the atoms together in the lattice (homopolar in one case and electrostatic in the other) is a point which can only be settled by further research. Reference should be made here to a recent interesting note by Clemens Schaefer (*Zeit. für. Physik*, **54**, 153; 1929).

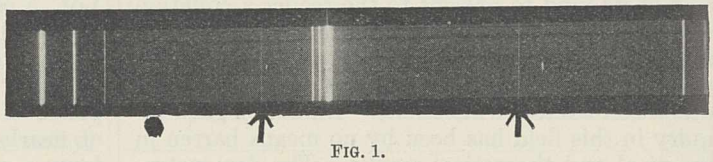

FIG. 1.

Besides the two Raman lines, the spectrum shows also a diffuse band at 4155 A. (marked with a dot), the origin of which is under investigation. [The band is too faint to be visible in the reproduction of the photograph in Fig. 1.—ED. NATURE.]

C. RAMASWAMY.

Physics Department,
The Presidency College,
Madras, India,
April 10.

Photoelectric Recording of Daylight.

IN a letter in NATURE of Mar. 1, 1930, Dr. W. R. G. Atkins and Dr. H. H. Poole describe an apparatus for the photoelectric recording of daylight. A photoelectric daylight recorder has been in existence at the National Physical Laboratory, Teddington, for two years and has been utilised there since April 1929 for almost continuous recording, and a few further remarks upon this subject may therefore be of interest.

In the first place, photoelectric recording of daylight was first described by James E. Ives [1] in 1925 and continuous recording has, it is believed, been taking place under his supervision at the Office of Industrial Hygiene and Sanitation, United States Public Health Service, Washington, since that time. Ives used a thin film barium photoelectric cell—made by T. W. Case—in which a complex surface of barium, oxygen, and an oxide of barium is formed on aluminium. Notwithstanding the fact that the thinness of the film and its complex nature makes these cells

much more sensitive to long wave radiation than those of pure barium in bulk—in probably the same manner as that occurring in the red-sensitive potassium cells described by N. R. Campbell [2] and in the cæsium infra-red sensitive cells referred to by L. R. Koller,[3] it was nevertheless found necessary to cover the aperture of the cell with a brownish-yellow filter in order to compensate for the excessive blue sensitivity as compared with that of the eye. The cell used was a large one, 2 inches in diameter and 5 inches long, with the result that the current was sufficient to be recorded with the aid of a Leeds and Northrup recording potentiometer.

The apparatus at the National Physical Laboratory is concerned with the measurement of visual daylight excluding sunlight, since it is skylight rather than sunlight which is of importance in the natural illumination of buildings. At present, therefore—in order to exclude sunlight all the year round—the illumination has been recorded only from the north octant of the sky, but an apparatus is being constructed whereby that from each of the four octants (N., S., E. and W.)

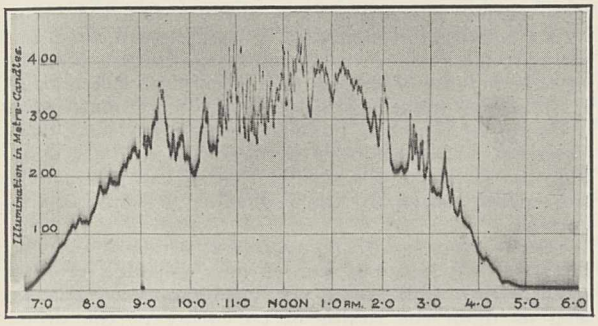

FIG. 1.

will be recorded and which will include an adjustable screen to cut out the strip of the sky which forms the sun's path.

The measurement of illumination from definite areas of the sky involves the use of screens, the size of which governs the size of the aperture of the photoelectric cell; so that the photoelectric cell used is a small one with a window only 1 inch in diameter. The photoelectric current is of course also small and not large enough to operate a thread or pen-and-ink recorder. Photographic recording is therefore employed.

The cell used is a potassium hydride neon-filled cell operated at 60 volts—or less in bright weather—and in consequence of the fact that it is used well below its glow voltage (180 v.) the sensitivity remains remarkably constant. A Wratten K3 filter is used in conjunction with the cell, and throughout the normal range of daylight colours this combination acts as if its colour sensitivity were identical with that of the eye.

The cell is mounted on the flat roof of a high building together with the energising battery, and two long rubber-insulated ignition cables lead to the recorder in a lower room. Having the battery close to the cell enables the two long leads to be both at practically earth potential instead of one being at a potential about 60 v. higher than the other, as would be the case if the battery were housed in the recording room.

The calibration is effected from the visual measurements made with an N.P.L. illuminometer thrice daily (at 9 A.M., noon, and 3 P.M.), and this method is found to be quite satisfactory.

A photograph of a typical record for one day as obtained at the National Physical Laboratory is here reproduced (Fig. 1).

Unless blue, violet, and near ultra-violet daylight are to be recorded and the yellow and red light are to be neglected, the use of sodium cells as used by Atkins and Poole is not satisfactory, for such cells are insufficiently sensitive to red light even when used in combination with a coloured filter to reproduce the colour sensitivity of the eye. The thin film potassium cells of the General Electric Company and the thin film cæsium cells of the British Thomson-Houston Company can both be used in combination with a filter to give a reproduction of the eye with regard to colour sensitivity with sufficient accuracy for daylight recording.

The thread recorder, when it is possible to obtain photoelectric currents large enough to operate it, is to be preferred on grounds of economy to the photographic recorder.

Since biologists are beginning to find it desirable to apply in their work the methods used in photometry and in the solution of illumination problems, it would appear that the time is ripe for some degree of co-operation and collaboration in these two branches of science.

T. H. HARRISON.
National Physical Laboratory,
Teddington.

[1] Ives, James E. *Trans. Ill. Eng. Soc.*, N.Y., **20**, p. 498; 1925.
[2] Campbell, N. R. *Phil. Mag.*, **6**, p. 633; 1928.
[3] Koller, L. R. *J. Opt. Soc. Am.*, **19**, p. 135; 1929.

Effect of Hydrogen and Water on Radiation from Cyanogen-Oxygen Flame.

IT is well known that hydrogen or water has a remarkable effect on the radiation from the carbon monoxide-oxygen flame (Garner and Johnson, *Jour. Chem. Soc.*, 280; 1928; Garner and Roffey, *Jour. Chem. Soc.*, 1123; 1929). When cyanogen is exploded with sufficient oxygen, the reaction is supposed to proceed in two steps, namely,

$$(1)\ C_2N_2 + O_2 \rightarrow 2CO + N_2$$
$$(2)\ 2CO + O_2 \rightarrow 2CO_2$$

(Dixon, *Jour. Chem. Soc.*, 759; 1896). If this is the case, the radiation from (2) should be affected by the presence of hydrogen or water. Dixon, on studying

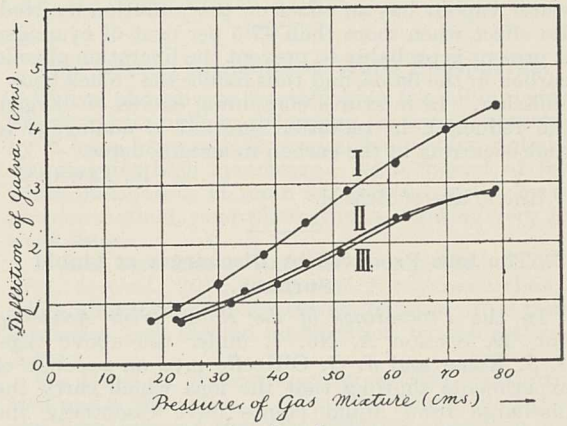

FIG. 1.

the ignition phenomena of these gases, concluded that water has no effect upon the combustion of cyanogen (*Jour. Chem. Soc.*, 384; 1886).

Recently, the total radiation from the explosion of cyanogen-oxygen mixtures was measured in a bomb fitted with a quartz window (cf. Garner and Tawada,

Trans. Far. Soc., 36; 1930), and a distinct difference between the dry and wet (that is, containing hydrogen or water) mixtures was found. Curve I in Fig. 1 shows the radiation from the dry mixture $C_2N_2 + 5O_2$; curve II that from a mixture containing 0·9 cm. pressure of water vapour; and curve III that from a mixture containing 1·3 per cent of hydrogen. It will be noted that hydrogen and water vapour have nearly the same effect, and this effect increases with increasing initial pressure. The reaction velocity also appears to change with the addition of hydrogen

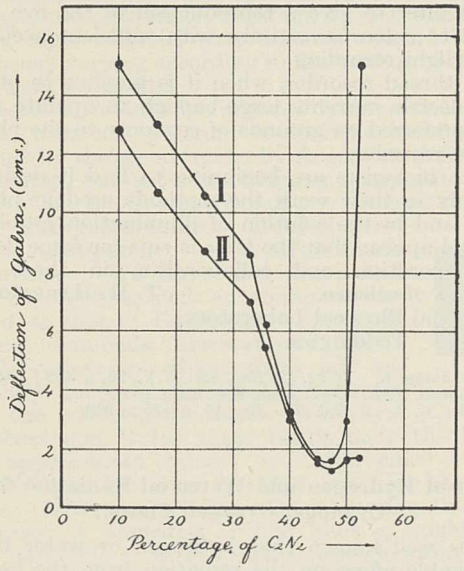

FIG. 2.

and water, since the explosion of the dry mixture is inaudible throughout the pressure range; whereas the explosion of the wet mixtures is distinctly audible at atmospheric pressure and may be heard even at 30 cm. pressure.

Fig. 2 shows the variation of total radiation with different proportions of oxygen, the partial pressure of cyanogen being constant (3·75 cm.). Curve I is for the dry gas, and curve II for the wet mixture (water vapour 0·8 cm.). These curves also show that water vapour has an effect on the radiation emitted. Its effect when more than 47·5 per cent of cyanogen is present is probably to prevent the liberation of solid carbon in the flame, and thus reduce the 'black body' emission. In mixtures containing excess of oxygen, the reduction in radiation emitted is analogous to that occurring in the carbon monoxide flame.

K. TAWADA.

University of Bristol.

The Ions Produced by Discharges at Liquid Surfaces.

IN the *Proceedings of the Royal Irish Academy*, vol. 39, Section A, No. 3, under the above title, J. J. Nolan and J. G. O'Keeffe give an account of experiments showing that the ions which carry the discharge from liquid points have essentially the same mobilities as those present in discharges from metal points. Some statements made by these authors regarding my early work on the same subject seem to imply that it is my contention that the current in such cases is carried altogether by minute droplets of liquid. I do believe this to be true under certain conditions, but not as a general rule; for positive discharges especially can be produced from liquid surfaces without the formation of any droplets, and I have shown in a later paper (*Phys. Rev.*, **16**, p. 102; 1920) than those to which reference was made by the authors named that the main characteristics of discharges from liquid points agree very closely with those obtained with metal points of the same dimensions.

Two widely different conditions may exist under which masses are torn from an electrified liquid surface. Large drops are pulled off by the electric field when nothing is done to counteract the pull of this field upon the surface. On the other hand, if this pull due to the field is neutralised by reduction of pressure inside of a droplet a condition of surface instability (see J. Zeleny: *Proc. Camb. Phil. Soc.*, **18**, p. 71; 1915. *Phys. Rev.*, **10**, p. 1; 1917) may arise during which a very fine thread of liquid is pulled out which breaks up into myriads of exceedingly small charged droplets.

The manner in which this is brought about is as follows. When an electrified hemispherical droplet is accidentally distorted, the place of increased curvature tends to move back to its former position owing to surface tension forces, and in addition it is acted upon by an increased electric pull in the outward direction owing to the surface density of charge being enhanced by this increase of curvature. When the electric field is sufficiently great this latter effect predominates and a thread of liquid is pulled from the surface. The potential at which this surface instability begins depends solely on the square root of the product of the surface tension by the radius of curvature of the surface.

On the other hand, the voltage at which an electric discharge by gaseous ions begins depends on the pressure and nature of the circumambient gas as well as upon the radius of curvature of the drop. For any given gas, therefore, it depends on the relative values of the surface tension and the gas pressure as to whether or not the surface instability will start at a lower voltage than the electric discharge. It so happens that for a small water drop in air at atmospheric pressure the two effects are initiated at approximately the same potential. Owing to the higher dielectric strength of carbonic acid, the surface of a like water droplet in this gas at atmospheric pressure becomes unstable at a much lower voltage than is required for initiating a discharge by gaseous ions; and it was found that the water surface began to lose its charge at a potential which was independent of the gas pressure over a considerable range of pressures.

This behaviour is a characteristic of surface instability and not of a disruptive electric discharge. For ethyl or methyl alcohol in air at atmospheric pressure, because of the much smaller values of their surface tensions, the surface instability also begins at a much lower voltage than does the electrical discharge. It is in such cases alone and only for potentials near that at which surface instability begins that I believe I have proved that the electric transfer is carried solely by liquid droplets.

JOHN ZELENY.

Sloane Physics Laboratory,
Yale University, New Haven, Conn.,
Mar. 28.

Water as an Activator of Luminescence.

IN the course of recent investigations on luminescence, it was noticed that many white salts showed, when wet, a bright blue luminescence under stimulation with a mercury vapour lamp, through a Uviol glass screen which excludes the visible region. On drying the salts completely, the luminescence dis-

appears so that it appears to be due to the presence of water. The phenomenon is very widespread, being noticeable with almost any white salt. It is not confined to those salts which are appreciably soluble in water; silica, for example, showing the effect to a marked degree (this possibly accounts for the blue triboluminescence seen, for example, at the heels of a runner on wet sands at night).

In most cases there is also a phosphorescence lasting for some seconds after the extinction of the exciting light. The spectrum, seen in a small direct vision spectroscope, appears to consist of a broad band with its maximum in the green at about 5500 A. The colour of the luminescence with various salts is always some shade of blue varying from whitish blue to Italian sky blue, suggesting a variation in the spectral distribution in different salts.

This phenomenon had a special interest for me in the light of other work recently carried out on the nature of the luminescent centre. It has now been established by a number of workers in this field that the luminescence of inorganic salts is due to the presence in solid solution of a trace of an activator, for example, bismuth in calcium sulphide. It has been shown by me (preliminary communication to the *Proceedings of the Leeds Phil. Soc.*, January 1929) that the relation between the brightness of luminescence and the atomic or molecular concentration of the activator is quantitatively accounted for by the hypothesis that the luminescence is due to the existence of centres consisting of one molecule or atom of the activator associated in solid solution with a definite number of solute molecules. This leads to the relation $I = A.c.\ e^{-nc}$, where c is the molecular concentration of the activator and n is the number of molecules making up the luminescent centre. Thus the existence of an optimum concentration is accounted for at the concentration $c = 1/n$.

This relation has now been shown to be satisfied for various activators, bismuth, tin, lead, in calcium oxide, and also for uranin in aqueous solution. Thus a determination of the optimum concentration gives the size of the centre.

In the case of the luminescence activated by water, it was again observed that the brightness varied with the amount of water present, passing through an optimum or a number of optima. It therefore appears that this blue luminescence is due to the association of water with the solid salts to form centres of a definite composition.

Preliminary measurements on lithium fluoride show that there exist in this case two optima, corresponding to the existence of centres of the composition $LiF \cdot H_2O$ and $LiF \cdot 2H_2O$. It is hoped that further quantitative work on the luminescence activated by water will throw light on the nature of the association of water with the salts which it activates.

J. EWLES.
Physics Department,
The University,
Leeds.

Do Glass Tubes or Rods Bend under their own Weight?

LORD RAYLEIGH, in his letter published in NATURE of Mar. 1, directs attention to an experiment performed to answer the question, Do glass tubes or rods bend under their own weight? I have tried a similar experiment bearing on this subject, and the results may be of interest to readers of NATURE.

The belief is current that glass tubes and rods of about 1 m. length and 1 cm. diameter, standing on end, will bend permanently under their own weight. To test the idea a 110 cm. length of glass tubing, 1 cm. in diameter and 1 mm. in wall thickness, was supported on horizontal supports 1 m. apart. The tube was loaded at the centre with a weight of 885 gm. This weight was just a little short of the average weight necessary to break a number of tubes of the same diameter and wall thickness, from the same lot of tubing. The percentage composition of the glass used was approximately as follows:—SiO_2, 64; Na_2O, 8·5; K_2O, 5·5; PbO, 22.

Young's modulus for this glass is 6400 ± 100 kgm./mm.^{2} and the tensile strength is $6{\cdot}0 \pm 0{\cdot}5$ kgm./mm.^{2}. This experiment was started in March 1924. The tube selected was originally straight enough to roll on a flat surface. After the lapse of six years there is a permanent deformation (with the bending weight removed) of 9 mm. at the centre of the 110 cm. length.

Lord Rayleigh interprets the data obtained in his experiment as indicating that the permanent deformation (resulting from suspending a weight of 300 gm. at the centre of a metre length of glass rod 4·9 mm. in diameter, for seven years) was too small to measure. In the experiment that I have described a large permanent deformation has been observed, but in this case the glass tube was stressed almost to its breaking point. Both experiments lead to the same conclusion, that glass rods and tubes of mature age do not bend under their own weight.

May I suggest that the common belief that laboratory tubing and cane glass will become permanently bowed if stood on end for a year or more can be explained in the light of the following consideration. Until the introduction of the machine method for drawing tubing, about ten years ago, all tubing was produced by hand shops. Hand-produced tubing in lengths of 1 m. is never perfectly straight—some of it is in fact badly bowed. The individual sticks in a loose bundle of slightly bowed sticks of tubing, stood on end in the corner of a room or in a rack, will assume under the influence of vibrations and the occasional disturbances caused by withdrawing a stick from the bundle, a configuration strongly suggestive of permanent flow under gravitational force. This is especially true if straight sticks enjoy first choice.

C. D. SPENCER.
Glass Technology Laboratory,
Incandescent Lamp Department,
General Electric Company,
Cleveland, Ohio,
Mar. 27.

The Crystal Structure of White Phosphorus.

WHITE phosphorus crystallises in the cubic system. Previous attempts to determine its crystal structure by X-rays have not given positive results, notwithstanding its high symmetry. As a matter of fact, white phosphorus at room temperature gives, by the powder method, poor photographs, showing very few weak lines.

It has been also stated (H. Joung, *Centralblatt f. Min. u. Geol.*, 107; 1926) that X-ray researches on white phosphorus are impossible because of its transformation into the red modification by the action of X-rays.

We failed to observe any appreciable transformation under the action of X-rays of long wave-length, and have inferred that the difficulty of getting good photographs could be ascribed only to the imperfection of the crystals and to the remarkable thermal agitation of the atoms at a temperature approaching the melting point, similar to the behaviour of certain alkali metals, which give sharp interference lines only at temperatures much below their melting point.

We experimented by dipping a glass capillary,

internally filled with liquid ammonia, in molten phosphorus and lifting it so as to have it coated with a thin layer of crystallised white phosphorus. The capillary was then fixed in the axis of a Debye camera. The temperature may be estimated at − 35° C.

The photograph obtained with the *K* radiations of an iron anticathode shows 22 lines, which can all be arranged in the cubic system for a lattice constant of the elementary cell of 7·17 A. Supposing the cell as containing 4 molecules P_4, the calculated density is 2·23, slightly greater than the data found in the literature at room temperature (values between 1·82 and 2·0).

The details of measurements and a discussion of the structure will be published elsewhere.

Several authors have deduced from cooling curves that at lower temperatures (less than *c.* − 70° C.) another modification is formed, the form of which is still uncertain, since one of the authors describes it as hexagonal, and others as trimetric or monoclinic (P. W. Bridgmann: *Jour. Am. Chem. Soc.*, **36**, 1344; 1914. D. Vorländer, W. Selke, and S. Kreiss, *Berichte*, **58** B, 1802; 1925).

We repeated our observations, filling the capillary with liquid air. The photograph obtained in such a way (at *c.* − 170° C.) shows a large number of lines which cannot be arranged in the cubic system.

The dimorphism of white phosphorus is thus confirmed. We cannot yet, on account of the complexity of the photographs, decide upon the symmetry of β-phosphorus, but we incline to the opinion that it belongs to a system of rather low symmetry; at any rate we may conclude that it has a rather complex elementary cell. Investigations are still in progress.

G. NATTA.
L. PASSERINI.

Laboratory of General Chemistry,
Royal Polytechnic, Milan,
Italy, April 4.

A Diamagnetic Simple Salt of Nickel.

ACCORDING to the accepted views on atomic structure, the atoms of nickel, palladium, and platinum should, in the fundamental state, show the same outer electronic structure, namely, s^2d^8, where *s* denotes an electron with $l=0$ and *d* an electron with $l=2$. Spectroscopic evidence seems to indicate that, in the case of palladium, the electronic distribution corresponding to the fundamental state is d^{10}. The magnetic properties of the compounds of these elements show great dissimilarity; for example, while $NiCl_2$ is paramagnetic and has a magnetic moment of about 14-16 Weiss magnetons, both $PdCl_2$ and $PtCl_2$ are diamagnetic (Bose and Bhar, *Zeit. f. Physik*, Vol. 48, p. 716). This difference was explained by these authors on the assumption that in $NiCl_2$ the two outer *s* electrons of the nickel atom are transferred to the two Cl atoms giving rise to a polar molecule, while in the other two compounds the two chlorine atoms are in covalent bond with the two uncoupled *d* electrons in the atoms respectively of palladium, or of platinum, thus neutralising the magnetic moments of these atoms. It has, however, been found that both K_2PtCl_4 and $K_2Ni(CN)_4$ are diamagnetic.

The magnetic similarity of these double salts of platinum and nickel made it worth while to investigate the properties of $Ni(CN)_2$. Mr. Sushovan Dutt, working in this laboratory, has made the interesting discovery that while $Ni(CN)_2,7H_2O$ is paramagnetic, and has a moment of the same order as the other divalent simple salts of nickel, this compound shows a progressive diminution of paramagnetism with dehydration, and it has been possible to obtain a salt with magnetic moment less than 2·5 Weiss magnetons. The salt is very hygroscopic, and in the process of transference from the desiccator to the sealed ampoule, into which it is introduced for magnetic measurements, it shows a perceptible change of colour. There seems to be no reason to doubt that on complete dehydration the compound would be found to be diamagnetic.

The observed facts can be accounted for on the assumption that, in the hydrated salt, one of the *s* electrons of nickel is transferred to each of the (CN) groups, giving rise to polar bonds, while in the dehydrated state the two (CN) groups are attached by covalent bonds to the two uncoupled *d* electrons of nickel. This is an interesting illustration of how the nature of the valency bond in a compound depends on its state of hydration, and of the suitability of the magnetic method for testing such bonds in compounds of paramagnetic elements. I am not aware of similar observations having been made before. Further investigations are proceeding.

D. M. BOSE.

University College of Science,
Calcutta, Mar. 28.

The Problem of Stellar Luminosity.

THOUGH I have the very greatest respect for anything written by my friend and teacher Prof. Eddington, I cannot see that in his letter in NATURE of Mar. 29 he meets my arguments.

Prof. Eddington quotes a sentence of mine beginning "Similar considerations show . . ." and says that I leave this assertion unsupported. The considerations in question, which are of a simple physical character, are to be found in the two paragraphs immediately following the sentence quoted. These considerations have nothing to do with evolution or secular changes occurring in Nature. Prof. Eddington has not discussed these arguments, though they are at the very basis of my line of thought.

My earlier paper in *Monthly Notices R.A.S.* (**87**, 708; 1927), discusses a density-distribution in which the sinks of energy in the outer layers of the star exactly balance the source of energy in the inner portions, so that the luminosity of this density-distribution is zero.

The 'Humpty-Dumpty' argument shows that the uranium model possesses a stable configuration, which is all that I require. But my 'cooling' argument goes considerably further than this.

The problem discussed by Prof. Eddington in brief is: given the mass *M* and the relative source-distribution, to find the luminosity *L* in the steady state. The problem I discuss (suggested by the uranium model) is: given the mass *M* and the rate of generation *L*, to find the source-distribution in the steady state. I do this by considering a range of density-distributions, choosing those compatible with the arbitrarily assigned *L* and *M* and deducing the source distribution afterwards. The conditions that the outer layers shall simultaneously enclose mass *M* and radiate to space at the rate *L* impose a restriction on the possible density distributions, the restriction depending on the surface opacity. In this problem *L* is a *datum*; it depends neither on mass, radius, nor opacity. The actual stars must be a subclass of the stars thus constructed. The *observed* mass-luminosity correlation must depend on the intrinsic nature of the energy-generating process; it is not accessible merely from steady-state considerations.

E. A. MILNE.

Wadham College, Oxford,
April 30.

New Bands in the Molecular Spectrum of Hydrogen.

IN the molecular spectrum of hydrogen, 3667 lines have been measured by Finkelnburg between λ4861 and λ3314, and Gale, Monk, and Lee have given a list of 3064 lines measured by them between λ3394 and λ8902. Of course, many of the lines in the two lists are common. There are several hundreds of lines in the extreme ultra-violet, first discovered by Lyman and later by Werner and Weizel. Of this multitude of lines, only about a thousand have been classified by Richardson and his co-workers, by Finkelnburg and Mecke, by Weizel, Hori, Dieke, and others. Thus we still have to account for more than 75 per cent of the lines.

Recently Richardson has given an account of all the levels which have so far been observed and also their interpretation according to Hund's theory of axial quantisation. It appears that to account for such a large number of unclassified lines, some of the selection principles must be sacrificed, and the one that naturally suggests itself is that for the azimuthal quantum K, namely, that $\Delta K = \pm 1$. It is well known that this principle is violated even in the case of atomic spectra when a large electrostatic field is present, for example, in Koch's experiment on the production of $1P$-mP lines of helium, and in the recent work of Nils Ryde (*Zeits. f. Physik*, **59**, 836), in the production of forbidden lines corresponding to $\Delta K = \pm 2$, 0, in the spectrum of neon. Since in molecule formation we have a very large electrostatic field coming into play, it may reasonably be expected that this principle will be completely violated.

Working on this idea, I have been able to identify a number of bands due to otherwise forbidden transitions; for example, between the B-level of Dieke and the a-level of Richardson $[2p'\Sigma \leftarrow\!- 2p\pi_{a,\,b}]$ in Richardson's recent notation. P, Q as well as R branches have been obtained for vibration frequencies $n = 0, 1, 2 \ldots$ and $n' = 0, 1, 2 \ldots$ The lines are mostly very weak. It appears that a large number of lines otherwise not accounted for may be due to a similar cause.

DATTATRAYA SHRIDHAR JOG.
Physical Laboratory,
University of Allahabad, India,
Mar. 8.

Relation of Fluidity of Liquids to Temperature.

IN reference to the editorial comment in NATURE of Mar. 29, may I say that my letter of Feb. 3 on the subject was communicated at the same time to the *Journal of Rheology* and appeared in its January issue in this country. As you have stated, I was unaware that Prof. Andrade was working on the subject. His formula $\eta = Ae^{k/T}$, where η = viscosity, is obviously identical with the one which I proposed,

$$\log \phi = -\frac{k}{T} + A,$$

where $\phi = 1/\eta$, the fluidity. As pointed out in my note of Feb. 15, also published in NATURE of Mar. 30, both of us were actually anticipated by Señor de Guzman and Prof. C. Drucker. It is curious that such a considerable lapse occurred in the recognition of what certainly appears to be the most satisfactory formula relating viscosity or fluidity of liquids to temperature. I was led to it myself by the work of Stewart, Katz, Prins, and others on the X-ray diagrams of liquids. The existence of 'partial regional orientation' of the molecules in liquids suggests a partition into non-oriented and oriented species, the latter being regarded as slightly deformed. Applying the Maxwell-Bolzmann equation, in the form

$$\frac{N-n}{N} = e^{-k/T},$$

where N = total number of molecules per unit space,
n = number of oriented molecules,
and assuming that the fluidity is proportional to $\frac{N-n}{N}$,
then $\phi = Ae^{-k/T}$,
where A and k are constants.

This derivation does not cover the actual mechanism of momentum transfer in liquids, and Prof. Andrade's theoretical treatment of the subject will be read with great interest.

S. E. SHEPPARD.
Research Laboratory,
Eastman Kodak Company,
Rochester, N.Y., April 14.

The Exit Gas from an Ammonia Discharge Tube.

WHEN ammonia is passed through a discharge tube, under the same conditions as used to prepare atomic hydrogen, an active gas is obtained. This active gas is reducing in character as shown by the reduction of cupric oxide and of a zinc oxide–chromium oxide catalyst. Small solid particles are heated to incandescence; a phenomenon often observed with atomic hydrogen. The solid ammonia condensed in the liquid air trap (1·5 m. from the discharge tube) gave an intense blue-green glow when the active gas passed over it.

If a substance like the zinc catalyst (which is known to remove atomic hydrogen) is placed in the gas stream, the glow in the trap is not affected. This must mean that the glow is not caused by atomic hydrogen, and suggests that there must be at least one other active product present.

Since the ammonia is broken up into hydrogen and nitrogen, there is a possibility that the exciting agent might be active nitrogen. However, if ammonia is allowed to condense in the trap and active nitrogen passed over the solid, the glow is not obtained. Ammonia, when passed into the stream of active nitrogen, extinguished the yellow afterglow and caused the reappearance of the green glow in the trap.

These experiments seem to indicate the presence of atomic hydrogen along with a nitrogen-hydrogen compound, probably NH or NH_2, in the exit gas from the ammonia discharge tube. We are continuing the work in an attempt to correlate the above with the ammonia synthesis and decomposition.

G. I. LAVIN.
J. R. BATES.
Frick Chemical Laboratory,
Princeton University,
Princeton, N.J., April 3.

Light in Four Dimensional Space.

WILL you kindly allow me to make a correction to my letter in NATURE of Feb. 8.

As dt is generally defined as the time co-ordinate *after* correction for the ordinary velocity of light over the distance dx the equations are true for all cases, and it is therefore unnecessary to assume the velocity of light infinite even in flat space. This and the fact that it becomes definitely a unit vector and loses the invariant character it possessed in the orthodox theory dispose of the suggestion that it might be a measure of the curvature of space. Restated, the assumption made is that at any point of space the angle between a ray of light and the world-line of its source is a constant.

J. HALCRO JOHNSTON.
Orphir House, Orkney, Mar. 26.

Jean Baptiste Joseph Fourier, 1768–1830.

WHILE the English school of physicists at the beginning of the nineteenth century was more concerned with experimental inquiries, the French physicists were rapidly extending mathematical analysis to many important physical problems. In this direction none achieved greater success than Jean Baptiste Joseph Fourier, whose "Théorie analytique de la chaleur" has long been a classic of science, and the centenary of whose death falls on May 16 of this year.

Laplace, we are told, was the son of a farm labourer; Poisson the son of a private soldier. Fourier also came from humble surroundings, his father being a tailor of Auxerre, where Fourier was born on Mar. 21, 1768. Yet Auxerre to-day claims Fourier as its most distinguished son and his statue stands in its midst. With poverty came misfortune, for Fourier was left an orphan while still a child, and the world owes something to the organist of Auxerre Cathedral, who proved a real friend to him. Next to the organist came the Bishop, through whom the boy was sent to the military school at Auxerre kept by the Benedictines of the congregation of Saint-Maur, and to the same school he returned as a teacher of mathematics after a short period of service as a novice of the abbey of Saint-Benoît-sur-Loire.

As a boy, easily at the head of his class, from his youth Fourier proved a leader of men, and the Revolution found in him an ardent but prudent Republican. From that time onwards he was a man of mark, and whether as a professor in the newly founded École Polytechnique; whether as the companion of Napoleon during the Expedition to Egypt; whether as the orator chosen to give expression to the national grief at the death of Kleber and Desaix; whether as the energetic and practical prefect of the department of Isère or as the perpetual secretary of the Paris Academy of Sciences, he fully justified the good opinion of his early benefactors. Four years were spent in the École Polytechnique; three years in Egypt; thirteen years in Grenoble as prefect of Isère; and fourteen years in Paris.

Fourier's mathematical studies began in the school at Auxerre, where he was wont to steal down to the class-room in the dead of night and pore over his books by the aid of candle ends secretly hoarded, and they were never again laid aside. Even when an administrator in Egypt, busily engaged with munition work for the army, or investigating the antiquities on the banks of the Nile, he found time to publish mathematical memoirs; while his great work on the theory of heat was written at Grenoble in 1812. The essay was written for a prize offered by the Academy of Sciences; it was applauded by Laplace, Lagrange, and Legendre, yet allowed to lie unpublished until 1822. His famous memoir has been described as a masterpiece of analysis, classing Fourier among the greatest mathematicians that ever lived. So early as 1835, Comte predicted that Fourier's analytical researches would be found of great use in other branches of physics, and this has proved to be true. Ohm was indebted to Fourier when searching for the law of conductivity of electricity; Kelvin used Fourier's mathematics when engaged with the Atlantic telegraph cable, and among Heaviside's papers was found a bill for a piece of music, with notes on his investigation of Fourier's work.

It was in 1816 that Fourier was first nominated for a seat in the Paris Academy of Sciences, but his election was not approved by Louis XVIII. Next year, however, the king reversed his decision, and five years later Fourier was chosen to succeed Delambre as perpetual secretary, his colleague being Cuvier. In this situation it fell to Fourier to pronounce the *éloges* on Delambre, Charles, and Herschel, for which he was given a chair in the French Academy. Widely respected, he died on May 16, 1830, and was buried in the Père La Chaise Cemetery, where lie the remains of so many of the most eminent men of science of France. His tomb is near that of Monge and also that of the Egyptologist Jean Champollion, whose youthful imagination had been stimulated by his conversations with Fourier at Grenoble.

Report of the Departmental Committee on Ethyl Petrol.

THE Departmental Committee on Ethyl Petrol, the final report of which has recently been issued (H.M. Stationery Office, 1*s*. net), was appointed some two years ago, with Sir F. J. Willis as chairman, after anxiety had been expressed in Parliament and the public Press that the widespread use of motor spirit containing lead tetraethyl might form a possible source of danger to health. In the manufacture of this substance itself in the United States of America a number of deaths had occurred, and some fear was felt in Great Britain that the use of ethyl petrol, which contains approximately one part of lead tetraethyl in 650 parts of petrol, by weight, might be dangerous to the health of its users and of the public, notwithstanding that a committee appointed by the Government of the United States reported in 1926 that there were no good grounds for prohibiting the use of ethyl petrol of this composition as a motor fuel, provided that its distribution and use were controlled by proper regulations.

In July 1928 the Committee presided over by Sir Frederick Willis issued an Interim Report (H.M.S.O., 4*d*. net) after considering the experimental work carried out by the United States Government Committee and by the Ethyl Gasoline Corporation, and after hearing evidence from a number of distinguished witnesses. In this Interim Report the Committee expressed the opinion that the findings of the United States Government Committee were justified. But some of the results of the investigations carried out in

the United States, for example, the almost universal presence of lead in the urine of persons not exposed to lead risks, did not find complete acceptance in scientific circles even in the United States, and the Committee felt that these results might not prove to be true under the conditions of life in Great Britain; consequently, the Committee then reported that while it was superfluous to embark upon such an extensive investigation as had been carried out in the United States, yet it was desirable to confirm certain aspects in that work and elucidate others not covered by it. Moreover, witnesses in evidence before the Committee had directed attention to possible dangers arising from the use of ethyl petrol, and the Committee drew up its programme of work with due regard to these features. Possible dangers suggested by witnesses were injuries to health from the inhalation of lead tetra-ethyl due to spillage, from the absorption of this substance through the skin, from the inhalation of lead dust in streets and in garages, and from the pollution of water supplies by soluble lead salts.

In order to carry out its programme of investigations, the Committee acquired the services of three members of the staff of the Government Chemist, with Mr. A. G. Francis as director of the research; for physiological work Prof. W. E. Dixon of Cambridge gave his services, while the War Office staff at Porton co-operated in carrying out the field experiments. The following is a brief account of the principal sections of that programme.

In the first place, the need was felt for a revision of methods in use for determining lead in traces accurately, and the method devised, which has definite advantages as regards this feature and also in saving of time, need not be described in detail, as it is published not only in the Report but also in the *Analyst* (p. 725, 1929).

It was confirmed that lead is being almost uniformly excreted in the urine of subjects not exposed to lead risks, the average of 55 persons in London being 0·04 mgm. lead (Pb) in a litre, a lower but still significant value being obtained from those living in country districts, while, in comparison, for 33 workers in an accumulator factory the average was 0·28 mgm. in a litre. In the last set of observations the quantity excreted was found by Dr. R. E. Lane to run in line with the apparent risk of exposure and to agree with deductions from the appearance of the blood.

Examination of fine settled dust in London and the surrounding country showed that it invariably contains lead in small quantities; residents in London are thus subjected to small daily doses of lead of approximately one-tenth of a milligram, and this daily inhalation of lead is doubtless one of the causes, if not the main cause, of the almost universal excretion of lead in the urine of persons not exposed to a definite lead risk. How far persons absorb lead from other sources seems to be a matter that would repay further investigation. A systematic examination for lead in water supplies and food stuffs, particularly canned foods and beverages or condiments sold in vessels closed with metallic capsules, would probably show further cause for the presence of lead in the human system. Very small quantities of lead taken in articles of food or drink are less objectionable than similar quantities of lead inspired into the lungs, because most of the lead taken into the alimentary canal is not absorbed but voided, whereas a greater absorption of lead takes place in the lungs.

As fears had been expressed before the Committee that pedestrians, and particularly drivers and traffic policemen, might suffer in health by breathing finely divided lead compounds derived from burning lead tetra-ethyl in an engine, a very severe traffic block was simulated in a tunnel at Porton, 12 cars using ethyl petrol being employed, when the air at breathing level was examined for its content of lead. At the same establishment experiments on several observers confirmed the value found in the U.S.A. for the fraction of inhaled lead dust that is retained by the lungs (16 per cent under resting and 32 per cent under active conditions). From these two sets of observations it was possible to arrive at the value of 0·2 mgm. of lead as a maximum absorption for a person exposed in close proximity to the rear of ten severe traffic blocks per hour during a 12 hours windless day. As the accepted figure is 2 mgm. per day for inhalation of lead to avoid chronic plumbism in the course of years, it is concluded that the risk from this cause either to traffic controllers or to pedestrians is negligible.

Some witnesses having attributed risks to garage workers and to water supplies from lead-containing deposits obtained in dismantling engines running on ethyl petrol, these substances were examined, but were found to be coherent in virtue of their oiliness, and not dusty. With due regard, therefore, to ordinary cleanliness, it was not considered that a risk to garage workers is involved from these deposits either by inhalation or through the alimentary canal, nor on account of their insolubility was there any chance of contaminating water supplies.

Although numerous experiments in the U.S.A. had failed to show any ill-effects of ethyl petrol when applied to either human skin or the skin of monkeys and other animals over long periods, the Committee resolved to follow up an observation made by Sir Robert Robertson in the Interim Report that while on evaporating isothermally ethyl petrol the first half contains no lead tetra-ethyl, and a proportion distils off with the petrol in the succeeding fractions, yet the lead tetra-ethyl is to some extent concentrated in the final portion. As such a liquid as the last applied by Prof. Dixon to the shaved skin of rabbits for 130 days gave no untoward effects, it is unlikely, keeping also in view the above mentioned experience abroad, that even garage workers whose skin is most prone to come into contact with used lubricating oil and with ethyl petrol can be regarded as being subjected to any danger.

Spillage of petrol in garages formed the next series of investigations. From what has been said, no ethyl petrol may be expected in the air of

garages until the ethyl petrol has been reduced to half its volume, but later, as it evaporates, it will be found in increasing quantities. The extent of the concentration of lead found in the air depends on many factors, but, in practice, the four following have importance: (1) the nature of the petrol with which the ethyl fluid has been mixed, (2) the quantity of ethyl petrol spilled and the frequency of spillage, (3) the surface on which the ethyl petrol is spilled, and (4) the ventilation of the garage.

To determine the magnitude of the concentrations of lead tetra-ethyl likely to be found, in practice, in the air of garages when ethyl petrol is spilled, conditions were chosen to represent the spillage of a single large quantity and the repeated spillage of small quantities of ethyl petrol in closed and open garages having floors made of four different materials, namely, asphalt, concrete, wood, and glazed tiles or bricks. It was found that the concentration of lead tetra-ethyl in the air was greatest when evaporation took place from a glazed surface and was least from asphalt. Both concrete and asphalt retained lead tetra-ethyl within their surfaces, thereby reducing proportionately the concentration of lead tetra-ethyl in the air. Increasing ventilation reduced both the concentration of lead tetra-ethyl in the air and the time during which lead tetra-ethyl was found in the air. If a large quantity of ethyl petrol is spilled in an unventilated garage, significant proportions of lead tetra-ethyl will be found in the air of the garage, but as the maximum proportion of lead tetra-ethyl found experimentally in the air under very severe conditions of spillage and ventilation was far below the concentration of lead tetra-ethyl stated by Eldridge (United States Public Health Bulletin No. 158, 1925, p. 31) to be lethal for mice, the risk of danger to health appears to be small. In an adequately ventilated garage, since the concentrations of lead tetra-ethyl likely to be found in the air even when large quantities of ethyl petrol are spilled are less than that stated by the American investigators to have no effects on the weight, growth, or life of animals breathing it for three hours daily for several months, the risk of injury to health appears to be negligible.

By far the greater risk, and one to which the Committee refers with emphasis, is that of carbon monoxide evolved in a badly ventilated garage.

That the results of the work carried out by the Committee's experimental staff agree with those obtained by investigators in the United States of America is noteworthy, because the methods adopted in the two investigations were often dissimilar in principle. From a consideration of all the investigations, whether carried out in America or in Great Britain, and of the evidence given by witnesses, the Committee concludes that the use of ethyl petrol of the present composition as a fuel for motor-cars will not constitute a risk to the health of the general public or to that part of the population which is most exposed thereto, namely, garage workers, police officers on traffic control duty, and drivers ot motor and other vehicles.

Finally, the Committee does not consider that there are any reasons for prohibiting the use of ethyl petrol in Great Britain, but recommends certain precautions, such as labelling of the cans containing it, with a warning to avoid spillage and use other than as motor fuel, dyeing the liquid, and retention of a concentration of lead tetra-ethyl not above its present limit.

Landscape at the Royal Academy.

By Dr. VAUGHAN CORNISH.

ONCE again, but unhappily for the last time, we see on the walls of the Royal Academy that rendering of chequered shade by which the late Mr. H. H. La Thangue, R.A., revealed the joyousness of sunlight, especially in Mediterranean lands, as in the picture "Packing Grapes" (120).

Outstanding among the studies of mountain scenery is "Cathedral Mountain from Lake O'Hara" (44), by Mr. Richard Jack, R.A. Cliffs set with pine trees rise from still, dark waters; snow slopes, above, coldly grey, reach to the foot of the towering crag from which the mountain takes its name. The deep shadowing of cyclopæan rocks harmonises with the sombre pines below. The companion picture, "Lake O'Hara, Canadian Rockies" (243), in another room is carried out in the same manner, a fine interpretation of the solemnity of mountains and "the strength of the hills". "A Glen of Arran" (81), by Mr. Guy Kortright, an assembly of mountain peaks strongly coloured in the full light of day, but stripped of atmosphere, is extraordinarily suggestive of silent solitude, so that the artist has been successful in his use of an extremely trying convention. Mr. Sydney Lee, R.A., has a painting of "Sunset in the Mountains" (401), which shows huge turreted forms silhouetted in shades of deep purple against a glowing sky; one of the most deeply emotional aspects of the high mountains.

Among the studies of the sea we come first to that of "Silver Moonlight: St. Ives Bay" (60), by Mr. Julius Olsson, R.A., in which a succession of long, low rollers sweep in silver foam over the shallows of a curving shore. The lights of the fishing fleet, dimly discerned on the dark waters beyond, bring the human touch without impairing the elemental character of the scene, for the long-shoreman is, in his occupation, still the primitive man whose work and sport are one. In "Fresh Morning off the Scillies" (161), by the same painter, a study apparently made from a sailing boat, the waves, rising as high as the point of sight, produce the effect of size and power which is lost when they are overlooked from a lofty deck. Thus seen, it is the sea which is the more massive element, the distant land, dimmed by the salt spray, appearing unsubstantial. Mr. Norman Wilkinson also pushes off in a boat, and thus gets full value from the waves in the only possible manner. "A Newfoundland Fisherman" (359)

by him is a study of a companion boat, with hull rising above the line of sight, the wonderful curves of wind-filled sails cutting across a rain-washed sky, the tumbling sea dark under the squall-cloud hanging overhead. Such pictures recall the adventure and the beauty which attend the sport of sailing, an occupation which, moreover, permits us to explore the scenery of our coasts and estuaries, which can never be fully appreciated from the landward side alone.

In "The Spey, Fochabers" (103), Mr. S. J. Lamorna Birch shows great skill and knowledge in the treatment of the waters of a river which, within a short compass, has many varieties of motion.

We cannot but deplore the scarcity of landscapes in which animal life is the focus of interest; but in Mr. Arthur Wardle's "Under the African Moon" (164) we have at any rate one fine example. The scene is the rocky desert, that stern landscape where man cannot live but has often gone to pray. Seen in the monochromatic moonlight, the lion and lioness watching from the edge of the escarpment are one in tone and colour with the background, the only contrast that of their rounded, supple forms against the rugged outlines of the rock. If we had an unbiased appreciation of the beauty of living form, should we not give more attention to that of the great felines and relatively less to that of man? Granted that a man's hand is a much finer structure than the paw of a beast, yet when we examine the limbs we find a balance and rhythm in those of the lion and leopard of which biped man cannot boast.

A word in conclusion on certain pictures which illustrate matters relating to that heritage of English scenery, the preservation of which, as was aptly stated in the *Times* of Friday, May 2, is becoming the subject of "a great national debate". "Midsummer Evening in Somerset" (279), by Mr. Charles S. Cheston, shows one of those splendid prospects of well-wooded lowland which are seen from hills of no great height in southern England. No native of a mountainous country looking up at these insignificant elevations would suppose it possible that they could provide such extensive views. In Somerset itself we have a notable example in the low ridge of the Polden Hills, where a view-point of special interest has fortunately been secured and vested in the hands of the National Trust. In "Blakeney from Cley" (766) Mr. A. Raine-Barker has sympathetically rendered in smooth water colour a landscape of interest in relation to an important Nature reserve, which derives an old-world charm from the great towers of the two village churches. "Moel Siabod" (1257), a small aquatint by Miss Eveleen Buckton, gives a good impression of the wild scenery in that part of the ancient Snowdonia which, it is hoped, will soon be scheduled as a National Park.

Mr. Harry van der Weyden's large canvas, "From Ballard Down" (420), shows the beautiful waste of Studland Heath and a very interesting outline of coast and estuary in the mellow sunshine of late afternoon. Access to this delightful bit of wild country has been lately made easy for the large resident and visiting population of Poole and Bournemouth, and this is for the moment a beneficial event. The beauty of the broad, open expanse is, however, of a particularly vulnerable character, and its charm will vanish if it be built upon. By all means let the many come and enjoy the heath, but let us hope that the corporations of Poole and Bournemouth will realise that, as Beachy Head stands to Eastbourne, so does an unspoilt Purbeck stand to their towns, an extra-mural asset of financial as well as sentimental value.

Obituary.

Prof. George A. Gibson.

PROF. GEORGE ALEXANDER GIBSON, whose death at Scotstounhill, Glasgow, on April 1, we greatly regret to record, was born at Greenlaw, Berwickshire, on April 19, 1858. His father, the late Mr. Robert Gibson, was highly respected throughout the Greenlaw district as a leader in ecclesiastical and political affairs.

Prof. Gibson was educated at the local Free Church school, from which he proceeded straight to the University of Glasgow, where he won high distinction in classics, English literature, and philosophy, as well as in mathematics. In 1882 he gained the Euing fellowship in mathematics and natural philosophy, and in the following year he was appointed assistant to Prof. William Jack, who then held the chair of mathematics. During the succeeding twelve years he established his reputation as an enthusiastic and capable teacher, and was responsible for the initiation and conduct of numerous courses on advanced mathematics, which were of great service to the honours students.

In 1895, Prof. Gibson was appointed professor of mathematics in the Glasgow and West of Scotland Technical College, where he remained until 1909, when he returned to the University of Glasgow as successor to Prof. Jack. During his period at the Technical College notable developments took place in the aims and scope of the work of that institution, and in all these Prof. Gibson took an outstanding share, thus earning the gratitude of his colleagues and of the governors of the College.

On returning to the University, Prof. Gibson took the opportunity to reorganise the mathematical teaching there; tutorial instruction was provided for all the students, and the curriculum was widened and extended. After the War the number of students rose to 900, but in spite of all difficulties the high standard of the work was maintained.

Prof. Gibson was a great teacher who loved his work, and for whom the interests of his students were paramount. He was also an eager and tireless student, with a remarkably wide and thorough knowledge of mathematical literature. He became a recognised authority on certain parts of the history of mathematics, and wrote numerous papers on the origins of the calculus and on the great Scottish mathematicians. He was the author

of several well-known text-books, the most notable being his "Elementary Treatise on the Calculus", a standard work extensively used throughout the British Empire. After his resignation in 1927 he prepared a large and important volume on advanced calculus, which is at present passing through the press. Many books, written by members of his staff, have also benefited by his profound learning and long experience, always freely and generously placed at the service of younger workers. In the Edinburgh Mathematical Society, which he joined soon after its foundation, Prof. Gibson was a leading figure, and a frequent contributor to its publications. From 1917 until 1920 he held the office of vice-president of the Royal Society of Edinburgh. The Universities of Edinburgh and Glasgow both conferred on him honorary LL.D. degrees, the former in 1905 and the latter in 1927.

An enthusiastic administrator, Prof. Gibson rendered important services to the cause of education in Glasgow. He was one of the original members of the Glasgow Provincial Committee for the Training of Teachers; after returning to the University he became a governor of the Technical College; for a long period he acted as chairman of the governors of the Park School Company; and in the Senate and University Court his sound and forceful counsels carried great weight with his colleagues. On the occasion of his retirement his friends and students combined to testify to their respect and admiration by raising a fund for the endowment of lectures on the history of mathematics, to be given at intervals in the University of Glasgow, and to be known as the George A. Gibson Lectures.

T. M. M.

Dr. David Draper.

In September of last year David Draper, one of the oldest of South African geologists, passed away at the ripe age of eighty years. He was well known throughout the land as the founder of the Geological Society of South Africa in 1895. He was born in the Cape Colony in 1849, and was the son of one of the English settlers who came out to South Africa in or about the year 1820. Most of Dr. Draper's schooling was done at Colesberg in the Cape Colony, which place he left whilst still in his teens to join the small army of diggers occupied in opening up the diamond mines of Kimberley in 1868. After taking an active part in this work with a fair amount of success, he departed for the Lydenburg and Barberton Gold Fields, which he closely studied, and later settled for some years in Natal, where he made himself acquainted with the extensive coal fields of that colony. The richness of the gold mines of the Witwatersrand afterwards drew Dr. Draper thither, and one of his first commissions of importance was to unravel the geological section from Vereeniging to the norite 'Pyramids' north of Pretoria on behalf of the local Chamber of Mines. This work, which covered an entire section of the Witwatersrand beds, was successfully accomplished and has stood substantially correct to the present day.

It was about this time that Dr. Draper realised the necessity of furthering the work of geologists, mining men, and prospectors in South Africa, and the result of his efforts was seen in the formation of the Geological Society of South Africa. In addition to being the founder and first secretary and treasurer of this Society, it is interesting to note that he was also the first South African-born fellow elected to the Geological Society of London.

One of Dr. Draper's first efforts for the South African Society dealt with the primary systems of South Africa, and the conglomerate beds of the Witwatersrand, which at that time were creating world-wide interest on account of their unique geological features and richness as gold bearers. From this time on Dr. Draper was an ardent worker in the field of geology, and visited such distant parts of the world as Borneo, Asia Minor, and Brazil on special geological excursions. Some of his most useful contributions relate to the diamond occurrences of South Africa and Brazil.

For the valuable services rendered to the science of geology in South Africa, Dr. Draper was made an honorary life member of the Geological Society of South Africa—a distinction conferred only twice on South African members during the existence of that Society. In 1927 the honorary degree of doctor of science was conferred on him by the University of the Witwatersrand.

The contributions to geological science by Dr. Draper were numerous, and a bibliography of his works, compiled by the present writer, contains no less than fifty-seven papers to scientific societies and the technical press in various parts of the world.

Harold S. Harger.

Dr. Albert von Le Coq.

A dispatch from the Berlin correspondent of the *Times* which appeared in the issue of April 25 announced the death of Dr. Albert von Le Coq, the famous German explorer and archæologist, at the age of sixty-nine years. Dr. Le Coq was a native of Berlin, and for some time was director of the Museum für Völkerkunde in that city. He was, however, best known for his investigations in Central Asia.

In 1904 and 1905, Dr. Le Coq made two expeditions of archæological exploration in the area at the foot of the eastern Tian-Shan Mountains in the neighbourhood of Kurfan and Koria. On one of these he was accompanied by Dr. Albert Grünwedel, the well-known authority on Buddhist art and archæology. As a result of the excavations in the sand-buried city ruins in the area, a large number of Buddhist wall-paintings and other relics were discovered and brought back to Berlin. The most important discoveries, however, were a large number of documents written in a variety of alphabets on Chinese paper, vellum, and wood. Not only did these reveal links between Hellenism, Persia, India, and China, but more important still it was found that a new and hitherto unknown Aryan language with two distinct dialects had been discovered. Study of Tocharian, this new language, has since revealed that it differs in phonetics, vocabulary, and

structure from all other of the Asiatic Aryan languages and belongs to the western or *centum* group of Aryan.

Dr. Le Coq's most important book described his work in Asia under the title "Buddhistische Spätantike in Mittelasien". A semi-popular and well-illustrated account of the results of his excavations was published (1928) in English under the title "Buried Treasures of Chinese Turkestan". In 1906, Dr. Le Coq was awarded the medal of the Order of St. John of Jerusalem, struck in gold for the first time, for saving the life of Capt. (now Brigadier-General) J. D. Scherer while on a journey in Central Asia in circumstances of exceptional difficulty. Dr. Le Coq was an honorary fellow of the Royal Anthropological Institute of Great Britain.

WE regret to announce the following deaths:

Prof. J. Wemyss Anderson, who was John William Hughes professor of engineering refrigeration in the University of Liverpool from 1920 until he retired in 1924, aged sixty-one years.

Prof. Mary Whiton Calkins, professor of philosophy and psychology at Wellesley College, past president of the American Psychological Association and of the American Philosophical Association, who was one of the first to establish a psychological laboratory, on Feb. 27, aged sixty-six years.

Dr. H. J. B. Fry, pathologist to the Research Institute of the Cancer Hospital and honorary secretary of the Investigation and Scientific Advisory Committees of the British Empire Cancer Campaign, on May 5.

Lieut.-Col. H. H. Y. Hearsey, formerly Principal Medical Officer of Nyasaland, known for his work on blackwater fever, on April 30, aged sixty-three years.

News and Views.

THE latest *Bulletin of the Geological Society of China* (vol. 8, No. 3, 1929) contains three memoirs which supplement the information given in the earlier *Bulletin* (vol. 8, No. 1) already discussed in NATURE of Mar. 22, p. 448) with reference to the discovery of an almost complete brain-case of *Sinanthropus* by Mr. W. C. Pei on Dec. 2, 1929. Father Teilhard de Chardin and C. C. Young give an account of the geographical and geological conditions at Chou Kou Tien and a summary of the evidence which goes to establish the fact that the place where the fossil remains were discovered was once a limestone cave actually occupied by Peking man at a period later than the Pliocene and earlier than the loess. They suggest that the age of all the fossils is Lower Pleistocene. Vast quantities of fossilised remains of animals associated with *Sinanthropus* were found. The identifications of these are given in the report and the palæontological evidence for the determination of the period is set forth with great clearness.

THE discoverer of the skull of *Sinanthropus*, Mr. W. C. Pei, gives an account of an event which is perhaps the most significant, if not the most momentous, in the history of human palæontology; and Prof. Davidson Black gives in print the account of the skull, which was reported (from his manuscript) in NATURE of Mar. 22. His memoir, however, is illustrated with a series of nine plates giving full-size photographs of some of the stages in the long and difficult task of removing the hard matrix of travertine from the skull. This was successfully completed during the week when the *Bulletin* was published (two months after the reports it contains were written), and then was revealed the unexpectedly simian type of temporal bone in association with a peculiar type of parieto-occipital conformation hitherto unknown in any other human skull with the solitary exception of the Piltdown skull in its correctly reconstructed form.

BY the courtesy of Prof. J. L. Myres, secretary of the Seventeenth International Congress of Orientalists, we have received a copy of correspondence with the Secretary of State for the Colonies covering a schedule of facilities to be extended to archæological expeditions in Palestine which have now been approved by the Secretary of State for the Colonies and are in force as from April 1 of the current year. The facilities and privileges in question will be granted by the Palestine Government to all archæological expeditions in possession of a valid licence to excavate in Palestine in accordance with the provision of Section 9 of the Antiquities Ordinance of 1929. It will, however, be necessary as a preliminary to the grant of any facilities that the holder of a licence should produce a statement by the Director of Antiquities that the expedition has been approved by the High Commissioner for the purpose of exemption and other privileges. The privileges, which are set forth in detail in the schedule together with the procedure to be followed in each case to secure their operation, are liberal and varied. They have been drafted with great care and a full knowledge of the difficulties arising out of legislative and fiscal regulations which beset archæological expeditions. Further, and this is even of more moment, they evince on the part of both the Palestine Government and the Colonial Office a sympathy with and interest in archæological exploration which are gratifying and encouraging to those concerned with the promotion of archæological study in the field.

THE facilities granted affect both the results of archæological exploration in Palestine and the personnel of the expedition. Most important under the first head is the regulation that export Customs fees will be remitted on antiquities allotted to the holder of a licence as a result of the division with the Department of Antiquities of the objects found; while import Customs duty is remitted on instruments and scientific appliances needed for the purpose of excavation and archæological study, as well as on camp and other equipment for the expedition. This applies whether the articles are imported by sea, air, rail, or parcel post. Reduction in railway fares is granted to all members of the expedition including half-fare reduction of third-class fares for labourers. In the case of skilled labour imported from Egypt, however, it must be shown that suitable labour is

not available in Palestine. Both archæological equipment and antiquities are entitled to a reduction of freight on the basis of one-half the full rates on passenger train and according to scale on goods trains. In order to minimise any difficulties which might arise under the immigration regulations, the normal procedure to obtain visas for members of the expedition and for such labourers as cannot be engaged in Palestine is to be simplified. On receipt of a statement in advance by the holder of a licence, the Director of Antiquities will issue a certificate to the Chief Immigration Officer, who will thereupon issue the necessary visa authority to the consular authority concerned. No remission of immigration fees will, however, be granted. The simplicity of the procedure in each case should ensure the smooth working of the regulations. They have been framed on such broad lines and in so friendly a spirit that expeditions in Palestine should be able to work with little, if any, of the 'red tape' difficulties which have often proved an embarrassment to archæological study in other countries.

A REGULAR telephone service between London and Australia was inaugurated on April 30. At the English end the transmitting station is at Rugby and the receiving station is at Baldock, Hertfordshire. The corresponding Australian stations are Pennant Hills for transmitting and La Perouse for receiving, both in the neighbourhood of Sydney. The two links are combined and controlled at the London Trunk Exchange and the Sydney Telephone Exchange. From these points access is obtained to the land line telephones of the two countries. The path of the voice from an English subscriber to Sydney goes first to the London terminus. It next goes over 85 miles of land line to Rugby, and then goes over the radio link of 11,000 miles to the station at La Perouse, seven miles from Sydney. From there it goes by the land line to the Sydney terminus and thence to the listener in Australia. When the Australian speaks it goes to the transmitting station at Pennant Hills, then the radio link to Baldock and back to London, which is connected to the subscriber by his telephone wire. The first official conversation was between the Prime Ministers of the two countries, and was broadcast both in Great Britain, at 8.30 A.M., and in Australia, and was heard very clearly. About an hour later the private conversations got blurred owing to 'fading'. This was attributed mainly to an atmospheric disturbance taking place in the Indian Ocean.

THIS new radio link connecting Rugby and Sydney, 11,000 miles long, is much the longest in the world. The length of the Buenos Aires to Madrid public telephone link is 6400 miles. On April 3 a radio link 5300 miles long was opened connecting Buenos Aires to Netcong, N.J., in the United States. These lengths make the telephone link between England and America, 3200 miles long, comparatively short. Five continents are now connected by telephone. It is possible, for example, for a subscriber in Santiago, South America, to talk to anyone in Ceuta, Africa. His voice would first pass over the wires crossing the Andes to Buenos Aires, then to Netcong by radio, and by wire to New York. From there it would go to Rocky Point, Long Island, and by radio to Cupar, Scotland; then by wire to London and by submarine cable to Boulogne. After going through Paris, Madrid, and Algeciras, it would go under the Straits of Gibralter by a submarine cable to its final destination. It could also have been sent direct from Buenos Aires to Madrid. It is instructive to note that the messages sent from New Jersey to the Argentine can be sent by one of three different wavelengths. It has been found that although one may be badly affected by atmospherics, another may be scarcely affected at all.

Now that the telephone service is so widely established, and seeing that its usefulness is continually increasing, the Post Office engineers might be excused if they regarded somewhat coldly other methods of communication. Like the ancient Athenians, however, they are always seeking after some new thing. The latest development is a teleprinter service for subscribers through telegraph exchanges. We learn that the first exchange will be in working order about the end of the year. The new service will be operated in a somewhat similar way to the telephone service. When the operation is completed, two subscribers will be able to telegraph typewritten messages to one another. Each subscriber will be provided with a teleprinter, the use of which can easily be mastered by a typist, and will be allotted a number. By depressing a button the exchange operator is called and the required number will be dialled to him. When the required connexion is made, 'thro' will be typed on the teleprinter. The subscription to the exchange which is at present contemplated is of the order of £70 a year and will cover the installation and maintenance of the lines and instruments and all communications with other subscribers on the exchange. Additional instruments can be hired at a cost of about £50 a year. At the outset, the new service will be confined to the London area, but we expect that it will develop so as to cover many of the larger centres. This innovation will make telegraphy more popular, as it will obviate the necessity of sending telegrams to a public office for dispatch. The first exchange will be in the Central Telegraph Office. It is hoped that subscribers will be able by this means to forward telegrams for dispatch by all telegraph companies and to receive their incoming telegrams directly on their teleprinter instruments.

THE Safety in Mines Research Board has just issued Paper No. 58 (London: H.M.S.O.) dealing with the use of steel pit props in collieries; as usual, the publication is issued at an uneconomic price, namely, one shilling, in order that it may be as widely read as possible in the coal-mining industry. The report is signed by Messrs. Ashley, Dixon, and Hogan; the first named is one of H.M. Inspectors of Mines, who has been employed as a practical investigator on behalf of the Board, whilst Prof. Dixon and Dr. Hogan

are well known research workers. The report points out that the value of steel arches for roadway support has been proved beyond doubt, and that steel props have been successful at the working face under a large number of conditions, it being necessary, however, that the type of prop selected should suit the particular conditions at the coal face. Some thirteen different forms of steel props are here fully described, together with the results obtained with them both in actual practice and under test, and a comparison of these props with ordinary Norwegian wooden round props is also appended. As regards the practical side of the question, it is shown that although the first cost of a steel prop is much higher than that of a wooden prop, the use of the former has been attended with very marked savings, which in one case is said to be as much as 9d. per ton of coal compared to the cost of timber.

PERHAPS the most interesting section of this report on steel pit props deals with the effect of the use of steel props on the accident rate, and the results are summed up in one sentence: "Where steel props have been used in Great Britain there has been a marked freedom from reportable accidents from falls of roof". Another interesting sentence states that "At Ashington Colliery, Northumberland, very few reportable accidents have occurred where steel props are in use". It will be remembered that a few months ago the miners at Ashington were prepared to come out on strike on the ground that the steel props used by that colliery company were a source of danger, and this authoritative statement to the contrary shows how absolutely without foundation was the above contention of the miners, and sheds light upon the trivial pretexts which are at times made the basis of a proposed strike.

BRIGHTLY coloured mock suns were seen from a number of places, including London, on the afternoon of May 1 last. The phenomenon is not often shown with sufficient brilliance in these latitudes to be obvious to the casual observer, and were it not for the fact that at places where a regular watch has been kept for it with certain optical aids, for example, at the Radcliffe Observatory, Oxford, it is observed on a considerable number of occasions in an average year, the phenomenon would be regarded as distinctly rare outside the polar regions. These mock suns showed characteristic horn-like projections away from the sun along the space appropriate for the mock sun ring, and occurred in connexion with the ordinary halo of 22° radius. A sun pillar was present, and an upper arc of contact—a bow of light making contact with the 22° halo, the convex side being towards the sun. The ice crystals in the upper atmosphere that caused the display were due to the presence of cirrus cloud connected with a system of depressions over southern Europe, and some turret cloud (alto-cumulus castellatus) was visible in London later in the day. Neither form of cloud is suggestive of settled fine weather, and, in spite of the presence of a large anticyclone centred over Scotland, thunderstorms broke out in southern England within twenty-four hours of the occurrence of the mock suns.

IN his Friday evening discourse delivered at the Royal Institution on May 2, Mr. H. E. Wimperis, Director of Scientific Research, Air Ministry, discussed the present state of our knowledge of the phenomenon of spin in aeroplanes. The motion of an aeroplane in a circular path is just as steady and just as normal as that of straight flight. Even in the most troublesome form of spin, the aeroplane cannot be charged with behaving in any but a purely normal and quite virtuous way. Our efforts must therefore be directed not towards the curing of a supposed fault but at making this particular form of stable motion as controllable at the will of the pilot as any other of the machine's forms of motion. With the aid of models and kinematograph films Mr. Wimperis illustrated the growth of the forces which make for autorotation of the wings and so lead to the ordinary spin, and of the centrifugal forces in the various aeroplane parts which tend to raise the nose of the machine into the 'flat spinning' attitude and definitely oppose the pilot's effort to get the nose down and so resume normal straight flight. A detailed study is being made of the various ways in which the pilot's controls can be so strengthened as to make him always able to overcome these autorotation and inertia forces. This study is being carried out by the use of model aeroplanes which are either observed and photographed when spinning, or are held in spinning attitudes in a wind tunnel so that the forces acting upon them can be measured. At the same time, full scale experiments in free flight are being undertaken so that records can be made by instruments of the nature of the motion in each of the various types of spin.

AT the annual meeting of the Royal Institution held on May 1, the report of the Committee of Visitors for the year 1929 was read and adopted, and the following officers elected: *President:* The Duke of Northumberland; *Treasurer:* Sir Robert Robertson; *Secretary:* Major C. E. S. Phillips. The alterations which are being made at the Royal Institution occupy a prominent position in the report of the Committee of Visitors. Plans are shown of the rebuilding now in progress, which has been undertaken at an estimated inclusive cost of £80,000. As is well known, the chief alterations have concerned the lecture theatre; the shape, size, and general aspect are being preserved so far as possible, but there will be greatly improved arrangements for entry and exit, increased comfort and additional lecture facilities, with full provision for the display of kinematograph films. A range of lighted show cases is being constructed round the semicircular corridor beneath the theatre tiers for the display of some of the Institution's historical apparatus. During the building operations, the principal pieces of apparatus used by Rumford, Davy, Faraday, Tyndall, and Dewar have been placed on exhibition at the Science Museum, South Kensington. As the

result of a private appeal, generous donations towards the costs of reconstruction have been received from individuals, City Companies, and electrical and chemical industries which owe their existence to the scientific work carried out at the Royal Institution. With the sale of the American MSS. known as the Dorchester Papers, the total receipts have been nearly £49,000. It is proposed to issue a wider appeal for the remainder of the money, and also for an endowment fund for research in the Institution and the Davy Faraday Laboratory, in connexion with the celebration of the centenary of Faraday's discovery of electromagnetic induction. The Faraday celebrations will begin on Sept. 21, 1931, and the centenary meeting of the British Association will open in London on Sept. 23.

WE have already referred to the increased interest being taken in the study of natural history in China. Fresh evidence of this movement is afforded by the publication of the first number of the *Hong Kong Naturalist*, a quarterly illustrated journal for Hong Kong and South China, to be devoted to the description of features of the fauna and flora of South China and neighbouring countries. The first number indicates the character of the magazine—a combination of more general articles for the non-expert and of more technical studies for the trained naturalist. Amongst the former are instalments of accounts of the birds, orchids, and ferns of Hong Kong and, specially to be commended, a simple diagrammatic scheme indicating the months when the nests of different birds may be found. The special articles include the beginning of a synopsis of the fishes of China. Some experience of magazines with such a twofold aim, however, suggests the warnings that continued articles which run through endless numbers are not popular, and that for the general naturalist systematics is often a bore. Biological studies, life histories, up-to-date summaries of modern points of view, should not be forgotten. They are equally scientific, have more interest, on the whole, for the general reader, and should tend to turn the attention of local field naturalists to profitable and more congenial lines of observation. Already, we understand, a gratifying demand for the new magazine has been received, and we wish it all success.

IN a recent issue of *Helios*, the German electrical journal for export use, which is printed in German, French, and English in parallel columns, there is an interesting article by E. Schwandt on automatic signalling for railway level crossings. The railway track for a distance of 300 yards on each side of the level crossing is insulated. When the train is on the insulated portion of the track, a local circuit is completed and the white lights from the lamps at the gates on both sides of the crossing being automatically screened show red. When the last carriage leaves the insulated track, the lamps give white light. For greater safety, instead of having a steady red light, intermittent flashes of white and red light can be given, the white flashes lasting longer than the red ones. The Berlin Municipal Railway has already adopted this method. The German Automobile Club has also taken up the problem of the best way to illuminate railway gates. In Germany, the level crossings in the country are often very inadequately illuminated. Sometimes even an oil lamp hung from the middle of the gate is considered sufficient. This can very easily be concealed by a cart standing in front of it. To obviate this danger it has been proposed to place on the gates sets of two or three lamps which give an intermittent light when the gates are closed. They are arranged so that it is practically impossible for all the lamps to be concealed from oncoming traffic at the same time. It would be an expensive undertaking to fit all unprotected crossings in Germany with warning signalling apparatus. The advisability of such devices is universally admitted, but it is not clear whether the State railways or the highway boards should bear the great expense of installing them.

THE forty-first congress of the Royal Sanitary Institute will be held at Margate on June 21–28, under the presidency of the Right Hon. Lord Cornwallis. The sections and their presidents are as follow: Preventive medicine, Sir Andrew Balfour; engineering and architecture, Sir Henry Maybury; maternity and child welfare, including school hygiene, the Lady Howard de Walden; hygiene of food, Mr. H. Williams; hygiene in industry, Mr. F. W. Goodenough; veterinary hygiene, Major-General Sir John Moore. Conferences of sanitary authorities, health visitors, and others will also be held. Among the subjects to be discussed are psittacosis, maternal mortality, public health service and school medical inspection and treatment, health of industrial workers, education of the health personnel, inspection of foodstuffs, food in relation to dental hygiene, and regional control of sewage purification works. Dr. O. Charnock Bradley, principal of the Royal (Dick) Veterinary College, Edinburgh, will deliver the Congress lecture, taking as his subject "Diseases of Domestic Animals from the Human Angle", on Tuesday, June 24. A feature of the Congress will be the visit of two hundred representatives of the American Public Health Association. An exhibition of appliances for the promotion of public health and sanitation has also been arranged.

THE German Association for Natural Science and Medicine has visited in recent years Innsbruck in the south, Düsseldorf in the west, and Hamburg in the north. This year the Association will proclaim science and civilisation at Königsberg in the far east of Prussia. The invitation circular is not to members of the Association alone, but also to all who honour German science, and makes welcome the participation of foreign savants who feel themselves in contact with German research. This ninety-first assembly of the "Gesellschaft Deutscher Naturforscher und Aerzte" takes place on Sept. 7–11, 1930. There will be general addresses, a short programme of sectional meetings, and numerous joint discussions. Festivities are to be limited in favour of the call of learning. The main topics include protoplasm, bird migration, logic and

natural science, the natural system of the elements, agriculture, and economics. The medical side will discuss blood pigments and bacteria, and will combine with biologists to discuss inheritance and with physicists to consider the eye. Joint discussions will deal with the cosmic frequency of the elements, the age of the earth, the synthesis of silicates and cosmic radiation. Botanists and agriculturalists will discuss meteorology. Various allied scientific societies are holding their meetings at the same time and place. The programme of excursions includes the neighbouring sand-dunes, lagoons, bathing-resorts, fresh-water lakes, and historic monuments. Longer journeys include Finland for mineralogists before the meeting, and after the meeting Leningrad and Moscow. Königsberg can be reached from Berlin without any further visa, passport, or tax; eight times daily by train in 9-10 hours; by fast motor-ship *via* Swinemünde-Zoppot-Pillau, 18 hours at sea; also thrice daily by air in 4-5 hours. The subscription for those attending the meetings, but not regular members, is 25 rm.; applications should be sent to Secretary G.D.N.A., Prof. Dr. Rassow, Leipzig C.1, Gustav-Adolfstr. 12, and if possible by mid-May by those wishing to join excursions.

THE report on the work of the National Illumination Committee of Great Britain, presented by the chairman at the annual special meeting on Jan. 30 last, which has recently been issued in pamphlet form, illustrates the widening activities of this Committee. Following recent international congresses, a considerable number of sub-committees has been formed, and a brief summary of the proceedings of each is presented. Amongst such sub-committees those dealing with coloured glass for signal purposes, traffic control signals, daylight illumination, colorimetry, lighting education, definitions and symbols, automobile headlights, factory and school lighting, street lighting and aviation lighting may be mentioned. In five cases the British committee has assumed secretariat responsibility, which involves the collection of information from abroad. The work of the Illumination Section of the British Engineering Standards Association, which is closely allied to that of the National Illumination Committee, is also reviewed. Technical committees dealing with nomenclature and definitions, lighting fittings, street lighting, electric lamps and optical projection apparatus are mentioned. Preparatory work in connexion with the International Illumination Congress to be held in Great Britain in 1931 is actively proceeding. Judging from the developments summarised in this report, Britain should be able to present an impressive record of work done.

THE tenth Report of the Committee of the Institution of Civil Engineers which is investigating the deterioration of structures in sea water has recently been published by H.M. Stationery Office (2*s*. net). It follows now familiar lines, recording the progress of the numerous test specimens exposed in various harbours of the world. Tests of iron and steel bars which have been corroded for five years at Plymouth showed that the interior of the metal was unaffected, normal tensile tests being obtained after machining off the corroded surface. Heat-treated and polished bars of chromium steels were found after five years to be deeply pitted by sea-water, although the polish remained perfect between the pits. Similar bars were quite unaffected by exposure to air or fresh water for the same time. Of the numerous tests made to determine the protective effect of different paints, mention should be made of the high degree of protection given by a coat of white lead over tar, such plates being in perfect condition after 17 months at half-tide level. Of the experiments on wood a remarkable result is the very high concentration of arsenical compounds necessary to protect against *Teredo*. The addition of naphthalene to creosote appears to be of advantage. The behaviour of concrete is to be studied by means of a further series of test specimens.

THE first conversazione this year of the Royal Society will be held at the Society's rooms on Wednesday, May 14, at 8.30 P.M.

DR. J. BRONTË GATENBY, professor of zoology and comparative anatomy in Trinity College, Dublin, has been appointed Theresa Seessel Fellow of Yale University and will work there at experimental cytology from Sept. 25 next until April 9, 1931.

THE Lord President of the Council has appointed Sir Ernest Rutherford, president of the Royal Society, to be chairman of the Advisory Council of the Department of Scientific and Industrial Research in succession to Sir William McCormick as from Oct. 1 next. Prof. V. H. Blackman will serve as chairman until October.

SIR JOHN FARMER, formerly professor of botany in the Imperial College of Science and Technology, London, and Prof. Edmund Beecher Wilson, Da Costa professor of zoology in Columbia University, New York, have been elected honorary fellows of the Royal Microscopical Society.

THE twentieth meeting of the Australasian Association for the Advancement of Science will be held in Brisbane during the week commencing May 28, under the presidency of Mr. E. C. Andrews, Government Geologist, Sydney. The local honorary secretary for the meeting is Dr. D. A. Herbert, the University, Brisbane.

THE Linnean Gold Medal for 1930 of the Linnean Society of London has been awarded to Prof. J. P. Hill, professor of embryology, University College, London, and the Trail Award and Medal has been awarded to Dr. Kathleen Bever Blackburn, of the Botanical Department, Armstrong College, Newcastle-on-Tyne. The presentations will be made at the anniversary meeting to be held on May 24.

"NATIONAL Baby Week" is to be celebrated in Great Britain this year on July 1-7, and the National Baby Week Council (117 Piccadilly, W. 1) suggests that at conferences special attention should be given to (*a*) the need for a national maternity service scheme, (*b*) better provision of nursery schools, and (*c*) spread of knowledge of parentcraft.

THE thirty-fifth general meeting of the German Bunsen Society (Deutsche Bunsen-Gesellschaft) for experimental physical chemistry, the leading German society in this field, will be held at Heidelberg, for many years the scene of Bunsen's work, on May 28–June 1. The principal subject for discussion will be spectroscopy and formation of molecules. The names of those desirous of participating should be sent to the "Ortsausschuss der Deutschen Bunsen-Gesellschaft, Heidelberg, Ploeck 55", with particulars of any accommodation required.

OWING to the prevalence of psittacosis or parrot fever in England and Wales during the last two months, the Minister of Health has issued an Order prohibiting as from May 20 the importation of parrots into the country (Statutory Rules and Orders, 1930, No. 299, Covering Circular 1108. London: H.M. Stationery Office). 'Parrot' includes macaws, cockatoos, love birds, lories, and others. The prohibition does not apply, under safeguards, to birds required for research, or consigned to the Zoological Society of London.

CURTIS'S *Botanical Magazine*, the beginning of periodical illustrated botanical literature, first appeared in 1787, and has an unbroken record of continuity. Beginning in 1827, each volume has been dedicated to an eminent botanist or horticulturist, and the Royal Horticultural Society, which now owns the magazine, is arranging to publish a commemorative volume with a short life-history of these persons, with their portraits. Of the portraits required, only seven now remain to be obtained, namely: Rev. John Clowes (1777–1846), Capt. Sir James Everard Home (1798–1853), George Curling Joad (died 1881), John Parkinson (died 1847), Sir Law(u)rence Peel (1799–1844), Mrs. Sherbourne, and Mrs. Wray. Any information regarding these portraits should be addressed to the Secretary, Royal Horticultural Society, Vincent Square, S.W.1.

FARMERS' and farm workers' associations and clubs, chambers of agriculture and horticulture, students' societies and other bodies interested in agriculture or market gardening, are invited to inspect the Rothamsted and Woburn Experimental Plots during the coming summer under the guidance of Mr. H. V. Garner and Capt. E. H. Gregory. At Rothamsted the soil is heavy, and the experiments deal with the manuring of arable crops, especially sugar beet, potatoes, mangolds, fodder mixtures, barley, oats, wheat, and meadow hay. At Woburn the soil is light, and the experiments there are concerned more particularly with the manuring of potatoes, sugar beet, malting barley, wheat, and the use of green manures. All communications and requests to visit the Stations should be addressed to the Secretary, Rothamsted Experimental Stations, Harpenden.

THE Ministry of Health has issued a 'scheme' providing for the payment of contributions by county and county borough councils to voluntary associations which provide services for the welfare of blind persons; an explanatory circular (No. 1086) accompanies it. The scheme has been made under Section 102 (1) of the Local Government Act, 1929, and came into force on April 1 last. Without such assistance the lot of the blind would be a pitiable one. An article in the January–March issue of *The World's Health* (vol. 11, No. 1) points out that a large proportion of blindness is preventable and that an International Association for the Prevention of Blindness has been created, supported by twenty-eight countries, the League of Nations, the League of Red Cross Societies, and others.

THE Statistical Report of the Health of the Navy for the Year 1928 has been recently issued (London: H.M. Stationery Office, 5*s*. net). The returns for the total force, 90,820 strong, for 1928 show decreases in the incidence of disease as compared with the five years' average and with 1927. The total number of cases of disease and injury was 40,505, equal to a ratio of 445·99 per 1000, a decrease of 26·64 in comparison with the five years' average and of 33·06 in relation to 1927. The strictest attention is paid, especially in foreign waters, to sterilisation of water and milk, as well as to the control of dangerous articles of diet, with the result that only seven cases of typhoid and paratyphoid fevers occurred. Venereal diseases, though showing some decrease compared with the five years' average, number 6175 cases, a slight increase relative to 1927. Malaria, with 469 cases, also shows a slight increase.

A BIOGRAPHY of Erasmus Darwin, author of "Zoonomia" (1794–96) and grandfather of Charles Darwin, has been written by Mr. Hesketh Pearson and will be published shortly by Messrs. J. M. Dent and Sons, Ltd. Mr. Pearson is a direct descendant of Darwin, and had access to his commonplace book and letters, as well as to family documents and other unpublished material.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in engineering at the Cardiff Technical College—The Principal, Technical College, Cardiff (May 17). A lecturer in mathematics and a foundry instructor at the Constantine Technical College, Middlesbrough—The Director of Education, Education Offices, Middlesbrough (May 19). A junior engineer under the Safety in Mines Research Board, for research on colliery wire ropes—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (May 19). An assistant engineer and lecturer in the School of Civil Engineering of the Gordon Memorial College, Khartoum — The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1 (May 20). An assistant lecturer in mathematics at the Belfast Municipal College of Technology —The Principal, Municipal College of Technology, Belfast (May 20). Lecturers in mathematics and metallurgy at the Sir John Cass Technical Institute—The Principal, Sir John Cass Technical Institute, Jewry Street, E.C.3 (May 22). An assistant lecturer in metallurgy at the County Technical College, Wednesbury—The Director of Education, County

Education Offices, Stafford (May 24). Evening teachers for building construction, carpentry, and joinery at the Richmond Technical Institute—The Education Secretary, Hotham House, Heron Court, Richmond, Surrey (May 24). An engineering assistant in the City of Nottingham Water Department—The Town Clerk, Guildhall, Nottingham (May 26). An assistant lecturer in the department of zoology and geology of University College, Southampton—The Registrar, University College, Southampton (May 26). An assistant lecturer in the department of metallurgy of the University College of Swansea—The Registrar, University College, Swansea (May 28). An assistant lecturer in political science at the London School of Economics and Political Science—The Secretary, London School of Economics, Houghton Street, Aldwych, W.C.2 (May 29). A professor of zoology in the University of Cape Town—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (Aug. 31). A lecturer in mathematics at the Diocesan Training College, Ripon—Miss Eva Lett, 14 Ladbroke Square, W.11. A civil engineering draughtsman under the South Staffordshire Waterworks Company — The Engineer-in-Chief, 26A Paradise Street, Birmingham. Temporary assistant chemists in the Admiralty Chemist's Department, Portsmouth—The Admiralty Chemist, H.M. Dockyard, Portsmouth.

Our Astronomical Column.

New Comet, 1930 d.—A new comet of the tenth magnitude was found by Prof. Schwassmann and Dr. Wachmann at Bergedorf early on May 2; it is the fourth comet that they have jointly discovered; it makes the fifth observed comet to pass perihelion in 1930. The following positions for 1930·0 have been telegraphed by the I.A.U. Bureau, Copenhagen:

Date.	R.A.	N. Decl.	Observers.	Place.
d h m	h m s	° ′ ″		
May 2 0 38·2 U.T.	16 1 40	35 57	Schwassmann and Wachmann	Bergedorf
2 22 0·5	16 3 59·13	36 6 29	Struve	Neubabelsberg
3 21 39·3	16 6 46·00	36 17 35	Vinterhansen and Möller	Copenhagen

The roughly estimated position for the evening of May 10 is R.A. 16h 28m, N. Decl. 37° 42′, about 2¾° S.W. of η Herculis.

The Total Solar Eclipse of April 28 in California.—Extensive preparations were made by the Californian astronomers to utilise the brief totality of this eclipse to the utmost. The eclipse afforded especial opportunity for observations of the flash spectrum; it was also hoped to obtain some photographs of the inner corona. Observers in aeroplanes were to try to photograph the moon's shadow on the ground. No astronomical reports are yet to hand, but from the telegrams in the daily papers it appears that the weather was clear. It will be remembered that the predecessor of this eclipse in 1912 was just total in Portugal, and narrowly annular near Paris. In 1858 it was almost total in England.

The Lowell Planet.—The Flagstaff orbit for this planet, with eccentricity 9/10 and period 3200 years, is still very uncertain. Prof. Banachiewicz and Dr. C. Smiley have calculated parabolic orbits on the hypotheses (1) that the motion is inward, which gives perihelion in 1958, (2) that it is outward, which gives perihelion in August 1902. Ephemerides on the two hypotheses are given in A.U.I. Circ. No. 274 for the last three years. Even in November 1927 the two orbits give positions differing by 8′ only, so that a longer arc than that of two months is required for a trustworthy result. The node is now known to be within 1′ of 109° 22′; the inclination is within half a degree of 17° 10′; it is noteworthy that these two elements were predicted nearly correctly by Prof. W. H. Pickering in his 1919 forecast, which also gave the present longitude correct within 5°. He gave node 100°, inclination 15°, with estimated uncertainty 5° in each. The present distance from the sun does not differ from 41 by more than a unit, but it is doubtful whether it is increasing or diminishing; increase is more probable. Several orbits are given by E. C. Bower and F. L. Whipple in *Lick Bulletin*, No. 421; four ellipses are given with periods 229 yr., 390 yr., 264 yr., 264 yr.; also two parabolic orbits. Prof. W. H. Pickering states in a letter that he has found a period of 210 yr. Unless images should be found on old plates, no decision on the eccentricity or period is possible until a longer arc is available.

Harvard Announcement Card No. 123 states that Mr. Henroteau and Miss Burland have discovered an object on plates taken at Ottawa in 1924 that appears to be trans-Neptunian; it cannot be the Lowell object, being too far north; the following positions are given, referred to the equinox of 1875·0:

1924 Feb. 7·666 G.M.T.	R.A. 6h 36m 55s	N. Decl. 23° 42·4′
24·556	Position not given	
29·560	6 35 40	23 39·3

The magnitude is not given.

From these figures Dr. A. C. D. Crommelin derives the following circular elements referred to equinox of 1924: Distance, 39·82; period, 251·3 years; node, 280° 29·4′; inclination, 49° 7′. In the Lowell planet the circular hypothesis gave a good approximation to the distance, so it may do so here also.

New Constellation Boundaries.—At the Leyden meeting of the International Astronomical Union in 1928, Commission III. was requested to prepare maps of the constellations, simplifying the constellation boundaries. M. E. Delporte, with a committee to assist him, undertook this task, and the resulting star atlas has just been published by the Cambridge University Press. The rule has been followed that the boundaries should be formed by lines parallel or perpendicular to the equator of 1875. The objection was raised at Leyden that the constellations have already lasted for thousands of years, and may last for a long time in the future, in which case the boundaries will become much inclined to the equator. The ecliptic would have been a more stable direction. However, on the basis that was adopted the work has been very well done, and the maps giving the new boundaries show also the stars down to magnitude 6 inclusive. The boundaries have been laid down on the principle that variable stars should be kept in the same constellations as before, and that there should be as little disturbance as possible of stars that bear constellation letters or numbers. The boundary between Pisces and Aquarius is so laid down that it will be about 6½ centuries before the equinox enters the latter constellation.

Research Items.

The Nisenan.—Mr. A. L. Kroeber publishes in vol. 24, No. 4, of the *University of California Publications in Archæology and Ethnology*, a study of a section of the Nisenan or Southern Maidu. Those with whom he deals are the valley people, who differ from those of the hills, though the two groups are sometimes classed together, on the ground of their unity of speech. In fact, Nisenan is not a specific tribal name, but is used in default of a native ethnic name. The Nisenan, now practically extinct, lived near Sacramento on the American and Feather Rivers. From the geographical and topographical information obtained, it was clear that native communications prevailingly followed the large streams, and therefore the ethnic outlook was directed towards the north and north-west within the Great Valley. The San Joaquin portion of the Valley was foreign. It seems that the groups tended to segregate themselves according to physiographic areas. Their dwellings were earth-covered, but at the mouth of Feather River they were tule-covered. They used as boats balsas made of tule and an approach to the canoe in the form of a log raft. Clothing comprised bark or tule aprons and duck feather blankets for the women, round shawls of tule for the men, and occasionally moccasins of buckskin. Their weapons were the bow with arrow points of obsidian, a spear of willow, used only in war, and a sling. The chief was selected when he was young, and succession was usually from father to son. Marriage within the village was not forbidden. Those who died of disease were cremated; but those killed in war were buried, as were also small children. A bear skin and ornaments were put on a dead person so that he should not trouble his living kin. The Kuksu cult or religious organisation comprised two societies with separate initiations. One was confined to men, the other took in a limited number of men and women. The dances were held in the summer in the dance house. The members of the *te'me'ya* ceremony or society wore a white ornament in the septum of the nose, which was bored for the purpose.

Acquired Characters.—The possibility that acquired characters may be inherited pushes itself more and more into the foreground, and Dr. M. F. Guyer's address to the Section of Zoological Sciences at the American Association for the Advancement of Science, on the last day of 1929, was a plea for further consideration of a theory which, twenty years ago, was regarded as discredited (*Science*, p. 169, Feb. 1930). He reviews some of the results of recent genetic studies by Müller, Metcalf, Goldschmidt, and others, and is led to ask whether the gene itself, or that larger vital unit of which it is a part, is really the fixed unvarying thing it is tacitly regarded to be. Genes must be nourished like other living things, since they multiply and grow and apparently display the other characteristics of living matter. They must therefore be open to the vicissitudes which beset other living substance. Once it is conceded that the constitution of the gene may wax and wane, then the way is open to the conception of how this may be induced through nutritive, toxic, or functional means. An acquired character might become an inherited character by some sort of germinal fixation that establishes it as part of the more habitual expression of the germ-plasm. The plasticity of the organism, to which these adaptations are attributed, must itself have genic significance, for the fact remains that the organism has the inherent capacity for acquiring the somatic modification.

Adelginæ (Phylloxeridæ) of North America.—In the *Stanford University Publications*, Biological Sciences, vol. 6, No. 1, Dr. P. N. Annand has a useful contribution towards a monograph of the American species of the group formerly known as the Chermesinæ and now, owing to changes of synonymy, termed the Adelginæ. In this work he describes and figures all the known American species, and gives a useful review of our knowledge of the biology of this exceedingly difficult subfamily of the aphides. Few groups of insects have so complex a life-cycle, or so great a range of polymorphism as is exhibited by the Adelginæ, while their importance, as pests of Conifers, renders it necessary that their economy should be adequately understood. Their primary host, so far as is known, is the spruce, while the intermediate hosts include such genera as *Larix*, *Pinus*, *Abies*, *Pseudosuga*, or *Tsuga*, as the case may be. Some species, however, are confined to the primary host, and others to the intermediate host without migration between the two. For the most part, however, migration takes place and this fact has an important bearing upon control measures. What is known of the life-cycle of these insects is due to the labours of a number of European investigators of several nationalities. A general summary of their work is provided and the terminology of Marchal is adopted in the systematic accounts of the American species. The latter form the greater part of the memoir and are drawn up with evident care and exactness. Dr. Annand's work brings together the essentials of what is known concerning these insects and should provide a stimulus to a better knowledge of the American species.

Buttress Roots.—Mr. T. Petch has an interesting note on this characteristic occurrence in the tropical forest in the *Annals of the Royal Botanic Gardens*, Peradeniya, vol. 11, part 3, January 1930; this is illustrated by some excellent photographs, which are, however, incompletely labelled for identification, whilst a text figure referred to in the paper frequently seems to be missing entirely. Buttress roots have usually been explained along teleological lines as supports to massive crowns, or as determined in position by prevalent winds. Mr. Petch's examination of their distribution does not confirm these theories, nor does he find them confined to the trees of the tropical rain forest. He points out the value, for observations and experiments upon this problem, of a tree like *Poinciana regia*, which shows wide differences as to the occurrence and distribution of such buttresses. He points out that in this species they may be found in young trees two to three years old, growing in quite sheltered positions; incidentally, he notes their occurrence in a seedling from a parent tree which was quite free from buttresses. He suggests as a working hypothesis that the presence of buttress roots is associated with a deficient tap root and that their formation is due to the restriction of the food and water currents to limited narrow regions of the stem continuous with the lateral roots. Mr. Petch also describes very interesting plank buttresses where the lateral stems join the main trunk, well above the ground, in some trees of *Canarium commune*; this occurrence, less commonly noted than the typical buttress roots, is illustrated by a very striking photograph.

Wankie Coalfield and its Fossil Flora.—*Bulletin* No. 15 of the Geological Survey of Southern Rhodesia is of particular interest in view of the discussion now

proceeding as to the age of the late Palæozoic glaciation of Gondwanaland. Mr. B. Lightfoot describes the geology of the central part of the Wankie Coalfield. The Karroo succession ranges from the Lower Wankie sandstones to the Batoka basalts, the former resting on a floor of Archæan gneisses. No intervening representative of the Dwyka conglomerate has been found in any of the exposures, but as this horizon elsewhere is older than the Wankie sandstones, the age of the latter is of critical importance. Dr. J. Walton has already announced in NATURE (Oct. 19, 1929, p. 614) the significant discovery in the Upper Wankie sandstones of several species and genera of plants which are characteristic of the European type of Upper Palæozoic flora. No such assemblage has hitherto been found in association with *Glossopteris*. Dr. Walton describes this mixed flora in a beautifully illustrated contribution to the *Bulletin*, and concludes that the evidence favours a Lower Permian or greater age for the Upper Wankie sandstones. The South African glaciation is therefore early Lower Permian or late Carboniferous.

French Floods of 1930.—The disastrous floods in the Midi of France early in March this year are described by M. L. Fournier in an illustrated article in *La Nature* for April 1. It is clear that the amount of rainfall, though heavy, was not alone responsible. Thus at Clermont-Ferrand the falls in January and February were 40 mm. and 30 mm. compared with the mean average of 35 mm. and 32 mm. At Nîmes the figures for the two months were 167 mm. and 108 mm. against a normal fall of 47 mm. and 45 mm. At Montpellier and Perpignan the excess was comparably as great. But this excess of rainfall would not alone have caused floods of such magnitude had it not melted considerable winter snowfall and so enormously increased the deluge of water. Furthermore, the rivers flowing to the west, the Aveyron and the Tarn, with their tributaries, flow in deep ravines which of course prevent the flood waters spreading and increase their disastrous effect. The deforestation of the Cevennes and adjoining regions had much to do with the violence of the floods, in allowing the water to sweep over the surface instead of soaking into the soil held in place by matted roots. Much of the destruction of buildings and bridges was certainly due to tree trunks swept against them, but these were isolated trees that were of no help in diverting the quick drainage of the hillsides.

Electron Diffraction Rings.—Some remarkably fine photographs of electron diffraction rings have been published by H. Mark and R. Wierl in the *Zeitschrift für Physik* for Mar. 18. They were obtained by passing electrons with velocities equivalent to between 30 and 50 kilovolts through sheets of aluminium, silver and gold about 10^{-6} cm. in thickness, and are mostly analogous to the rings obtained in the powder method of X-ray analysis. The extreme sharpness of the rings is largely due to the fact that the time of exposure of the recording film has now been reduced to a fraction of a second, during which there is little chance for conditions to change within the apparatus. The importance of this work lies partly in the information that it gives concerning the law of scattering of electrons by atoms, and partly in the fact that it is a step in the development of a new technique for the examination of thin films.

Flow of Underground Water.—In a paper entitled the "Exponential Law of Subsoil Flow", read by Dr. N. K. Bose before the Punjab Engineering Congress, 1930, an interesting light is thrown on the difficult subject of the flow of underground water. From observations upon a series of wells, from one of which water was pumped, Dr. Bose shows that the ratio of any increments in the rise of the water-level varies as the times of these rises, thus:

if S_0 = the depression below rest-level at time t_0
S_1 = " " " " t_1

$$\log_{10}\frac{S_0}{S_1} = -\lambda(t_1 - t_0)$$

The observations on several wells were carried out during a period of 8 days and appeared to confirm this relationship. It is analogous to Slichter's relationship where, in the above, λ is a function of the yield and dimensions of the well. Rewriting the above in the form

$$S_1 = S_0 e^{\lambda(t_1 - t_0)}$$

the author proceeds to correlate this exponential relationship with the similar laws of velocity flow (Stockes's equation) of viscous fluids.

Anode Spots.—In addition to the well-known striations of the electric discharge in gases, another periodic structure occasionally appears in the form of a highly symmetrical arrangement of bright spots on the anode. One investigation of the conditions under which these appear was reported by O. S. Duffendach and C. H. Thomas in the first January number of the *Physical Review*, and a second paper on the same subject has been published recently by J. Oishi and K. Yosiaka in the *Proceedings of the Physico-Mathematical Society of Japan* (vol. 12, No. 1, January 1930). Cases have been recorded in which upward of seventy spots have formed on an anode a few square centimetres in area. Occasionally the rings of spots rotate, presumably under the action of the magnetic field of the current passing through the discharge tube, but neighbouring rings of spots may move in opposite senses. Spots have been found in hydrogen, carbon monoxide, nitrogen, and some other gases, but not in pure oxygen, argon, or neon. The explanation of the origin of the spots is as yet incomplete; Prof. Duffendach and Mr. Thomas have adduced considerable evidence which tends to show that they are formed by gas being evolved from the material of the anode, and have made on this basis a study of some of the processes of evolution and absorption of gas in the discharge. The Japanese investigators, however, from their work with hydrogen, question if this view is correct. The regular array of spots is strongly reminiscent of a diffraction pattern.

A New Lateral Extensometer.—Few subjects, if any, have received more experimental attention from engineers than the measurement of Young's modulus, E, over a very wide range of conditions, and many extensometers such as those of Ewing and Marten are in common use. On the other hand, apparatus for determining Poisson's ratio, η, are relatively few. Among those who have devised such instruments is Prof. E. G. Coker, who in *Engineering* for April 11 describes a new form of the lateral extensometer designed some years ago by Dr. Scoble and himself. An essential feature of such delicate instruments for measuring small displacements is that the forces produced in it should be minute, and this is obtained by the chief control being exerted by a light spring. In general the instrument consists of a horseshoe frame carrying between its jaws two pointed spindles, one of which is provided with a micrometer screw, while the other presses against the short arm of a bell crank lever, the longer arm of which is connected to a small mirror which can rotate through a small angle. The movement of the mirror will be proportional to the contraction of the specimen. The horseshoe frame is mounted on a compound slide rest which in turn is

pivoted to a block which can be moved up and down a vertical pillar fixed in the base of the mounting. One illustration shows the extensometer in use on a rod under tension, the reflected spot of light from the mirror being recorded autographically on a vertical revolving cylinder.

Oxidation of Benzene.—An investigation of the kinetics of the oxidation of gaseous benzene is reported by C. N. Hinshelwood and R. Fort in the April number of the *Proceedings of the Royal Society*. It has been found that the reaction is predominately homogeneous. A first stage which occurs without change in pressure is followed by further oxidation of the initial products by a mechanism not unlike that of the oxidation of ethylene and acetylene, probably first to glyoxal, formaldehyde, and formic acid, and finally to steam, carbon monoxide, and a little carbon dioxide. It appears that the reaction is of the chain type, and from the greater sensitivity of the rate of reaction to benzene concentration than to oxygen concentration, that the chains are propagated more readily when the initial oxygenated product encounters another molecule of hydrocarbon than when it is oxidised further by oxygen.

Vapour Pressure of Solutions.—A modified form of wet-bulb hygrometer suitable for the measurement of vapour pressures has been described by Prof. A. V. Hill in the April number of the *Proceedings of the Royal Society*. A symmetrically constructed thermopile is set up in a test-tube, in which the vapour pressure is maintained practically constant by the presence of a suitable solution supported on filter paper. Two other strips of filter paper are moistened with the two solutions to be compared, and are laid one on each face of the thermopile, when a difference in temperature is set up on account of the different rates of condensation which is proportional to the difference between the vapour pressures of the solutions on the two faces. The constant of the instrument is found by calibration with known solutions. It takes rather more than half an hour to obtain a reading, and the error of a single observation is of the order of 1½ per cent of the difference read. This method for measuring vapour pressures has the great advantage that it requires very small quantities of the solutions, whilst it has a wide range, it being possible to measure, on one hand the difference in vapour pressure between 0·1 *M*. sodium chloride and 0·2 *M*. cane sugar, or, on the other, the difference between 5 *M*. sodium chloride and water, the latter difference being of the order of 500 times the former.

Dielectric Constants of Water and Hydrogen Peroxide.—Measurements of the dielectric constant of water at various temperatures, made by Cuthbertson and Maas, are given in the February number of the *Journal of the American Chemical Society*. The temperature range used was 0°-75°. The results of previous observers are divergent, and little attention has been paid to the measurement of the temperature coefficient over a wide range. The values at 0°, 15°, 25°, 50°, and 75° C. were found to be 84·4, 78·5, 75·4, 69, and 62·9, respectively. From 25° to 75° the relation to temperature is approximately linear; at lower temperatures the numerical value of the coefficient is greater. The authors point out that the value at room temperature, 18°, namely 77·0, is appreciably lower than the mean of the values found by other observers, namely, 81·05, whilst their values for non-conducting liquids found with the same apparatus agree well with the accepted values. They also note that the Debye equation for polarisability has no significance for a liquid such as water, in which the tendency to association probably varies with the temperature. A second paper by the same authors deals with hydrogen peroxide, the dielectric constants of which and its aqueous solutions were measured. A maximum occurs at 35 per cent of hydrogen peroxide. The value for pure hydrogen peroxide is 89·2 at 0°. The specific conductivity was less than 2×10^{-6}, indicating only very slight dissociation.

Active Nitrogen.—The March number of the *Journal of the Chemical Society* contains a further paper by E. J. B. Willey on active nitrogen, in which the decay of the afterglow has been especially studied. Previous work indicated that the ternary reaction $2N + N_2 = 2N_2 + \text{glow}$ would provide an explanation of the negative temperature coefficient of the decay, but further work showed that the process was to be represented as $2N + 2N_2 = 3N_2$ and that the luminosity and chemical activity are closely related, and not independent as formerly suggested. Other workers have found that the spectrum of the afterglow is independent of the nature of the impurities which must be present to cause nitrogen to develop its glow when sparked, and the view has gained ground that these 'photogens', as they are called, poison the walls of the vessel and prevent recombination of atoms thereon. If this theory is correct, a quantitative relation will exist between the decay mechanism and the purity of the nitrogen, and this was investigated experimentally, the glow being measured by means of a photo-cell. The afterglow was found to be probably partly homogeneous and partly heterogeneous, according to experimental conditions. Unless the walls of the vessel are poisoned by foreign gases, the recombination process is non-luminous and occurs as a surface reaction. As the concentration of impurity rises, the wall reaction diminishes and the homogeneous decay increases. The afterglow probably originates in a reaction $N + N^1 = N_2^1$; $N_2^1 + N_2 = 2N_2(+\text{afterglow})$, N^1 being a metastable 2·3 volt atom which is the chemically active species the energy of which has been measured earlier. No changes are to be seen in the order of decay as it proceeds, neither do the spectral characteristics of the glow between 5900 A. and 4000 A. appear to alter.

New Developments in Technical Electrolytic Processes.—A lecture given by Prof. Billiter to the Society of Austrian Chemists forms the subject of a lengthy article in the *Chemiker-Zeitung* for Mar. 12. Tribute is paid to the excellent work which has been done in this field by Americans. Whereas it was generally supposed twenty years ago that electrolytic methods would gradually be replaced by thermo-electric processes, it is now realised that electrolysis is destined to play a leading part in technical operations in the future. Amongst the processes which are carried out in aqueous solutions the following are described: the refinement of copper, the extraction of zinc, the electrolysis of water, and the preparation of hydrogen peroxide. The increased demand for pure water which is needed for electrolytic operations and for filling accumulator cells, has led to the development of methods of purifying water by electro-osmosis, which yields a purer product than distillation. Important progress has also been made in the use of molten electrolytes, particularly fluorides, by means of which the technical production of beryllium has become possible and improvements have also been made in the extraction of sodium and aluminium. Sodium can now be obtained from the molten chloride, and aluminium is refined by the electrolysis of molten fluoride to a higher degree of purity than was possible in the older process. The use of molten fluorides in electrolysis is rapidly becoming more common.

The Future of British Agriculture.

MANY people to-day are searching for remedies for the depression that hangs so heavily over agriculture, particularly in Great Britain. In a recent paper before the Surveyors' Institution, Mr. T. Wibberley makes his contribution to the problem, and envisages a future for British agriculture when it will rest, even more than to-day, on livestock. This will be achieved, in his opinion, not by the further extension of grassland, but rather by using arable land, to a much greater extent than at present, for the production of food for livestock, by the growth of forage crops, either for grazing, or for cutting for hay or silage, or for harvesting as mixed grain, and by keeping the land more continuously cropped.

Livestock certainly holds out more promise than most other branches of farming. Sir William Haldane has forecast a reasonably bright future for beef-production at home, provided it be of good quality and that there are no great developments elsewhere, as yet unforeseen. The stock population of Great Britain has lately decreased all round, and, if our beef has to face competition from chilled imports of high quality, our mutton is free from similar competition because of transport costs; our pork is at present protected by the import embargo, and there is abundant room for greater bacon production if we could but compete successfully with the Danish article. In addition, we still have a sheltered market for milk, a market capable of considerable expansion by educating the public to the value of milk for children: the poultry industry also is developing.

As against this, grain can be produced so much more cheaply in other parts of the world that it can be transported for thousands of miles and still compete successfully with the home-grown product. It would appear unsound to base the future of our agriculture on the production of uneconomic crops. At the same time, it is difficult to picture a farming system without grain, and even where it is uneconomical to sell, the farmer can feed more of his own grain to stock. In successful farming systems in Great Britain or in Denmark at the present time, nearly half the arable area is still devoted to grain; indeed, Denmark recovered from the depression at the end of last century without appreciably altering the proportion of arable area devoted to grain. Since the period 1889–93 this proportion has been consistently 2 or 3 per cent below that of England, but about 14 per cent greater than that of Scotland, where more use is made of temporary leys. Grain crops are needed for the production of straw, required by the animals on the farm. Arable land cannot yet be farmed successfully without farmyard manure, whether it be made naturally or by chemical means.

The proportions of arable land devoted to different crops in the various periods from 1889 to 1927 is as follows:

	1889–93.			1899–1903.			1909–13.			1923–27.		
	England.	Scotland.	Denmark.	England.	Scotland.	Denmark.	England.	Scotland.	Denmark.	England.	Scotland.	Denmark.
Corn crops	52	36	49	50	36	49	52	36	46	51	35	49
Roots .	17	17	5	17	17	9	18	18	14	17	17	18
Green crops	27	46	39	30	47	36	27	46	35	28	48	31
Fallow .	4	..	7	3	..	6	3	..	5	4	..	2

'Roots' includes potatoes.
'Green crops' includes temporary grass, lucerne, mustard, etc.

Denmark emerged from her agricultural crisis by increasing the root break and the livestock population, although, even now, the proportion of arable area under roots is only slightly greater than in Great Britain, and much below what it is in particular districts, such as East Lothian and the Holland division of Lincolnshire. Mr. Wibberley suggests a similar change now for British agriculture, except that the increased production of stock food should be in the form of various forage crops rather than roots.

There seems little doubt that forage crops are cheaper to produce than roots, and this economic problem reacts on the agricultural situation in a way that is frequently overlooked. The labour situation, at least in the southern parts of Great Britain, is neither sound nor stable, and no farming system can be sound if it rests on an unsound foundation. The farmer, under present conditions, cannot face a higher total wage bill; but it is equally impossible to retain the best men amongst the agricultural labourers at present wages, despite all efforts at rural education, particularly if and when an industrial revival occurs. The future will probably see fewer workers, and, unless agriculture is content to struggle along with inferior labour, these will be more highly paid and will produce more, many aspiring, possibly, to eventual independence. Labour considerations alone indicate developments of agriculture in three directions:

(1) A more extensive mechanised farming, demanding, of course, large fields and open country.
(2) More stock-keeping, affording scope for good well-paid men.
(3) Smaller holdings worked by families setting a high value on independence, and recruited from the rising generation of keen young men, such as those sons of rural workers turned out in increasing numbers by farm institutes.

Mr. Wibberley is not hopeful of intensive grassland management. However, if only the existing grassland in Great Britain were better managed, our stock-carrying capacity would be greatly increased; but this would accentuate the problem of providing sufficient food to last the winter.

The extent to which arable land should be further utilised for animal food production is difficult to decide. Each district or even farm must be considered separately. The weather is liable to upset a complex forage-cropping system; soils in drier districts may dry out; weeds may get out of control, specially if the next crop is sown on the unploughed stubble of the old; particular farms—or farmers—may not be suited to tractor work, and certain soils would prove unsuitable for continuous cropping. The crops grown would also differ: in those parts where high yields are obtainable, and labour is efficient, roots can hold their own. At very least, better advantage could be taken of the full growing season, and an end should be made of such practices as leaving a winter oat stubble untouched until the winter, and bare of crop from August to March or April.

The future of British agriculture seems to demand a closer relationship between the grassland, well managed, and the arable; a better demand for the produce, particularly that raised under sheltered conditions; a better marketing organisation, more education, and the reduction of losses which may at present be preventible or non-preventible. One feels on safe ground in believing that the future of agriculture in any district will continue to be largely influenced by local conditions, economic, geographic, and climatic, and in accepting the Prime Minister's phrase, "the inevitability of gradualness". H. G. MILLER.

The Physical Reality of 'Side-bands.'

By F. M. COLEBROOK, Wireless Division, National Physical Laboratory.

THE variation of the amplitude of a continuous electric wave in a periodic manner is commonly understood as being equivalent to adding waves of certain defined frequencies to the original wave train. The mathematical formulation underlying this interpretation has not been questioned, but Sir Ambrose Fleming, an eminent authority on wireless communication, has recently voiced, in the columns of NATURE, a doubt that many others may have shared as to the physical reality of the added radio-frequencies attributed to the process of modulation.

It is necessary to consider what is meant by the words 'physical reality' in this connexion. It will probably be generally agreed that no more than the purely pragmatic criterion is involved. If an amplitude modulated continuous wave is found to behave in every respect as if it consisted of waves of the original frequency associated with waves of the hypothecated side frequencies, then the latter can be said to exist physically in the only sense in which the phrase has any useful meaning.

From the purely practical point of view of wireless communication, the criterion can be still further limited to those characteristics which are actually involved in the processes of transmission and reception.

Prof. Fortescue [1] and Mr. Ratcliffe [2] have pointed out in the course of correspondence on this subject that there is experimental evidence for the physical reality of side-bands in the above sense. The following experiments are thought to give clear and decisive evidence to the same effect.

A valve-maintained oscillator was adjusted to a frequency of 40,100 cycles per second. In the field of this oscillator a receiving circuit was set up, consisting of an inductance and a tuning condenser. A valve-voltmeter was connected across the terminals of the latter, and the ordinary tuning curve of the receiving circuit was recorded. It was found to be a single-peaked resonance curve of the ordinary type. The oscillator was then modulated at 4010 cycles per second by means of the e.m.f. induced in a suitably tuned circuit coupled to an audio frequency oscillator set at the above frequency. The tuning curve of the receiving circuit was again recorded. It is shown in Fig. 1. The tuning capacities of the side peaks correspond very approximately to the frequencies 40,100

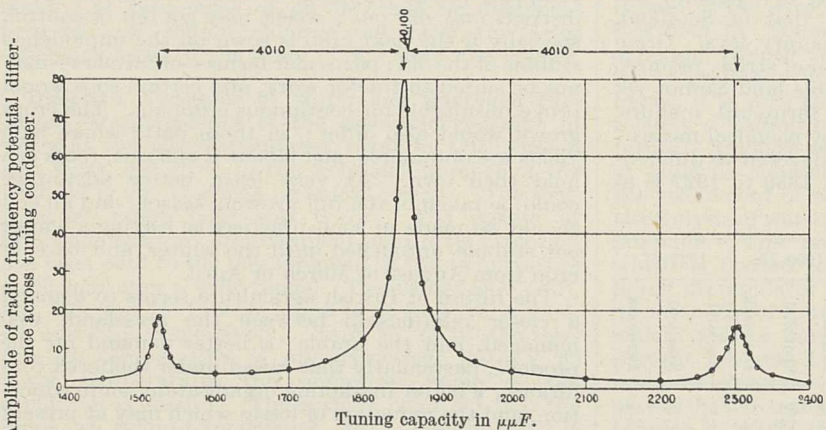

FIG. 1.—Radio frequency resonance curve. Radio frequency, 40,100 cycles/sec.; modulation frequency, 4010 cycles/sec.

+4010 and 40,100 −4010 cycles per second. This demonstrates that the modulated continuous wave behaves as if it had wave components which produce resonance in a circuit tuned to the above sum and difference frequencies.

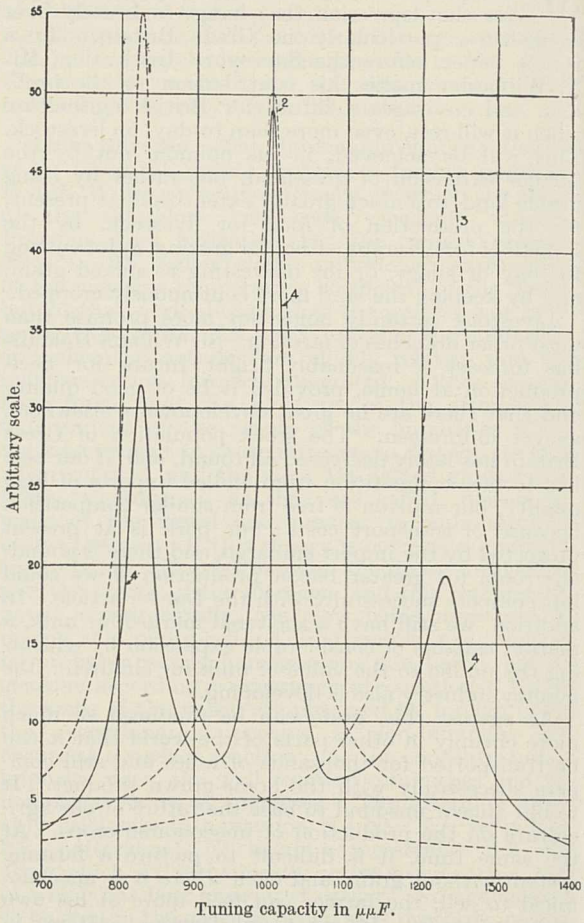

FIG. 2.—Curves 1, 2, 3: calculated resonance curves corresponding to carrier and side frequencies, assuming equal e.m.f.'s for each. Curve 4: calculated variation of the modulation frequency output with tuning capacity. Carrier frequency, 80,000 cycles/sec.; modulation frequency, 8000 cycles/sec.

The next step was to investigate analytically and experimentally the result of rectifying the potential difference across the tuning condenser produced by the modulated field. It is well known that the rectified current will contain a component of modulation frequency. The case was analysed in general terms for square law rectification and a formula was derived expressing the variation of the intensity of the modulation frequency component as a function of the tuning capacity. As a numerical example the following values were assumed:

$\lambda = 3768$ metres
($\omega = 2\pi \times$ frequency $= 51 \times 0^5$),
Modulation frequency = 7960
(*i.e.* $2\pi \times$ mod. freq. $= 5 \times 10^4$),
Receiving circuit inductance = 4 millihenries,
Receiving circuit resistance = 40 ohms.

This case is illustrated in Fig. 2. It will be ob-

served that there are three distinct tuning maxima corresponding very approximately (though not quite exactly) to the tuning capacities for resonance of the sum and difference frequencies. Further, of the two side maxima, that corresponding to the smaller tuning capacity is taller and narrower than the other. An important point is that the shape of this curve is independent of the modulation depth (that is, the relative magnitude of the amplitude change due to the modulation). The ordinates, however, are proportional to the modulation depth.

For the experimental investigation a rectifying valve was connected across the tuning condenser, and the intensity of the modulation frequency component of the anode-circuit current was measured by means of the same valve-voltmeter as was used in the radio frequency experiment. Care was taken that the received voltage applied to the rectifier was small enough to result in square law rectification, and also that the recorded output voltage contained no appreciable radio frequency components (these being filtered out by the action of an audio frequency transformer). The result is shown in Fig. 3. The circuit constants and frequencies were different from those considered in the analytical case, and the respective curves are not therefore in quantitative agreement. The principal features of the analytical deductions are, however, fully confirmed, there being three distinct tuning maxima with similar relative heights and breadths. (It will be noted that the radio frequency differs slightly—$\frac{1}{4}$ per cent, in fact—from that in Fig. 1, but this is immaterial. In each case the audio frequency was set to exactly one-tenth of the radio frequency, to avoid interference between the latter and the tenth harmonic of the former).

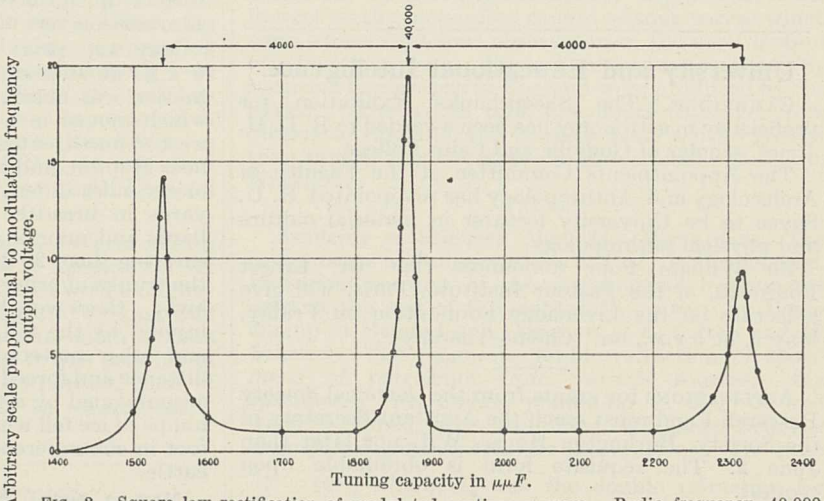

FIG. 3.—Square law rectification of modulated continuous wave. Radio frequency, 40,000 cycles/sec.; modulation frequency, 4000 cycles/sec.

The above analysis was based on the usual representation of the modulated wave as the sum of a carrier frequency and the two sum and difference frequency wave trains. The experimental confirmation, therefore, shows that these side frequencies exist physically in an actual modulated wave train in the sense in which that phrase has been defined above.

It should be pointed out that if in another actual case the three peaks are not observed, it will not be a logical deduction that the side frequencies do not exist. The matter is quite comparable with spectrum analysis in optics. There is a limit to the resolving power obtainable with a spectroscope or grating. Similarly there is a limit to the resolving power obtainable in a tuned receiving circuit. For example, with carrier and modulation frequencies of a million and a hundred cycles per second respectively, there would almost certainly be one peak only in the tuning curve, unless by some means, such as the use of retro-action in the valve rectifier, the receiving circuit resistance were reduced to very much less than its normal value. Thus the separate peaks may not be observable under medium wave broadcasting conditions. It was found, however, that three peaks were observable in another set of measurements made at frequencies comparable with those involved in long wave broadcasting.

Full details of the theoretical and experimental work described above are given in a paper entitled "The Rectification of a Modulated Continuous Wave" which will shortly be published in *Experimental Wireless*.

[1] NATURE, Feb. 8, 1930.
[2] NATURE, Feb. 22, 1930.

Kevin-Sunburst Oilfield, Montana.

MUCH is heard concerning the oil possibilities of the Rocky Mountain States of North America, but in spite of all the survey work accomplished in likely regions, there has really only been one conspicuous development, Salt Creek, Wyoming, a field which is still producing well over 20,000 barrels of oil per day. It is therefore encouraging to note the progress of the comparatively new Kevin-Sunburst field in Montana, which, with a daily production of more than 6000 barrels and with reasonable probabilities of extension, ranks second in importance throughout the mountain States.

Oil was originally discovered at Kevin in March 1922 in a structure known as the Sweetgrass arch, an uplift comparable in many respects with the better-known Cincinnati fold of Ohio. The Kevin-Sunburst structure is essentially a 'bulge' on the crest of the arch, located just south of the Canadian boundary. In the five-year period to 1927, some 1500 wells were drilled into this structure, of which more than 880 were productive, a proportion which, for the Rocky Mountain fields, is quite high. The area has more than usual stratigraphical interest, since it includes a prominent representative of the Jurassic system beneath the thick spread of Cretaceous rocks so characteristic of this part of the world. One does not expect extensive developments of Jurassic rocks in the Rocky Mountain States, having regard to geological conditions in general at this epoch; still more surprising is the fact that the best production of petroleum in this field comes from the Ellis formation of that age, from sands situated not far above the

base, an unconformable contact with the Carboniferous. There is also minor production from the Cretaceous beds.

The point at once arises that the Carboniferous rocks (Madison limestone) may be the ultimate source of the oil and that the Jurassic can only claim migrated supplies. The unconformity is a big one, so that this may indeed be the case, though Mr. A. J. Collier, the author of the recent bulletin on the subject (U.S. Geological Survey, No. 812-B) giving the latest account of this field, inclines to the view that the indigenous source is the Ellis formation, and backs his opinion with data of more than local interest.

University and Educational Intelligence.

CAMBRIDGE.—The Sheepshanks Exhibition for proficiency in astronomy has been awarded to R. D. H. Jones, scholar of Gonville and Caius College.

The Appointments Committee of the Faculty of Archæology and Anthropology has reappointed R. U. Sayce to be University lecturer in material culture and physical anthropology.

Sir William Pope announces that Dr. Ernest Fourneau, of the Pasteur Institute, Paris, will give a lecture on the Liversidge Foundation on Friday, May 9, at 5 P.M., on "Chemo-Therapy".

APPLICATIONS for grants from the Chemical Society Research Fund must reach the Assistant Secretary of the Society, Burlington House, W.1, not later than June 2. The requisite form is obtainable upon request.

RAMSAY memorial fellowships for chemical research, one limited to candidates educated in Glasgow, will shortly be awarded. The fellowships will each be of the yearly value of £250 plus, possibly, a grant for expenses. They will be tenable for two years, with a possible extension of a year. Applications must be sent to reach the secretary of the Ramsay Memorial Fellowship Trust, University College, Gower Street, W.C.1, by June 5 at latest.

STATE grants to Universities in Great Britain are to be increased by £250,000 a year. For five years they have stood at £1,550,000, to which figure Sir Austen Chamberlain raised them in 1925. When the Universities presented to the Chancellor of the Exchequer last November, through a deputation introduced by Lord Cecil, the case for a further increase, they asked also for capital grants for buildings. Mr. Snowden recognised "the great and increasing extent to which they are serving the social and industrial progress of the people" and that "it is quite reasonable that the State should contribute in substantial measure to the cost of maintaining our universities and colleges as active centres of education and research, and few, if any, items of public expenditure can be of clearer national value", but he holds that there is comparatively little weight in the arguments for capital grants. The most cogent argument for increased assistance is based on the increased expensiveness, due to the progress of science, of the plant and staff requisite for maintaining the high standard of efficiency in instruction and research which is indispensable for national well-being in the face of the economic competition of other nations in the world of commerce. For the provision of new plant Mr. Snowden thinks that "the fine record of benefactions received by the universities during the last four or five years encourages the hope that during the coming quinquennium private generosity may again prove not unequal to the task".

Historic Natural Events.

May 11, 1894. Remarkable Hail.—During a severe hailstorm at Vicksburg (U.S.A.) a remarkably large hailstone was found to have a solid nucleus, consisting of a piece of alabaster, from $\frac{1}{2}$ to $\frac{3}{4}$ inch in length. During the same storm, at Borina, 8 miles east of Vicksburg, a gopher turtle, 6 in. by 8 in., and entirely encased in ice, fell with the hail. These hailstorms occurred on the south side of a region of cold northerly winds; they were apparently accompanied by local whirls which carried heavy objects from the earth's surface up to the clouds, where they were encased by successive layers of snow and ice.

May 12, 1811. Tornado in Derbyshire.—About 5 P.M. at Bonsall, in the Peak district, a singular motion was observed in a cloud of serpentine form, which moved in a circular direction, from south by west to north, extending itself to the ground. It began near Hopton, and continued along a course about five or six miles in length and about four or five hundred yards in breadth, tearing up plantations, levelling barns and miners' cots. It uprooted large ash trees, carrying them 20-30 yards, and twisted the tops from the trunks of other trees, dropping them 50-100 yards away. Cows were lifted from one field to another, and injured by the fall; miners' bubble-tubs, wash-vats, and other materials were carried to a considerable distance and forced into the ground. The tornado was accompanied by a tremendous hailstorm; stones and lumps of ice fell which measured from nine inches to a foot in circumference, breaking windows and injuring cattle.

May 13, 1922. Hailstorm at Montpellier, France.—On this date a hailstorm occurred at Montpellier, France. So great was the fall that traffic was blocked in the streets, and the inhabitants were obliged to clear the pavements with shovels. The hailstones averaged half an inch in diameter, and on open ground they lay to a depth of four inches, but in streets where they were washed into heaps by the accompanying rain, and caked together, they formed a layer from $1\frac{1}{2}$ to 2 feet deep.

May 13–17, 1921. Magnetic Storm and Sunspot.—A magnetic storm of great intensity and long duration commenced on May 13·6 and lasted until May 17. At Greenwich the traces of declination, horizontal force, and vertical force passed continually beyond the recording sheets; the measured ranges of the three elements were respectively $>100'$, $>740\gamma$, and $>460\gamma$. At Kew the corresponding ranges were $132'$, $>650\gamma$, and 1500γ. The storm reached its greatest intensity between 0^h and 8^h G.M.T. on May 15. Oscillations of the needles were frequently so rapid that the movements were barely recorded on the photographic sheets. The disturbance was accompanied by brilliant displays of the aurora, and there were serious dislocations of the telephone and telegraph services over a great part of the world. At the time of the commencement of the storm, a large naked-eye sunspot was one day's travel east of the sun's central meridian. The spot, which was situated on the sun's equator, was of unusual development.

May 14, 1886. Floods.—Following three days of excessive rainfall in Wales and the west Midlands on May 11–13, disastrous floods occurred on May 14 and 15. At Worcester the Severn rose to 17 ft. 10 in. above the ordinary summer level; this was described as the highest flood for 115 years. The Trent at Nottingham was nearly 19 feet above the summer level, but did not equal the flood of 1852.

May 15, 1586. Waterspout.—At Kestrzan in Bohemia a powerful whirlwind carried the water of two

ponds into the air with all the carp and pike that they contained. On the following day there was a waterspout on Lake Constance near Meilen.

May 15, 1608. Cold Spring.—Not only the winter of 1607–8 (see Jan. 10) but also the following spring, were abnormally cold. The rivers remained frozen well into the spring, and it is recorded that so late as May 15 boys were sliding on the frozen ditches at Dantzig. The season was also severe in North America, and resulted in the destruction of the European colony of Sagadahoc.

May 15, 1893. Drought.—The famous 'spring drought' of 1893 was, while it lasted, one of the most severe on record in England and the neighbouring parts of Europe For a period of 114 days commencing on Feb. 28, the total rainfall in London was only 1·09 in., and during the four months March to June less than a third of the normal rainfall was experienced in southern England. At Hurst Castle (Hampshire) a period of 59 days from Mar. 18 to May 15 was completely rainless, and a large part of southern England had no rain in April.

May 16, 1646. Rain of Brimstone.—Worm relates that "the whole city of Hasnia [? Asniara Is. off Italy] and all its streets were inundated with a mighty rain so that men were prevented from walking and the air was infested with a sulphureous odour; when the waters had subsided somewhat it was possible in some places to collect a sulphureous powder, some of which would pass for real sulphur as regards taste, colour, smell, etc.".

Societies and Academies.

LONDON.

Geological Society, April 9.—Léon W. Collet: The structure of the Canadian Rockies. The results of a two months' expedition (financed by the Shaller Fund) along the Athabasca Valley (Jasper National Park) and round Mount Robson (B.C.). A complete section across the Rockies was made, from the eastern border to Yellow Head Pass. This mountain-chain is made up of seven 'blocks' thrust one over the other from west to east, and separated by 'clean-cut thrusts' of the type of the North-West Highlands of Scotland. The Canadian Rockies and the Alps show two different types of folding. The structure in blocks of the Canadian Rockies corresponds to Argand's 'ground folds' (*plis de fond*), while the Alps are made up of 'recumbent folds' developed in a geosyncline. In the Canadian Rockies the energy necessary for the folding was much greater than in the Alps for in the former the strata have been cut into blocks as far down as the Pre-Cambrian. The Ordovician and the Silurian are missing in the eastern part of the Rockies. The Ordovician alone appears in the western part. This stratigraphical gap is a repercussion, across the Canadian Shield, of the Caledonian folding of the Canadian Appalachians.

Royal Meteorological Society, April 16.—S. K. Banerji: The electric field of overhead thunderclouds. Changes in the electric field produced by eighteen thunderclouds during their passage over the Colaba Observatory in 1929 suggest that the majority were of the 'unitary type' and had their front part negatively charged, the central part positively charged, and the rear negatively charged. A few were of the 'double type' and produced changes in the field as if two thunderclouds of unitary type had passed over in succession. In those thunderclouds which caused heavy rainfall, fluctuations in the central positive field occurred by loss of charge by rainfall or by increased concentration of positive charge by increased vertical current, in agreement with the breaking-drop theory. The monsoon clouds produced an electric field which was pre-eminently negative during periods of rainfall.—F. J. W. Whipple: The great Siberian meteor and the waves, seismic and aerial, which it produced. On June 30, 1908, a great meteor fell in Siberia, probably the greatest meteor which has occurred in historic times. The blast of air produced by the meteor devastated the forests over an enormous area. Leonard Kulik explored the region in 1927 and found the numerous holes in which, it is presumed, the fragments of the original meteor are buried. The impact of the meteorites caused seismic waves which were recorded at four observatories, the most distant of which was Jena. Remarkable waves recorded by sensitive barographs in England were produced by the meteor. The waves took five hours to travel from Siberia to England, the velocity being a little greater than that of the waves due to the famous eruption of Krakatoa.

PARIS.

Academy of Sciences, Mar. 24.—Bigourdan: The instruments and observations of P. J. de Beauchamp. Historical account of the astronomical instruments used at the end of the eighteenth century by Beauchamp at Bagdad and elsewhere.—A. Cotton and M. Scherer: The magnetic double refraction of specimens of petroleum from various sources. Six specimens, with boiling points up to 250° C. and roughly refined, were examined, the large Bellevue magnet being utilised for the observations. The ratio $\frac{C_m}{d} \times 10^{14}$, where C_m was the double refraction for unit field and unit thickness, varied between 5·53 for Pechelbronn petroleum to 27·0 for the Morenic oil.—Henri Villat and Maurice Roy: The problem of Saint-Venant in the case of pure torsion.—Alfred Rosenblatt: Certain relations between the integrals of the first species of Picard belonging to an algebraic surface.—M. Cioranescu: Certain inverse problems relating to potential.—Maurice Coissard: A class of partial differential equations of the first order, with two independent variables.—Antonio Signorini: A mixed problem.—T. Bonnesen: Inequalities between arithmetical means.—J. Dieudonné: Some applications of the lemma of Schwarz.—Henri Cartan: The analytical transformations of encircled domains.—L. Ahlfors: Some properties of meromorph functions.—Elie Cartan: Linear representations of simple and semi-simple groups.—R. Swyngedauw: The measurement of the power dissipated in organs of transmission.—N. S. Argeanicoff: The theory of Witoszinsky.—Alexandre Rajchman: An algebraic equation which occurs in the kinetic theory of gases.—Th. De Donder: The signification and invariance of the quantic constant h deduced from gravifics.—Pierre Bricout: An absolute micromanometer with electrostatic compensation.—A. Poirot: The anodic rays of sodium, potassium, calcium, and barium.—Constantin Salceanu: The magnetic double refraction of organic substances in the fused state. The measurements were made with the large electro-magnet of the Academy of Sciences in a field of about 43,000 gauss. Data are given for β-methylnaphthalene, at temperatures between 89° C. and 36·5° C., and for three different wave-lengths.—R. Coustal and F. Prevet: The optimum concentration for the phosphorogen and flux in zinc sulphide, copper, and the variation of this optimum with the temperature of the preparation. Copper behaves differently from other phosphorogens, especially as regards the extremely small quantities required when the temperature of preparation is high.—Guy Emschwiller: The photolysis of organic

iodides: the utilisation of the light. The photolysis of organic iodides is a complex phenomenon. The coefficient of utilisation of the ultra-violet light depends on the temperature and on the nature of the organic compound. The quality of the radiation also has an effect. In the calculations it is necessary to take into account the fact that the iodine set free acts as an internal screen. Details of experiments on ethyl iodide are given.—**Maurice François**: The action of concentrated ammonia on the compound $HgCl_2 2NH_3$. The formation of monomercurammonium chloride, $HgNH_2Cl$, and of hydrated dimercurammonium chloride, Hg_2NCl,H_2O.—**J. J. Rutgers**: The micro-estimation of mercury in organic compounds. The organic compound is burnt in a current of oxygen mixed with the vapour of aqua regia, the mercuric chloride formed being afterwards electrolysed. Examples are given showing the accuracy of the method.—**Edmond Rabaté** and **Jean Fleckinger**: A colour reaction for the proteids of the wheat seed. The hydrobromic acid reagent suggested by Denigès as a specific test for ionised copper is also a good reagent for the proteids of the embryo and the diastase layer of wheat seeds.—**Albert Kirrmann**: The condensation of pyruvic acid with the fatty aldehydes.—**Desmaroux** and **Mathieu**: The solutions of diphenylurea in nitrocellulose. Study of the alterations produced in the X-ray photographs of films of nitrocellulose by the additions of varying proportions of diphenylurea to the nitrocellulose solutions before forming the film.—**M. Bourguel** and **R. Truchet**: The action of the chlorides of the aromatic sulphonic acids on the sodium derivatives of acetylene hydrocarbons. In an attempt to prepare acetylene sulphones the reaction was abnormal; there was no sodium chloride produced, the reaction found being

$$R \cdot C \equiv C \cdot Na + ClSO_2R' = R \cdot C \equiv C \cdot Cl + R'SO_2Na,$$

a simple exchange of chlorine for sodium, the reaction products being a sulphinate and α-chloro derivative of the acetylene hydrocarbon.—**L. Berthois**: Study of the heavy minerals of the granite massif of Fougères (Ille-et-Vilaine). Details of the isolation of zircon, tourmaline, monazite, sphene. In the contact zone were found andalusite, sillimanite, and zoisite.—**Ch. Gérard**: Some particular points of the stratigraphy of the ferruginous Aalenian of Meurthe-et-Moselle.—**André Rivière**: A section observed in the middle valley of the Djerjeroud (Persia).—**H. Arsandaux**: The present eruption of Mt. Pelée. The products of consolidation do not differ from those of the previous eruption.—**Mlle. D. Le Maitre**: The presence of algæ and of foraminifera of the genus *Endothyra* in limestones of Devonian age.—**A. Demolon** and **G. Barbier**: The valuation of the phosphoric acid deficiency of soils. The basis of the method is the amount of phosphoric acid extracted by the soil from a phosphate solution containing 1 per cent of acetic acid and varying proportions of phosphate. It is considered that such measurements form a better criterion of the deficiency of the soil in phosphates than the determination of the amounts of phosphate extracted from the soil by the usual methods.—**Emile F. Terroine** and **Mlle. Thérèse Reichert**: Common salt in cattle feeding: its action on nitrogenous metabolism.—**A. Vandel**: The production of *intercastes* in the ant, *Pheidole pallidula*, under the action of parasites of the genus *Mermis*.

GENEVA.

Society of Physics and Natural History, Feb. 20.—**P. Chodat**: A new method for the determination of the iso-electric point by ferments. The author communicates the results of his experiments relating to the variations of the curve expressing the activity of the ferment catalase as a function of the real acidity of the medium: according to the nature of the system employed, saline or protein, normal or deviating curves are obtained. Deviations are interpreted as being due to the isoelectric state of the particles of proteid utilised as a buffer.—**R. Wavre**: The method of the cavity and the internal movements of the planets. The author shows that the method of the cavity, for the discussion of the equilibrium figures relating to the fluid stars, is still applicable if the latter are endowed with permanent rotation of genus one. The study of the internal movements of genus one, although longer, does not introduce essentially new theoretical difficulties compared with the study of equilibrium figures.

ROME.

Royal National Academy of the Lincei, Jan. 5.—**T. Levi-Cività**: Characteristics and bicharacteristics of Einstein's gravitational equations. The general theory of characteristics developed by Volterra and Hadamard is applied to the particular case of the gravitational equations of relativity.—**V. Nobile**: The intermediary trihedra of reference for stellar dynamics: criteria of selection.—**L. Rolla** and **L. Mazza**: Systems of telegraphy and telephony by means of pencils of infra-red radiations. Experiments are described in which the source of the radiation is an arc between hollow carbons packed with mixtures of halides (mainly fluorides) and oxides of alkali and alkaline earth metals. The modulation circuits were analogous to those used by other investigators, but were fitted with devices to render the arc more stable, while the modulation current was obtained by amplifying the microphone current by a thermionic valve. The transmitter consisted of a small parabolic mirror (diameter 18 cm.), of ray filters, and of a special electromagnetic vibrator connected with a Morse telegraphic transmission instrument. With arcs carrying 100 watts, satisfactory telephonic communication was possible over distances exceeding 6 km.—**G. Tizzoni** and **G. De Angelis**: Certain causes which may weaken or destroy the immunising power of our phenolated anti-cancer vaccine. Infection of adeno-carcinoma pus (Ehrlich), even with common bacteria, modifies appreciably and in some cases completely annuls the activity of the phenolated vaccine. Such infection has no effect on the growth or power of the virulent cancerous pus, which has thus greater resistance than the vaccine. It is hence absolutely necessary that the vaccine should be bacteriologically pure.—**E. Bompiani**: Projective interpretation of certain ordinary differential equations of the second order. New results are given in connexion with the projective interpretation, already published, of certain types of differential equations $v'' = F(u, v, v^1)$ on a surface σ of S_3.—**L Laboccetta**: Segmental interpolation and classification of polygonal functions.—**C. Popovici**: Integro-functional equations.—**L. Godeaux**: A property of the envelope of certain families of quadrics.—**B. Finzi**: Dynamic actions relative to plane irrotational motions of viscous liquids. Formulæ are determined which permit of the characterisation of the dynamic actions exerted on a line of flux by a viscous liquid in irrotational motion. The expressions obtained represent the sum of two terms, the first being independent of the viscosity of the liquid and expressible by the known formulæ of Blasius, while the second gives the effect due to the viscosity. The expressions defining the viscosity are particularly simple and are analytical in character; moreover, they are valid not only for lines of flux but, unlike the expressions of the formulæ of Blasius, also for any line whatever.—**N Siracusano**: New phenomena observed in the annular discharge. The two hypotheses,

advanced by J. J. Thomson and Lehmann respectively, to explain the annular discharge observed when the discharge currents of two large Leyden jars excited by a coil or an electric machine are passed through a few coils of copper wire round a highly evacuated glass tube or flask, are discussed. The conclusion drawn is that both hypotheses may be accepted, since the conditions of excitation and gas pressure are such as to give rise to the causes assumed by each. Various new observations are described.—**Remo de Fazi and F. Pirrone**: Studies on indones; new reactions of α-ethyl-β-phenylindone and of α-methyl-β-phenylindone (10). Attempts to prepare diethyldiphenyltruxones by the action of copper on αβ-dichloro-α-ethyl-β-phenylhydrindone, obtained by passing chlorine into a solution of α-ethyl-β-phenylindone in anhydrous carbon tetrachloride, resulted in the formation of $\alpha\alpha^1$-diethyl-$\beta\beta^1$-dichloro-$\beta\beta^1$-diphenyldihydrindone and α-ethyl-*b*-phenylindone.—**E. Oddone**: The depth of activity of the hypocentres of earthquakes and the causes of the latter.—**M. Tirelli**: Irreversible change in the viscosity of the eggs of *Bombyx mori* L. The experiments described deal with the changes produced in the viscosity of silkworm egg juice with eggs of a pure Chinese race and of a Chinese-Italian cross by heating and by treatment with gaseous ammonia.—**C. Jucci**: Pigments of the blood, cocoon, and egg of the silkworm.—**G. Lentati**: Study of the primary endocrine tissue of the pancreas of birds.—**G. Mezzadroli and E. Vareton**: Further investigations on the action exerted by a radio-oscillator for ultra-short waves of 2-3 metres wave-length on the germination of seeds and on the growth of plants (1). Ultra-short electromagnetic waves always exert a favourable influence on the germination of seeds and on the development of plants, the extent of the action increasing with the nearness of the radio-oscillator and, within certain limits, with the intensity of the waves. Interposition of a Lakhovsky oscillating circuit over the germinator or plants during the exposure to the waves enhances the effects.—**L. De Caro**: Regulating power of the principal constituents of muscle juice.

Official Publications Received.

BRITISH.

The Proceedings and Transactions of the Nova Scotian Institute of Science, Halifax, Nova Scotia. Vol. 17, Part 3, Session 1928-1929. Pp. xix-xxxii+149-212+iii. (Halifax, N.S.) 50 cents.

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 17: The Mineral Content of Pastures. Progress Report on Co-operative Investigations at the Waite Agricultural Research Institute. Pp. 29. (Melbourne: H. J. Green.)

Government of India: Meteorological Department. Magnetic, Meteorological and Seismographic Observations made at the Government Observatories, Bombay and Alibag, in the Year 1925, under the direction of Dr. S. K. Banerji. Pp. iv+135+5 plates. (Calcutta: Government of India Central Publication Branch.)

Union of South Africa: Department of Agriculture. Science Bulletin No. 74: South African Tanning Materials. Part 2: Trees and Plants other than the Black Wattle. By C. O. Williams. (Division of Chemistry, Series No. 93.) Pp. 68. (Pretoria: Government Printing Office.) 6*d*.

The Ross Institute and Hospital for Tropical Diseases (Incorporated), Putney Heath, London, S.W.15. Annual Report and Accounts for 1929. Pp. 65. (London.)

Quarterly Journal of the Royal Meteorological Society. Vol. 56, No. 234, April. Pp. 103-205. (London: Edward Stanford, Ltd.) 7*s*. 6*d*.

Journal of the Chemical Society. April. Pp. iv+569-905+x. (London.)

Proceedings of the Cambridge Philosophical Society. Vol. 26, Part 2, April. Pp. 123-284. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

The Quarterly Journal of the Geological Society. Vol. 86, Part 1, No. 341, April 23rd. Pp. xlviii+128+14 plates. (London: Longmans, Green and Co., Ltd.) 7*s*. 6*d*.

FOREIGN.

Mitteilungen der Prähistorischen Kommission der Akademie der Wissenschaften. Band 2, Nr. 5: Der Oberleiserberg, ein Zentrum vor- und frühgeschichtlicher Besiedlung. Von Dr. Herbert Mitscha-Marheim und Dr. Ernst Nischer-Falkenhof. Pp. 391-438+19 Tafeln. (Wien: Hölder-Pichler-Tempsky A.-G.)

Field Museum of Natural History. Zoological Series, Vol. 18, No. 1: Descriptions of Five new Indo-Chinese Birds. By Outram Bangs and Josselyn Van Tyne. (Publication 272.) Pp. 4. (Chicago.)

University of California Publications in American Archaeology and Ethnology. Vol. 28, No. 3: The Ghost Dance of 1870 in South-Central California. By A. H. Gayton. Pp. 57-82. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 35 cents.

The Peking Society of Natural History. Bulletin, Vol. 4, Part 3: Yenching Science Conference Papers. Pp. 117. (Peking.) 1.50 dollars.

Flora Sinensis. Series B, Vol. 24, Part 1: Chinese Medicinal Plants. Ephedra. Part 2: The Botany of Mahuang. By Prof. Bernard E. Read. Abstracted from the work of J. C. Liu, with additional Notes from Stapf, Meyers, Groff and others. Pp. 29+2 plates. (Peping: Peping Union Medical College.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 26, Part 1: Flora of Hokkaido and Saghalien. 1: Pteridophyta and Gynospermae. By Kingo Miyabe and Yushun Kudo. Pp. iii+79+3 plates. (Tokyo: Maruzen Co., Ltd.)

Scientific Papers of the Institute of Physical and Chemical Research. Nos. 228-231: Does Puncture Test under Oil give the True Electric Strength of Insulators?, by Takeshi Nishi; Contribution to the Study of Photographic Chemistry, Report 1: On the Dispersion of Silver Halides through Aqueous Medium, by Tsuneo Suzuki; On the Spark Ignition of Low Inflammable Gas Mixtures, by Kiyohiko Yumoto; Colour of Alloys, by Masawo Kuroda. Pp. 275-320+plates 20-23. 95 sen. No. 232: The Near Infra-Red Spectra of Helium and Mercury, Part 2. By Toshio Takamine and Taro Suga. Pp. 6+3 plates. 25 sen. No. 233: On the Absorption Spectra of Salt-Solutions. 2: The Absorption Spectra due to the Oxyacidic Anions. By Sechi Kato. Pp. 7-21. 25 sen. No. 234: The Angular Intensity Distribution of Continuous X-ray Spectrum, 2. By Yoshikatsu Sugiura. Pp. 23-47. 50 sen. No. 235: On the Absorption Spectra of Salt-Solutions. 3: The Absorption Spectra due to the Cations. By Sechi Kato. Pp. 49-58. 25 sen. (Tōkyō: Iwanami Shoten.

CATALOGUES.

A General Catalogue of the Manufactures of Adam Hilger, Ltd., containing Sections D, E, F, H, K, L, M, and N. (January 1930.) Pp. 8+D29+E49+F44+H44+K3+L9+M30+N16+x. (London: Adam Hilger, Ltd.)

Classified List of Second-hand Scientific Instruments. (No. 97, April 1930.) Pp. vi+58. (London: C. Baker.)

Diary of Societies.

FRIDAY, MAY 9.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Dr. D. Clouston: The Report of the Royal Commission on Indian Agriculture.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Dr. J. S. Plaskett: The High Temperature Stars (George Darwin Lecture).—Radcliffe Observatory, Oxford: Positions of the New Planet from Photographs taken at the Radcliffe Observatory.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Anatomy of Fossil Man: The Races represented by Fossil Remains discovered by Miss Dorothy Garrod in the Caves of Palestine.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—E. J. Williams: (*a*) The Inductance of Electromotive Forces in a Moving Liquid by a Magnetic Field; and their Application to the Investigation of the Flow of Liquids; (*b*) The Motion of a Liquid in an Enclosed Space.—E. Simeon: The Generation of Sound by the Siren Principle.—Demonstration by Dr. A. G. Milligan of the Regional Absorption of Dyes by Crystals of Alum and Rochelle Salt.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.—E. R. Sykes: On a New Species of *Turris* from Japan.—G. C. Robson: Remarks on Melanism in Land Mollusca.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (Annual General Meeting), at 6.15.—J. W. Moffatt and J. C. Emerson: The Rotary Automatic Telephone System.

BEDSON CLUB (Armstrong College, Newcastle-upon-Tyne), at 6.30.—Prof. J. B. Cohen: Synthetic Drugs (Bedson Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (Annual General Meeting) (at Criterion Restaurant, Piccadilly), at 6.45.—Sir Frederic L. Nathan and others: Discussion on The International Abstracting and Classifying of Scientific Literature.—Dr. H. Levinstein: Chemistry House—the Present Position.—H. J. Pooley: The Jubilee Meeting of the Society.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. J. Garstang: Archæology and Bible History.

ROYAL SOCIETY OF MEDICINE, at 9.—Prof. J. Murdoch: Radium Treatment of Cancer (Lecture).

SATURDAY, MAY 10.

PHYSIOLOGICAL SOCIETY (in Physiology Department, Cambridge), at 2.30.—W. H. Forbes and F. J. W. Roughton: The Oxygen Dissociation Curve of Dilute Blood Solutions.—N. B. Taylor, H. D. Branion, and H. D. Kay: Some Effects of the Administration of Excessive Doses of Irradiated Ergosterol to Normal and Parathyroidectomised Dogs.—H. J. Jordan: The Viscosity of Muscles in Lower Organisms, its Biological Significance and its Regulation by Nervous Centres.—Dr. G. V. Anrep: Respiratory Arhythmia.—G. Stella: Coronary and Thebesian Circulation.—E. Volhard: Carotid Sinus.—Prof. J. Barcroft: Some Effects of Trauma on the Volume of the Spleen.—T. Cunliffe Barnes: Impulse Discharges in the Nerves of the Crab.—S. Zuckerman and Dr. A. S. Parkes: The Œstrous Cycle of the Hamadryas Baboon.—Samson Wright: Action of Adrenaline and Related Substances on Respiration.—*Demonstrations*:—I. de Burgh Daly and W. V. Thorpe: A Variable Cam Poppet Valve for Negative Pressure Respiration.—I. de Burgh Daly: A Brodie-Starling Kymograph Extension for Doubling the Recording Surface.—Prof. E. D. Adrian: Persistent Discharges from Injured Nerve Fibres.—C. A. G. Wiersma: An Experiment on the

'Resonance Theory' of Muscular Action.—H. Taylor: The Effect of Hydrocyanic Acid on the Total Ventilation.—Prof. J. Barcroft, A. Dale, G. Endres, B. Matthews, and H. Taylor: Circulatory and Respiratory Phenomena in the Marmot.—E. N. Willmer and L. P. Kendal: Apparatus for Obtaining Photographic Records of Tissues growing *in vitro*.—Alison S. Dale: Apparent Effect of Vagus Drugs on the Ventricle of the Perfused Mammalian Heart.—Prof. J. Barcroft: Some Points in Blood Gas Technique.—B. H. C. Matthews: (*a*) The Response of a Single Sensory Nerve Ending; (*b*) A Simple Amplifier for Class Use.—A. Hemingway: An Adaptation of the Montgomery-Lipscomb Flow Recorder.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Torquay).

SUNDAY, MAY 11.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Torquay).

MONDAY, MAY 12.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. J. Garstang: Joshua and the Higher Critics.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Major K. Mason and others: Discussion on Nomenclature in the Himalaya.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Anatomy of Fossil Man: A Review of the more Recent Discoveries of Fossil Man made in Africa.

CHEMICAL INDUSTRY CLUB, at 8.—Dr. H. Moore: Waves and Quanta.

MEDICAL SOCIETY OF LONDON (Annual General Meeting), at 8.—Sir Arthur Keith: Modern Medicine and Evolution (Annual Oration).

ROYAL IRISH ACADEMY (Dublin).

TUESDAY, MAY 13.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section) (Annual General Meeting), at 5.—Sir James Purves-Stewart and others: Informal Discussion on The Treatment of Disseminated Sclerosis.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

IRON AND STEEL INSTITUTE (at Royal Metal Exchange, Swansea), at 6.30.—E. Mort: Tin and Sheet Mill Rolls: Their Treatment, Performance, and Premature Failure in Service.—R. Whitfield: Single-Sheet or Thin-Pack Normalising, or Heat Treatment *versus* Box-Annealing of Sheets.—A. R. Page and J. H. Partridge: The Properties of some Steels containing Chromium.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. W. Green: Developments in Powdered Fuel Practice for Marine Service.

QUEKETT MICROSCOPICAL CLUB (at 11 Chandos Street, W.1), at 7.30.—Exhibition by D. J. Scourfield of Lantern Slides of Marine Organisms prepared by Dr. Sorby.—G. Tandy: A Botanist on the Great Barrier Reef.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—H. A. Stayt: The Bavenda.

WEDNESDAY, MAY 14.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Anatomy of Fossil Man: An Account of Human Fossil Remains discovered in Pleistocene Deposits of China and described by Prof. Davidson Black.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology) (Annual General Meeting), at 5.—Sir Charles Gordon-Watson (who will show a film illustrating the treatment; followed by M. Lacassagne), S. Cade, Mr. Lockhart-Mummery, W. S. Perrin, and others: Discussion on Radium in Cancer of the Rectum and Colon.

GEOLOGICAL SOCIETY, at 5.30.—C. Barrington Brown: The Geology of North-Eastern British Somaliland.

SOCIETY OF RADIOGRAPHERS (in Reid-Knox Memorial Hall), at 7.—C. H. Holbeach: The Planning of an X-Ray Department.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (jointly with Coke Oven Managers' Association—Northern Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Dr. F. S. Sinnatt: Cenospheres and the Structure of Coke.—J. H. Carlisle and Dr. F. S. Sinnatt: The Formation of Cenospheres as a Means of Studying the Swelling Capacity of Coal.

ROYAL SOCIETY OF ARTS, at 8.—C. E. Douglas: Rice Cultivation and Treatment.

THURSDAY, MAY 15.

ELECTRICAL ASSOCIATION FOR WOMEN (at Park Lane Hotel, Piccadilly), at 11.15 A.M. (Annual General Meeting).—From 8 to 10.30 (at Institution of Electrical Engineers).—Reception.—L. B. Atkinson: Some Electrical Reminiscences.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Prof. H. E. Armstrong: The Origin and Nature of Coal and Chars.—Prof. E. V. Appleton and A. L. Green: On some Short-Wave Equivalent Height Measurements of the Ionised Regions of the Upper Atmosphere.—M. L. E. Oliphant: The Liberation of Electrons from Metal Surfaces by Positive Ions. I.—M. L. E. Oliphant and P. B. Moon: The Liberation of Electrons from Metal Surfaces by Positive Ions. II.—*To be read in title only*:—Prof. E. V. Appleton and J. A. Ratcliffe: On some Simultaneous Observations on Downcoming Wireless Waves.—S. Ramachandra Rao: (*a*) Total Secondary Electron Emission from Polycrystalline Nickel; (*b*) Total Secondary Electron Emission from a Single Crystal Face of Nickel.—N. F. Mott: The Scattering of Electrons by Atoms.—J. Hargreaves: The Effect of Nuclear Spin on the Optical Spectra III.—H. S. W. Massey: Scattering of Fast Electrons and Nuclear Magnetic Moments.—J. L. Burchnell and T. W. Chaundy: Commutative Differential Operators. II.—Prof. W. A. Bone, L. Horton, and S. H. Ward: Researches on the Chemistry of Coal. VI.—L. C. Jackson and L. F. Broadway: An Application of the Stern-Gerlach Experiment to the Study of Active Nitrogen.—Prof. O. W. Richardson: The Emission of Secondary Electrons and the Excitation of Soft X-Rays.—G. Temple: The Operational Wave Equation and the Energy Levels of the Hydrogen Atom.—A. Eagle and R. M. Ferguson: On the Coefficient of Heat Transfer from the Internal Surface of Tube Walls.—O. H. Wansbrough-Jones: (*a*) The Interaction of Oxygen with Nitrogen after Collision with Electrons; (*b*) The Formation of Ozone from Oxygen after Collision with Electrons.—Prof. T. M. Lowry and C. P. Snow: The Optical Rotatory Power of Quartz on either Side of an Infra-Red Absorption Band.—Sir William Hardy: Problems of the Boundary State.—F. Francis, S. H. Piper, and T. Malkin: The *n*-Fatty Acids.—Dr. H. Jeffreys: The Wake in Three-Dimensional Fluid Flow.—L. Rosenhead: The Spread of Vorticity in the Wake behind a Cylinder.—S. Venkateswaran and S. Bhagavantam: The Raman Spectra of some Aldehydes and of Mesitylene.—M. Ritchie: The Density and Compressibility of Phosphine Gas: the Atomic Weight of Phosphorus.—E. A. Moelwyn-Hughes: Phloridzin: An Investigation of Certain of its Chemical Properties and its Behaviour towards Sucrolastic Enzymes.—L. J. Freeman: The Spectra of Trebly-Ionised Oxygen (O IV) and Trebly-Ionised Nitrogen (N IV).—A. Elliott: The Absorption Spectrum of Chlorine II.—G. Temple: The Group Properties of Dirac's Matrices.—Prof. O. W. Richardson and U. Andrewes: A Comparative Study of the Excitation of Soft X-Rays from Single Crystal Surfaces and from Polycrystalline Surfaces of Graphite and Aluminium.—Prof. O. W. Richardson and S. Ramachandra Rao: (*a*) The Excitation of Soft X-Rays from some Polycrystalline Metal Surfaces; (*b*) The Excitation of Soft X-Rays from a Single Crystal Face of Nickel.

LINNEAN SOCIETY OF LONDON, at 5.—H. R. Hewer: Studies in Colour Changes in Fish. Part 5. The Colour Patterns in Certain Flat-fish and their Relation to the Environment.—Dr. E. M. Delf: The Release of Oogonia in the Fucaceæ.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. G. I. Taylor: Recent Work on the Flow of Compressible Fluids (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—Annual General Meeting.

CHEMICAL SOCIETY, at 8.—D. C. Jones and L. Outridge: Adsorption by Silicic Acid Gel in the System *n*-butyl Alcohol-benzene.—B. W. Bradford and G. I. Finch: On the Dielectric Strengths of some Explosive Mixtures containing Carbonic Oxide.

ROYAL SOCIETY OF TROPICAL MEDICINE, at 8.15.—Dr. H. M. Shelley: Pellagra in Nyasaland.

BRITISH INSTITUTE OF RADIOLOGY (Annual General Meeting) (in Reid-Knox Memorial Hall), at 8.30.—Dr. P. J. Kerley: The Pathology of Early Pulmonary Tuberculosis as revealed by X-Rays.

INSTITUTION OF ELECTRICAL ENGINEERS (Hampshire Sub-Centre) (at Southampton).

INSTITUTION OF MINING AND METALLURGY (at Geological Society).

FRIDAY, MAY 16.

ROYAL SOCIETY, EDINBURGH, at 4.30.—Prof. G. Wiegner: Base Exchange (Address).

BRITISH INSTITUTE OF RADIOLOGY (Medical Meeting), at 5.—Radiology in Urinary Diseases and General.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Anatomy of Fossil Man: The More Recent Discoveries of Neanderthal Man in Europe. The Present Position of the Neanderthal Problem.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Dundee Technical College), at 7.30.—R. H. Fowler: Some Recent Advances in the Electron Theory of Metals (Kelvin Lecture).

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. C. M. Yonge: The Great Barrier Reef of Australia.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Forest Products Research Laboratory, Princes Risborough).

SATURDAY, MAY 17.

PHILOLOGICAL SOCIETY (jointly with Oxford Philological Society) (at Magdalen College, Oxford), at 5.30.

PUBLIC LECTURES.

MONDAY, MAY 12.

LONDON (R.F.H.) SCHOOL OF MEDICINE FOR WOMEN, at 5.30.—Dr. A. Lacassagne: Treatment of Uterine Cancer by Radiations. (Succeeding Lectures on May 13 and 15.)

TUESDAY, MAY 13.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, at 5.30.—Prof. A. J. Kluyver: The Chemical Activities of Micro-organisms. (Succeeding Lectures on May 15 and 16.)

UNIVERSITY COLLEGE, at 5.30.—Prof. W. E. Blatz: Modern Theories in Habit Training in the Pre-School Child.

WEDNESDAY, MAY 14.

SOCIETY FOR CULTURAL RELATIONS BETWEEN ENGLAND AND U.S.S.R. (at London Central Y.M.C.A., Tottenham Court Road), at 8.30.—J. G. Crowther: Science in Soviet Russia.

THURSDAY, MAY 15.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: Recent Discoveries at Beth-Pelet, Palestine. (To be repeated on May 24 and 26.)

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, PADDINGTON, at 5.—Dr. Leonard E. Hill: The Physiology of Diving.

ROYAL SANITARY INSTITUTE, at 8.—E. Willis: The Collection and Disposal of Refuse (Chadwick Lecture).

CONGRESSES.

FRIDAY, MAY 16.

SOCIETY OF MEDICAL OFFICERS OF HEALTH (at Harrogate), at 4.—Discussion on Rheumatism in its Public Health Aspects.

MAY 19, 20, AND 21.

INTERNATIONAL CONGRESS ON MALARIA (at Algiers).