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The Smithsonian Institution and Scientific Education.

SINCE the last Report of the Smithsonian Institution was published, a new secretary, Dr. Charles G. Abbot, Director of the Astrophysical Observatory, has been appointed, and the Report to June 30, 1928, appears over his signature. It is impossible in these columns to mention, far less to do justice to, the manifold activities of this wonderful institution, with its great museums of science and of art, its zoological park, its astronomical observatory, and its international exchange service. But the new secretary, in virtue of his appointment, has felt it to be his duty to make a wide survey of the activities of "the Smithsonian," in order to gain some knowledge of the most effective ways in which it may advance the mission of its founder, James Smithson, "for the increase and diffusion of knowledge amongst men."

Dr. Abbot's conclusions are of great interest, and since they are of general application, deserve wide attention. He points out that, to the casual observer, it may appear that the most important function of the Smithsonian is the administration of the national museum, art galleries, and zoological park confided to its direction. The educational value of these is great, but a closer analysis would show that their influence is largely confined to the neighbouring States, and that a lessening of influence, which increases rapidly with distance, affects more distant States and foreign countries.

On the other hand, to be contrasted with this relatively local influence, is the wider reach of the International Exchange Service, as associated with the publications of the Institution. Reviewing the whole field, Dr. Abbot is led to the conclusion that the care of the public exhibits, educational and interesting though they are, is after all not the greatest duty of the Smithsonian Institution. In his view its main services to science are :

"In the collection of new specimens, which the passage of a few more years might prevent for ever ; in the study of existing national collections to unlock the treasures of knowledge which they certainly contain ; in the promotion of researches growing out of our expert experience in the field of radiation ; in the publication of knowledge in both technical and popular forms ; and in the wide diffusion of knowledge through exchanges and correspondence in all these lines, activities entirely suited to the genius and situation of the Smithsonian, which in their world-wide application and future promise, outrank in value the more local influence of the public exhibitions."

The one thing that is lacking to promote these

researches on the scale they deserve is, the impecunious institutes of Britain will learn with a shock of sympathy, lack of adequate means.

Put broadly, Dr. Abbot's view rather sounds like pitting against one another the advance of technical knowledge and the scientific education of the people, the latter of which is bound in the end to be more local in its development, since the less educated a person may be the more he must depend on sense impressions and the less on the mental stimulus of the written word; and the Smithsonian plumps heavily for the former. Now we are not convinced that the contrast is a necessary one, since if both the scientific education of the people and the advance of technical scientific knowledge are essential, it can scarcely be said that one is of more value than the other. Both are necessary ingredients in the sum of scientific advancement.

If science is to make the progress it deserves, it must be upon the basis of a wide sympathy and understanding amongst the plain men of the earth. At the lowest terms of this compact, research can obtain the adequate funds which the Smithsonian and every other scientific institution longs for, only when the public has grasped the vital importance of scientific results so thoroughly that it compels the disbursement for such purposes of the State funds which it itself contributes. In other words, in these democratic days, the adequate prosecution of research is inextricably bound up with the scientific education of the people.

Science and Humanism.

THE neglect of science by historians, and the misunderstanding of its service by representatives of labour, are familiar to most readers of NATURE. The new review *The Realist*, to which reference was made in our issue of April 6, p. 540, contains two contributions dealing respectively with these subjects—one by Dr. Singer on scientific humanism and the other by Mr. John Gibson on the relations of labour and science. Both describe from different points of view a state of things which our readers would wish to alter: both resolve themselves ultimately into a question of education.

Dr. Singer starts with the astounding fact, often commented on in these columns, that our accustomed books on history, even such monumental works as the "Cambridge Modern History," ignore, for the most part completely, the rôle played by science in the historic process. As he says—and it is a new way of putting it—"Had it so fallen out that Galileo and Kepler, Newton and Lavoisier and Darwin had been Persians, Turks, Indians, and Russians instead of Italians, Germans, Frenchmen, and Englishmen, it is very certain that the face of the civilised world would have been quite different from what it is. Yet such names are wellnigh ignored in ordinary works of history." The 'ordinary' historian, when charged with this, says either that history is past politics, or how men have come to live together more or less peacefully in States, or, if he does not subscribe to this narrow and exploded heresy, that he does not know about science and thinks it better to leave it to those who do. The latter argument, however, is not applicable to such a work as the "Cambridge Modern History," which is a composite production and might just as well contain chapters on science as it does certain chapters on literature.

The right solution is one which will take years of philosophic thinking to achieve, namely, what is the place which science has taken in building up the social structure which is, as most of the historians now perceive, the proper subject of history. Dr. Singer therefore seems to us perfectly right in laying more stress on the introduction of science in its proper place in the presentation of general history than on the elaboration of the historic side in the teaching of science, though that also is a good thing.

The article by Mr. Gibson, on science and labour, is more depressing and raises another educational question of a wider kind. Mr. Gibson notes the almost complete absence of any knowledge or interest in science among the workmen whom he has met, and also finds dread and opposition to the spread of machinery as displacing the human worker. He is probably generalising from the class of workmen—those in the building trades—who suffer most immediately from the introduction of new machines and have the least turn for mechanics. The picture would not be so black if it were painted of any branch of the engineers. So far as the educational question is concerned, it should be easier rather than more difficult to imbue the young workman with some knowledge and interest in science than his more lettered fellow-scholar who gives so much time to literature and the study of the dead languages. The boy who goes to a technical or a central school with an industrial bias—and these places are growing—has a good opportunity of approaching science at least on the practical side, and Mr. Gibson's account of the young man of to-day who does all

the needed repairs to his motor bicycle or his wireless set, inspires one with some hope. It is, of course, precisely by that channel that the intelligent teacher of science will approach the theoretical basis.

On the question of the displacement of the man by the machine, Mr. Gibson is dealing with a problem of social and economic organisation which has been with us all through the Industrial Revolution. It cannot be said that we have dealt with it very wisely or successfully, and yet we are all agreed that operations which can be as efficiently performed by a machine should, in the interest alike of production and the producer, be so done. Every displacement, however, should be accompanied by careful provision for the displaced. The social *raison d'être* of the machine is that it frees the human agent for other work, either in the further conquest of Nature or the development of his own faculties.

Srinivasa Ramanujan.

Collected Papers of Srinivasa Ramanujan. Edited by G. H. Hardy, P. V. Seshu Aiyar and B. M. Wilson. Pp. xxxvi+355. (Cambridge: At the University Press, 1927.) 30*s*. net.

RAMANUJAN was born in India in December 1887, came to Trinity College, Cambridge, in April 1914, was ill from May 1917 onwards, returned to India in February 1919, and died in April 1920. He was a fellow of Trinity and a fellow of the Royal Society.

Ramanujan had no university education, and worked unaided in India until he was twenty-seven years of age. When he was sixteen he came by chance upon a copy of Carr's "Synopsis of Mathematics", and this book, now sure of an immortality its author can scarcely have dreamt of, woke him quite suddenly to full activity. A study of its contents is indispensable to any considered verdict upon Ramanujan. It gives a very full account of the purely formal side of the integral calculus, containing, for example, Parseval's formula, Fourier's repeated integral, and other 'inversion formulæ'. There is also a section on the transformation of power series into continued fractions. Ramanujan somehow acquired also an effectively complete knowledge of the formal side of the theory of elliptic functions (not in Carr). The matter is obscure, but this, together with what is to be found in, say, Chrystal's "Algebra", seems to have been his complete equipment in analysis and theory of numbers. It is at least certain that he knew nothing of operations with divergent series or of work on the distribution of primes. Above all, he was totally ignorant of Cauchy's theorem and complex function-theory.

The work he published during his Indian period did not represent his best ideas, which he was probably unable to expound to the satisfaction of editors. In the beginning of 1914, however, a letter from Ramanujan to Mr. Hardy (then at Trinity, Cambridge) gave unmistakable evidence of his powers, and he was brought to Trinity, where he had three years of health and activity.

I do not propose to discuss here in detail the work for which Ramanujan is solely responsible (a very interesting estimate is given by Prof. Hardy, p. xxxiv). If we leave out of account for the moment a famous paper written in collaboration with Hardy, his definite contributions to mathematics, substantial and original as they are, must, I think, take second place in general interest to the romance of his life and mathematical career, his unusual psychology, and, above all, to the fascinating problem of how great a mathematician he might have become in more fortunate circumstances. In saying this, of course, I am adopting the highest possible standard, but no other is appropriate.

Ramanujan's great gift is a 'formal' one; he dealt in 'formulæ'. As a specimen we may take the following (which no one can ever resist quoting). If $p(n)$ is the number of ways of expressing n as a sum of positive integers ('partitions of n'), then

$$p(4)+p(9)x+p(14)x^2+p(19)x^3+\ \ldots = 5\frac{\{(1-x^5)(1-x^{10})(1-x^{15})\ \ldots\}^5}{\{(1-x)(1-x^2)(1-x^3)\ \ldots\}^6}.$$

The great day of formulæ, however, is over. No one, if we are again to take the highest point of view, seems able to discover a radically new type, though Ramanujan comes near it in his work on partition series. A hundred years or so ago his powers would have had ample scope. Discoveries alter the general mathematical atmosphere and have very remote effects, and we are not prone to attach great weight to rediscoveries, however independent they seem. How much are we to allow for this; how great a mathematician might Ramanujan have been 100 or 150 years ago; what would have happened if he had come into touch with Euler at the right moment? How much does lack of education matter? Was it formulæ or nothing, or did he develop in the direction he did only because of Carr's book—after all, he learned later to do new things well, and at an age mature for an

Indian? Such are the problems Ramanujan raises; and everyone has now the material to judge them. The letters and the lists of results announced without proof are the most valuable evidence; indeed, they suggest that the 'note-books' would give an even more definite picture of the essential Ramanujan, and it is very much to be hoped that the editor's project of publishing them *in extenso* will eventually be carried out.

Carr's book quite plainly gave Ramanujan both a general direction and the germs of many of his most elaborate developments. But even with these partly derivative results one is impressed by his extraordinary profusion, variety, and power. There is scarcely a field of formulæ that he has not enriched, and in which he has not revealed unsuspected possibilities. The beauty and singularity of his results are entirely uncanny. Are they odder than one would expect things selected for oddity to be? The moral seems to be that we never expect enough; the reader at any rate experiences perpetual shocks of delighted surprise. Prof. Watson and Mr. Preece have begun the heroic task of working through the unproved statements; some of their solutions have appeared recently in the *Journal of the London Mathematical Society*, and these strongly encourage the opinion that a complete analysis of his note-books will prove very well worth while.

There can, however, be little doubt that the results showing the most unmistakable originality and the deepest insight are those on the distribution of primes (see pp. xxii-xxv, xxvii, 351, 352). The problems here are not in origin formal at all; they concern approximative formulæ for such things as the number of primes, or of integers expressible as the sum of two squares, less than a large number x; and the determination of the order of the errors is a major part of the theory. The subject has a subtle function-theory side; it was inevitable that Ramanujan should fail here, and that his methods should lead him astray; he predicts the approximative formulæ, but is quite wrong about the orders of the errors. These problems tax the last resources of analysis, took more than a hundred years to solve, and were not solved at all before 1890; Ramanujan could not possibly have achieved complete success. What he did was to perceive that an attack on the problems could at least be begun on the formal side, and to reach a point at which the main results became plausible. The formulæ do not in the least lie on the surface, and his achievement, taken as a whole, is quite extraordinary.

If Carr's book gave Ramanujan direction, it had at least nothing to do with his *methods*, the most important of which were completely original. His intuition worked in analogies, sometimes very remote, and to an astonishing extent by empirical induction from particular numerical cases. Lacking Cauchy's theorem, he naturally dealt much in transformations and inversions of order of double integrals. But his most important weapon seems to have been a highly elaborate technique of transformation by means of divergent series and integrals. He had no strict logical justification for his operations. He was not interested in rigour, which for that matter is of secondary importance in analysis, and can be supplied, given the real idea, by any competent professional. The clear-cut idea of what is *meant* by a proof, nowadays so familiar as to be taken for granted, he perhaps did not possess at all. If a significant piece of reasoning occurred somewhere, and the total mixture of evidence and intuition gave him certainty, he looked no further. It is a minor indication of his quality that he can never have *missed* Cauchy's theorem. With it he would have arrived more rapidly and conveniently at some of his results, but his own methods enabled him to survey the field with an equal comprehensiveness and as sure a grasp.

I must say something finally of the paper on partitions (pp. 276-309), written jointly with Hardy. The number $p(n)$ of partitions of n increases rapidly with n; thus

$$p(200) = 3972999029388.$$

The authors show that $p(n)$ is the integer nearest to

$$(1) \qquad \frac{1}{2\sqrt{2}} \sum_{q=1}^{\nu} \sqrt{q} A_q(n) \psi_q(n),$$

where $A_q(n) = \Sigma \omega_{p,q} e^{-2np\pi i/q}$, the sum being over p's prime to q and less than it, $\omega_{p,q}$ is a certain $24q^{\text{th}}$ root of unity, ν is of the order of $\sqrt{n}$, and

$$\psi_q(n) = \frac{d}{dn} (\exp\{C\sqrt{(n - \tfrac{1}{24})}/q\}), \quad C = \pi\sqrt{(\tfrac{2}{3})}.$$

We may take $\nu = 4$ when $n = 100$. For $n = 200$ we may take $\nu = 5$; five terms of the series (1) predict the correct value of $p(200)$. We may always take $\nu = \alpha\sqrt{n}$ (or rather the nearest integer), where α is any positive constant, provided n exceeds a value $n_0(\alpha)$ depending only on α.

The reader does not need to be told that this is a very astonishing theorem, and he will readily believe that the methods by which it was established involve a new and important principle, which has been found very powerful and fruitful in other fields. The story of the theorem is a romantic one. (To do justice to it I must infringe a little the rules

about collaborations; I therefore add that Prof. Hardy confirms and permits my statements of bare fact.) One of Ramanujan's Indian conjectures was that the first term of (1) was a very good approximation to $p(n)$; this was established without great difficulty. At this stage the $n-\frac{1}{24}$ was represented by a plain n—the distinction is irrelevant. From this point the real attack begins. The next step in development, not a very great one, was to treat (1) as an 'asymptotic' series, of which a fixed number of terms (*e.g.* $\nu=4$) were to be taken, with an error of the order of the next term.

From now to the very end Ramanujan always insisted that much more was true than had yet been established: "there must be a formula with error $O(1)$". This was his most important contribution; it was both absolutely essential and most extraordinary. A severe numerical test was now made, which elicited the astonishing facts about $p(100)$ and $p(200)$. Then ν was made a function of n: this *was* a very great step, and involved new and deep function-theory methods that Ramanujan obviously could not have discovered by himself. The complete theorem thus emerged.

The solution of the final difficulty was probably impossible, however, without one more contribution from Ramanujan, this time a perfectly characteristic one. As if its analytical difficulties were not enough, the theorem was entrenched also behind almost impregnable defences of a purely formal kind. The form of the function $\psi_q(n)$ is a kind of indivisible unit; among many asymptotically equivalent forms it is essential to select exactly the right one. Unless this is done at the outset, and the $-\frac{1}{24}$ (to say nothing of the d/dn) is an extraordinary stroke of formal genius, the complete result can never come into the picture at all. There is, indeed, more than a touch of real mystery. If only we *knew* there was a formula with error $O(1)$, we might be forced to the correct form of ψ_q. But why was Ramanujan so certain there was one? *Theoretical* insight, to be the explanation, had to be of an order scarcely to be credited. Yet it is hard to see what numerical instances could have been available to suggest so strong a result; and unless the form of ψ_q were known already, *no* numerical evidence could suggest anything of the kind—there seems no escape, at least, from the conclusion that the discovery of the correct form was a single stroke of insight. We owe the theorem to a singularly happy collaboration of two men, of quite unlike gifts, in which each contributed the best, most characteristic, and most fortunate work that was in him. Ramanujan's genius did have this one opportunity worthy of it.

The volume contains a biography by the second of the editors, and the obituary notice by Prof. Hardy. These give a vivid picture of Ramanujan's interesting and attractive personality. The mathematical editors have done their work most admirably. It is very unobtrusive, the reader is told what he wants to know at exactly the right moment, and more thought and bibliographical research must have gone into it than he is likely to suspect. J. E. LITTLEWOOD.

Filterable Viruses.

Filterable Viruses. By Harold L. Amoss, Jacques J. Bronfenbrenner, Alexis Carrel, Edmund V. Cowdry, Rudolf W. Glaser, Ernest W. Goodpasture, Louis O. Kunkel, Stuart Mudd, Peter K. Olitsky, Thomas M. Rivers. Edited by Thomas M. Rivers. Pp. ix+428+15 plates. (London: Baillière, Tindall and Cox, 1928.) 34*s.* net.

THE nature of 'virus' still eludes precise definition. No one knows exactly what it is, and none of the hypotheses covers all the apparent facts without a certain amount of artificial straining. At one extreme there is the conception that a virus is a parasite, something analogous in a general way, though not necessarily closely similar to a bacterium or a protozoon, with properties appropriate to its very small size. It is odd, though, if this is so, that no saprophytic virus is known. We can imagine a pathogenic bacterium arising by some process of adaptation from the many similar saprophytes existing everywhere in Nature, but the viruses are always associated with living cells and have never been certainly known to multiply in their absence. At the other extreme are those who look upon them as derivatives of the cells with which they are associated, possibly particulate but not living individual organisms. The difficulty in this view is to explain the transmissibility, the remarkable power of multiplication or increase, and the specificity revealed by serological reactions.

Midway between these extremes come those who, like Boycott, regard viruses as an order of being neither wholly alive nor wholly dead, but with some of the properties of both states; or, like Wollman, look upon them as altered detachable genes, capable of leaving their cells of origin and entering other similar cells, an intriguing combination of infection and heredity. The parasitic conception, however, is a convenient working hypothesis. Nothing certainly disproves it, and it will probably

continue to hold the field until there is conclusive evidence of the origin of a virus *de novo*, as is already suggested by the work on bacteriophage and the filterable tumours.

Animal pathologists lay great stress on filterability as an important character, and so no doubt it is when it occurs. But its present importance is perhaps chiefly a historical residue. Even in animal virus diseases it is not a constant character, and the plant pathologist attaches little importance to it, even in diagnosis, since most of the virus diseases of plants are not transmissible by extracted juice, whether filtered or not. It is possible that it may come to have a real importance as a means of distinguishing viruses which can be detached from their cells without loss of character from those which cannot, but this is still in the future. One is glad to see that in the book under review the term 'filterable viruses' is used in a general non-committal way to cover all the active transmissible agents which produce virus disease.

The present volume is sure of a welcome, and deserves it. The amount of information that has accumulated on the subject of virus diseases since Iwanowski showed, thirty-seven years ago, that tobacco mosaic is filterable, is so enormous that even the specialist cannot keep abreast of it all. It covers so wide a field (mammals, birds, fish, plants, insects, even bacteria) and the literature is so widely scattered that it is difficult so much as to hear of all the papers that appear, and the collection of the salient facts into a single volume is a useful piece of work. Even in this volume of more than 400 pages, detailed survey has proved impracticable, and the method adopted is to select certain diseases of man, animals, fowls, etc., and treat them as typical examples of the different groups, prefacing them with some chapters of a more general nature.

The first chapter, on "Some General Aspects of Filterable Viruses," by the general editor, T. M. Rivers, has already appeared in the *Journal of Bacteriology*. It discusses in a series of short sections such questions as epidemiology, immunity, filterability, size and the like, giving briefly the ascertained facts and occasionally the theories. This chapter, we think, might have been considerably expanded. The book, as a whole, no doubt aims mainly, and commendably, at recapitulating established fact rather than theoretical discussion; but—to take only one example—to abandon a consideration of whether viruses are animate or inanimate, on the ground that "it leads one into the sterile discussion of what life is, a problem still in the realm of metaphysics," seems scarcely adequate.

An excellent chapter follows on filters and filtration, by Stuart Mudd, practical and sane, and also salutary because many unwarranted conclusions have been drawn from experiments with filters. The third chapter is by A. Carrel, on tissue-culture, in the study of viruses, a method likely to lead to greater results than it has produced as yet. E. V. Cowdry contributes a cautious, well-balanced, and informative discussion on intracellular pathology, with excellent illustrations, coloured and uncoloured.

Then follow the special articles already referred to: Poliomyelitis in man by H. L. Amoss, foot and mouth and vesicular stomatitis by P. K. Olitsky, contagious epithelioma in birds by E. W. Goodpasture, virus diseases of insects by R. W. Glaser, of plants by L. O. Kunkel, and of bacteria by J. J. Bronfenbrenner. All these are authorities on the subjects of which they treat, and, although in every case a specialist will no doubt wonder at some omissions and feel disposed to quarrel with some statements made, still they do give excellent reviews of present knowledge and convenient summaries of present opinion, and that is what one hopes to find in chapters such as these. They are addressed not so much to the specialist, who presumably knows the facts of his own subject, as to the semi-specialist and the worker on cognate lines, who cannot easily keep in touch with current knowledge outside his own limited field. This function they serve admirably. The whole volume is a most useful and convenient collection of the available information on filterable viruses.

J. HENDERSON SMITH.

Problems of Island Life.

Diptera Brachycera and Athericera of the Fiji Islands: based on Material in the British Museum (Natural History). By Mario Bezzi. Pp. viii + 220. (London: British Museum (Natural History), 1928.) 15*s*.

ISLAND life presents problems of great interest to the biologist and in particular to the student of geographical distribution. Among the many islands of Polynesia a great field for research awaits inquiry. In so far as the insects and other invertebrates are concerned, we know as yet comparatively little respecting what peculiar forms are present, how the creatures of one group of islands differ from those of another, and from where they have been derived.

The Hawaiian group is better known than any other Pacific archipelago, a fact largely due to the wisdom and foresight of those Englishmen who inaugurated the "Fauna Hawiiensis" and saw it through to completion. Its volumes form the groundwork for all subsequent progress in Hawaiian entomology, besides providing an important contribution to the problems of island life in general. The work was not instituted one month too soon—in fact, species had already disappeared and become lost to science before its inception. To-day the spread of cultivation on the island of Oahu, for example, has practically destroyed the whole of the indigenous insect fauna over most of the terrain—what is left is mainly to be found on the forest-clad flanks of its steep mountains. Without the "Fauna Hawiiensis" we should be at a loss to-day to know whether many of the insects are introduced or indigenous, and when it comes to problems of pest control this knowledge acquires added importance. The work of the Percy Sladen Trust Expedition, under Prof. J. Stanley Gardiner, has similarly laid the foundations of our knowledge of the fauna of the Seychelles and neighbouring islands in the Indian Ocean.

It is only a matter of time when Fiji, Samoa, and all the larger oceanic islands will inevitably come under the influence of cultivation to the same extent as the Hawaiian group. To-day they are changing, and new elements are entering their fauna through the agency of increased maritime communications. Sooner or later a highly composite and drastically altered fauna will result. There is no doubt, therefore, if we are to have an adequate knowledge respecting the native insects and other elements of the fauna of Polynesia, every opportunity needs to be utilised, at least to collect material, before civilisation advances much further. It might be feasible to circularise and impress this fact upon all resident naturalists and induce them to send specimens to our national collection. It may be necessary to provide them with instructions, store boxes and apparatus, but it would be worth while and the costs would be relatively trifling.

The small volume by the late Prof. Bezzi, now before us, consists of a series of highly technical detailed descriptions of flies from the Fiji Islands. Since its author was one of the most eminent of Dipterists, it is consequently authoritative. Altogether 239 species of flies are dealt with, and it is noteworthy that only 30 of them were known to exist in Fiji (including the Tonga Islands) up to the end of the year 1925. It is also interesting to note that 60 per cent of the flies enumerated are endemic to Fiji, and nearly all were previously undescribed. Certain families of flies, notably the Ortalidæ, Trypetidæ, Chloripidæ, and Muscidæ, comprise, on the other hand, a good many non-endemic forms, probably on account of their association with the activities of man. Their distribution by commerce in fruits and other vegetable matter, or by the drifting of trees and plant debris in the sea, accounts for the presence of a considerable number. Excluding the imported elements, the Fijian dipterous fauna is an endemic one of Austro-Malayan origin. A point of great economic importance is the fact that the Mediterranean fruit-fly (*Ceratitis capitata*) is happily absent from the list, and yet it is a pest in some other Pacific islands.

The Natural History Museum has done zoology a service in publishing this volume, and it is to be hoped that its appearance will stimulate the collection of further material bearing upon the unique problems of island life. A. D. IMMS.

Methods of Sea-water Biology.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 256. Abt. 9: *Methoden der Erforschung der Leistungen des tierischen Organismus*, Teil 5, Heft 2. *Methoden der Meerwasserbiologie.* Über Kultur und Methodik beim Studium der Meerespflanzen, von Josef Schiller; Methoden der Untersuchung der Bodenfauna des Meerwassers, von Harald Blegvad. Pp. 181-330 +11 Tafeln. (Berlin und Wien: Urban und Schwarzenberg, 1928.) 10 gold marks.

SCHILLER'S work occupies 129 pages of this part of Abderhalden's "Handbuch," the remaining 20 with 11 tables being Blegvad's portion. The former contains detailed information on the setting up of small aquaria, their aeration and temperature control. Some account is given of the chemical composition of sea-water and of the various salt solutions used for the culture of fresh-water and marine algae; sections are devoted to the organic nutrients useful in the study of marine Chryso- and Cryptomonads and other plants, also to solid media and colloidal solutions. Attention is directed to the necessity of regulating the intensity of the light, and details are given concerning the construction of various types of light filter, solid and liquid. References are made in particular to Pringsheim's work on the culture of algæ; mention is made of Schott und Gen.'s light filters,

but the Wratten and Corning filters have been omitted.

Throughout, one is struck with the fewness of the references to British and American work—but then British marine biology has been preponderatingly zoological, and Oltmanns remains the standard authority on the marine flora of a sea-going nation. The Americans, though active on the Pacific coast, have been late comers into this field. A section is devoted to the isolation of organisms required for pure cultures and there is a figure of a pipette, with rubber teat, of quite unserviceable thinness; the centrifuge tube shown would break at the first time of using. Simple forms of water-sample bottles are shown, but the standard Nansen-Petersen is not mentioned.

The purely botanical portion is done with Teutonic thoroughness, the groups being considered one by one in great detail. The reviewer confesses to a feeling of surprise at reading of the large number of algæ that have been cultivated. Mention is made of Thuret's early (1854) work on the crossing of *Fucus vesiculosus* and *F. serratus*, also of subsequent work by Lloyd Williams and by Sauvageau. Overton's (1913) work on the parthenogenesis of the ova of *Fucus*, induced artificially, has been included. When it was first published, the reviewer repeated it—the experiment goes beautifully. Nobody appears to have used algal material for such studies since Overton published, which is strange, since sea urchin and other animal eggs have been worked at assiduously. In conclusion, the Phanerogams *Zostera* and *Posidonia* are mentioned in virtue of their marine habitat, and a long list is given of the algæ of the Adriatic, North and Baltic Seas, with their vegetation periods and ease of cultivation.

The whole article constitutes a very useful compendium of the present state of knowledge on this subject.

Blegvad's article deals mainly with various bottom-grabs, such as that of the late Director C. G. Joh. Petersen. For quantitative work, grabs are made to cover 0·1 m.^{2} or, for larger animals, 1 m.^{2}. These are described and illustrated. It is hard to see the value of including pictures of a dredge swung clear for use, of a boat with square net, and of partly filled sample bottles. The results obtained with the bottom-grabs are of great interest. A figure gives the large annual variations, from 1910 until 1922, in the population density of the sea-bottom at one station in *Abra alba* and in *Solen pellucidus*. The bottom fauna in Timfjord is worked out in great detail in Table 1. Other tables (plates) show pictorially the distribution of animals in the various associations (*Besiedlung*, colonisation) or communities found on different types of sea-bottom. These are excellent, as it is very difficult to visualise the meaning of numerical fauna lists. Plate XI. shows the seas surrounding Denmark stippled and marked to show the areas covered by the various communities. No other seas have been worked out with such detailed accuracy. This article is commendably brief, and is packed with information.

Our Bookshelf.

Chemical Publications: their Nature and Use. By Prof. M. G. Mellon. (International Chemical Series.) Pp. viii + 253. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 12*s.* 6*d.* net.

To the several books and various other publications that deal specifically with the topography of the literature of chemistry is now added one which, in addition to supplying the usual kind of information and advice in the manipulation of such tools as are available—extremely valuable as both are—goes a step further, and drives its lessons home by providing material for practice in the specialised technique which is described. Already, of course, chemical literature has reached such vast proportions (having grown at a rate not altogether indicative of real chemical progress) that we feel a lurking sympathy for the business man who had to give up business in order to attend to his card index. Moreover, the areas of intersection of chemical and other scientific spheres have tended to enlarge and become indistinctly defined.

It is not surprising, therefore, that general excursions having in view an exhaustive examination, a rapid disinterment of what in the circumstances may be buried treasure, or even a hurried survey to provide a background for some commercial decision, tend more and more to be entrusted to specialists, or at any rate practicians, in the art. For exactly the same reasons it is clearly desirable that students of chemistry should find time to familiarise themselves with the records of their subject. The material in this book is intended to constitute the basis of an undergraduate course.

There are nine chapters, in which the development of the literature, original sources (periodicals, institutional proceedings, patents, and miscellaneous contributions), and secondary sources (periodicals and serials, bibliographies, works of reference, and text-books) are discussed, and the technique of the search is described. The subject is placed on a class-room basis—or rather, on a library basis—by the inclusion of fourteen groups of problems (arranged in a manner somewhat reminiscent of 'prep. in the lower fourth'), in which the student is required, for example, to supply full details concerning an assigned journal, to collect, complete with 'chapter and verse,'

selected physico-chemical data, or to 'look up' an organic compound. Most chemists have learned the use of the literature in the school of necessity, so that although its appearance as an exercise may seem to them somewhat strange and curious, they will all the more readily perceive the advantage of early systematic direction. A. A. E.

Radiomovies, Radiovision, Television. By C. Francis Jenkins. Pp. 143. (Washington, D.C.: Jenkins Laboratories, 1929.) 2.50 dollars.

C. F. JENKINS, the author of this work and one of the pioneers of television, took up inventing as a profession about thirty years ago. He now possesses more than four hundred patents in America and other countries, and has a private laboratory in Washington for carrying out his researches. He has done an immense amount of work in developing 'radiomovies,' both by using wires (television) and by transmitting them by radio waves (radiovision).

In July last, Mr. Jenkins began broadcasting radiomovies at fixed times. He thus gave the amateurs something for which to 'angle.' A few weeks later more than a hundred amateurs had finished their receivers and could reckon with certainty on getting their regular picture stories. At first only silhouettes were broadcast, as it was essential to keep the frequency band less than ten kilocycles. The Radio Commission has now assigned to his company a band 100 kilocycles wide (4900-5000 kilocycles), and at the present time thousands of amateurs receive half-tone 'movies' on their receiving picture sets. The pictures transmitted are mainly pantomime pictures, but Mr. Jenkins expects that his new machine, which is practically finished, will revolutionise the art and make it possible to transmit pictures of theatrical performances, outdoor games, inaugural ceremonies, and even grand opera with full vocal accompaniment.

This book describes how to make and work a receiving set. It concludes with descriptions of other of Mr. Jenkins's inventions, including a landing altimeter which enables an airman to glide his machine to a landing in a fog, a novel method of predicting hurricanes by means of the snapping noises they produce in a radio receiver, and a method of guiding an aeroplane on its course in a fog. He is the inventor of the motion picture projector, the principle of which is in use all over the world. The Franklin Institute awarded him a gold medal for this invention in 1895.

The Journal of the Institute of Metals. Vol. 40. Edited by G. Shaw Scott. Pp. xii + 877 + 37 plates. (London: The Institute of Metals, 1928.) 31*s.* 6*d.* net.

REPORTS on the corrosion of condenser tubes and on the properties of alloys for die-casting occupy a prominent position in the new volume. The work on corrosion has had a definite result in showing that cupro-nickel and a special aluminium brass have a high resistance to attack by streams of air bubbles carried off by the water, perhaps the most frequent cause of damage. The researches of this committee have proved particularly valuable to the tube industry.

Die-casting has made great progress in recent years, although even now it is far less used in Great Britain than in America, and the present papers contain valuable information as to the metals best suited to this class of work. W. Hume-Rothery describes the methods most suitable for the preparation and study of alloys containing highly reactive metals, such as sodium and calcium, and F. Hargreaves continues his investigations of alloys which are softened by cold working instead of being hardened. An example of the detailed study of a complex alloy system is that of the alloys of aluminium with copper, silicon, and iron by A. G. C. Gwyer, H. W. L. Philips, and L. Mann, illustrated by very good photomicrographs and by numerous diagrams. Under ordinary conditions of cooling, these alloys depart considerably from equilibrium, so that they are used in a metastable condition. An unexpected result is recorded by D. R. Tullis, who has freed aluminium alloys from the gases causing unsoundness by passing a stream of chlorine through the molten metal, this process, unpromising at first sight, having proved to be technically successful.

The volume contains many other papers and the usual abstracts.

Travels and Settlements of Early Man: a Study of the Origins of Human Progress. By T. S. Foster. Pp. 320. (London: Ernest Benn, Ltd., 1929.) 21*s.* net.

MR. FOSTER has worked over the data of palæontology and prehistoric archæology in their bearing upon the distribution of man with considerable ingenuity, and still greater enthusiasm, which have involved him in frequent departures from the orthodox view. He is both stimulating and provocative. He is an ardent supporter of what he calls the Anatolian strain, that is, a race originating in the Anatolian plateau of what is more usually called the Armenoid type, as a factor in the development of civilisation. He has allowed full play to his theory when working out racial strains in the culture of the Pacific. Although it cannot be said that this is entirely assumption, the evidence is a very slender support for so elaborate a superstructure. His view of the origin and growth of American culture depends upon the acceptance of the Calaveras and New Jersey skulls—which are more than doubtful—and the Central and South American early civilisations seem to be left hanging in the air.

New Worlds for Old: the Realm of Modern Physics. By Robert G. Lunnon. Pp. v + 106. (London: Methuen and Co., Ltd., 1928.) 2*s.* 6*d.* net.

THIS little book is intended for those of the general public who are not acquainted with the modern developments of physics. It is a perfectly accurate, though necessarily incomplete, account of the discoveries of the last twenty-five years. The writing is most suitable for a book of its kind, and the average reader is not likely to arrive at false conclusions, as is so often the case, through the fact that the terminology is beyond him.

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.*]

The Nature of the Penetrating Radiation.

UP to the present time the view that the penetrating radiation consists of short gamma rays has been prevalent chiefly because the large penetrating power which these rays possess is associated with radiation of gamma ray type. Our recent experiments, however, indicate that this radiation is of corpuscular nature.

The experimental arrangement consisted simply of two 'tube-counters,' of the type recently developed by Geiger and Müller (*Die Naturwiss.*, **16**, 617; 1928), which were placed above one another at some distance apart in a space screened by 6 cm. of lead and 5 cm. of iron. Each of the counters was connected to an electrometer, and the deflections of the two electrometers, which were due chiefly to the penetrating radiation (Geiger, *Phys. Zeitschr.*, **29**, 839; 1928), were registered side by side on a moving film. With this arrangement a considerable number of simultaneous deflections of both instruments was recorded. For small distances between the counters, up to about 20 per cent of the total number of deflections of one counter were coincident pairs. This percentage is so great that it must be explained on the basis that coincidences occur if the same corpuscular ray enters both counters.

Two hypotheses may be made concerning the origin of this corpuscular radiation. One is that the primary radiation may be of the gamma type and the coincidences the result of secondary electrons. In this case one would expect the corpuscular rays to be more easily absorbed than the penetrating radiation that caused them. The alternative is that the penetrating radiation is really of corpuscular nature, in which case agreement should exist between the absorption coefficient of the rays causing the coincident deflections and that directly measured for the penetrating radiation itself.

In order to distinguish between these alternatives, a block of gold 4·1 cm. thick was placed between the counters, the diminution in the number of coincidences thereby giving a measure of the absorption of the corpuscular rays. The first attempts were made in a laboratory of the Reichsanstalt, where the thick floors and ceilings of the rooms above us greatly hardened the radiation. There was no definite diminution in the number of coincident pairs under these conditions. We then repeated the experiment on the roof of the building with the lid of the screen removed. Under these conditions the unfiltered radiation from above acted directly on the counters, and a definite diminution in the number of coincidences was observed on introducing the gold block. The observed difference gives (μ/ρ) Au $= (3{\cdot}6 \pm 0{\cdot}5) \times 10^{-3}$ for the mass absorption coefficient. This value agrees well with that measured directly for the unfiltered cosmic rays. We conclude from these data that the penetrating radiation is not of gamma but of corpuscular type.

The complete description and discussion of these experiments will appear in the *Zeitschrift für Physik*.

W. BOTHE.
W. KOLHÖRSTER.
Physikalisch-Technische Reichsanstalt,
Berlin-Charlottenburg,
Meteorologisch-magnetisches Observatorium,
Potsdam, April 3.

Temperature Conditions in the Suez Canal, July–December 1928.

THE study of the temperatures met with in the Suez Canal is invested with more than ordinary interest in view of the linkage affected between two different sea areas and the possibilities of an exchange of faunas.

The Cambridge expedition to the Suez Canal (*Transactions of the Zoological Society*, 1927) has shown that more marine animals have moved from the Red Sea to the Mediterranean than from the Mediterranean to the Red Sea. The expedition also published valuable evidence to show that for most of the year the canal water was under the influence of a slow residual drift from the Red Sea. This, however, was reversed during the months of the Nile flood.

In studying the question of the migration of young or drifting organisms through the canal, temperature has very rightly been considered as of first importance as a possible limiting factor.

The only series of data concerning the temperatures of the canal that offer anything like a contemporaneous series are those taken by the *Pola* expedition in October 1895 and May 1896.

The present observations were all made within two days on each occasion and so were very nearly simultaneous.

The following list shows the positions at which they were made:

Suez Canal Station 1. Opposite entrance buoy to Suez Canal, Port Said.
" " 2. Opposite Canal Company's signal station at Ballah.
" " 3. 1 kilometre S.E. of the Canal Company's landing stage at Ismailia.
" " 4. Opposite the Northern Light Buoy of the Great Bitter Lakes.
" " 5. "Kilometre 130" of the Canal.
" " 6. Opposite the last buoy but one of the Suez Canal at Suez.

It is the intention of the directorate of Fisheries Research, Coastguards and Fisheries Service, to take routine temperature and salinity observations from these positions over a run of years.

The surface observations for July 1928 and February–March 1929 are shown here:

Station	S.C.1	2	3	4	5	6
Date	19.7.28	19.7.28	19.7.28	20.7.28	20.7.28	20.7.28
Time	1043	1450	1637	1228	1628	1855
Temperature, °C.	28·92	29·28	29·60	29·18	28·85	26·55
Date	28.2.29	28.2.29	28.2.29	1.3.29	1.3.29	1.3.29
Time	1034	1505	1705	1139	1343	1753
Temperature, °C.	14·32	14·70	14·96	15·25	17·85	17·53

A Nansen-Petersen insulated closing bottle was used with a Schmidt thermometer.

Examining the Cambridge and *Pola* expedition temperatures, one is struck by the anomaly of higher figures for Port Said than for Suez. This same condition is shown in my figures for July. In February–March, however, there is a higher temperature at Suez than at Port Said, and from Station S.C.2 to Suez there is a steady rise along the whole length of the canal.

There seems to be, then, a higher temperature at the northern end of the canal than the southern in summer, and a higher temperature at the southern than the northern end in winter. This relatively higher summer temperature of the water at Port Said is quite inexplicable on ordinary considerations of position, and I am led to suggest the following explanation.

The sea in the neighbourhood of Port Said is constantly receiving Nile water. This comes out through a large shallow lake—Lake Menzaleh—and in the summer and autumn through the Damietta mouth of the Nile. Travelling through a thousand miles of heated desert—partly discharging through a shallow lake which is rapidly heated by the sun—the effluent water of the Egyptian Nile is much hotter than that of the Mediterranean Sea in the summer.

The order of the temperatures in these delta lakes is well shown by Paget (Fisheries Report of Egypt, 1921). It will be seen that the average monthly temperature in August and July is 30° C.

R. S. WIMPENNY.

Villa Fortuna,
Rue Lavaison,
Bulkeley, Alexandria.
Mar. 26.

Anti-Knock Ratings of Pure Hydrocarbons.

PROF. NASH and Mr. Howes emphasise the fact that whereas their figures for trimethylethylene and diamylene were quoted for twenty per cent volume concentration, our own were for twenty per cent weight concentration. From curves obtained for these hydrocarbons, reproduced in Fig. 1, it is clear

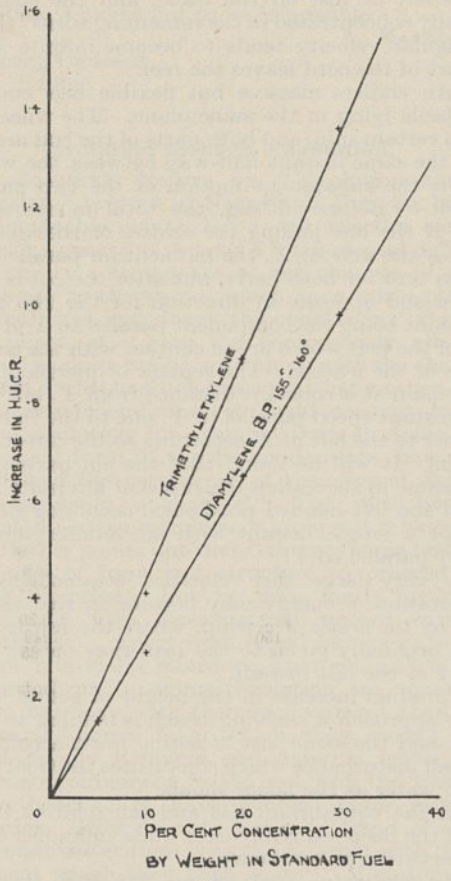

FIG. 1.

that over the range examined the relationship between weight-concentration and increase in H.U.C.R. is linear. Knowing the specific gravities, it is a matter of simple calculation to show that the discrepancy cannot be due to our use of what we regard as the only rational procedure. The specific gravity of the standard fuel was 0·725 at 60° F.

So far as the possible effects of volatility are concerned, all tests at these laboratories are carried out with sufficient intake air, heating, and jacket and head temperature to ensure that no appreciable difference in anti-knock rating is found with any further heating, whether low boiling gasolines or heavy kerosines are being tested.

The recent recommendations made by Campbell, Lovell, and Boyd regarding the importance of making all comparisons at the mixture strength which gives maximum pinking have been in use here for upwards of two years. The Armstrong engine developed independently in these laboratories while their work was in progress includes both variable compression head and bouncing pin.

In order to find definitely whether differences in volatility are the cause of discrepancies between one fuel and another, experiments have been carried out with:

1. Standard heating conditions and compression adjusted to suit the sample.

2. Evaporative cooling, high compression and throttling to control the pinking as is the practice when using the Delco engine.

The mean results were identical, although the values of single readings using the second set of conditions were more erratic owing probably to the method of cooling which tends to induce stray hot spots.

We feel that possibly complete agreement might be reached on those points still in doubt if tests were carried out using a common supply of trimethylethylene and diamylene in both engines, employing a range of air-fuel ratios.

In the case of the Ricardo E.5 engine and the Armstrong engine used in this laboratory, the effect of air-fuel ratio has already been thoroughly studied. Similar experiments could be made without alteration to apparatus on the Delco plant, and we have no doubt concerning the ultimate results.

Confirmation of the accuracy of our figures is afforded by the fact that substantially identical values are obtained using such a wide range of research engines as:

(*a*) The Thornycroft overhead valve engine of 1025 c.c. capacity. (*b*) The Ricardo sleeve valve engine of 350 c.c. capacity. (*c*) The Armstrong engine with a fixed ratio head. (*d*) The Armstrong engine with a variable compression head.

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R. STANSFIELD.

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Sunbury-on-Thames.

WE would thank the Editor of NATURE for kindly allowing us to reply to the above letter of Messrs. Birch and Stansfield, but feel that we must not trespass on the space of this journal any further in that all contribution to our knowledge of the subject under discussion ceased with our letter which appeared in the issue of April 6.

In our previous communication no suggestion was made that the difference in the results obtained for diamylene and trimethylethylene was due entirely to the fact that Messrs. Birch and Stansfield employed concentrations by weight, whereas we used concentrations by volume. Nevertheless, the fact must necessarily contribute to the discrepancy.

It is also not impossible that the samples of diamylene as used by Messrs. Birch and Stansfield and ourselves were not chemically identical. The boiling ranges were not the same, and seeing that the diamylene as made from trimethylethylene is

probably not a single chemical entity but a mixture of isomers, the composition of the diamylene produced may vary with the method and condition of the particular polymerising reaction used. Diamylene, prepared in this way, cannot be chemically described with the same certainty that would be associated with trimethylethylene.

With regard to the other point raised, it is well known that differences in results obtained by different workers with different engines may be due to technique and design, and it is well realised that concordant results will never be obtained until a standard method of test is employed by all laboratories.

We welcome Messrs. Birch and Stansfield's suggestion of carrying out tests using a common supply of trimethylethylene and diamylene in both types of engine, as we feel that such collaboration would result in a much greater advance than further correspondence at this stage of our knowledge.

In the meantime, it is known to us that research workers in the United States have been carrying out similar investigations for some years, and now that the results of our work have been disclosed, it would add materially to our knowledge of the subject if they would publish their conclusions.

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Rise and Fall of the Tides.

FROM information published by the Hydrographic Department of the Admiralty it is possible to find the rise and fall of the tides and the times of high and low water on almost all the coasts of the world except in the extreme north and south latitudes.

The periods of the tides depend on astronomical conditions, and the many terms which are involved have been investigated. The periods, however, furnish no information as to the tidal range, that is, the difference in elevation between high and low water.

A very simple calculation, however, depending merely on the masses and distances of the tide-producing bodies, suffices to show that were the earth fluid and devoid of rigidity, then the difference between the semi-axes of the tidal spheroid would be of the order of one in twenty million, or about a foot at the earth's surface.

From the Admiralty Tables it will be seen that on coasts facing the open ocean the observed rise and fall in relation to the land lies somewhere between 5 and 10 feet on the average, but that where the coast-line is complicated and the water shoals gradually, far greater variations appear, which may range from 0 to 50 feet.

It is not necessary to go outside the English and neighbouring coasts to find examples of such differences. For example, near the mouth of the English Channel the rise and fall is about 20 ft.; in the Bristol Channel, nearly 50 ft.; at Portland, about 5 ft.; and in the neighbourhood of Mt. St. Michel, 50 ft. These large differences may be accounted for in part by interference, that is, by the tide reaching the position of observation by different routes of unequal effective lengths; or again, resonance may be involved, as is apparently the case in the English Channel, where high and low water at the opposite ends occur at the same time.

The most general cause, however, which operates to make the coastal rise and fall so much larger than the equilibrium tide in the open ocean, is the gradual concentration of energy which occurs when a wave of small amplitude but large mass travels from deep to shallow water.

Among many familiar examples which depend on the same sort of concentration of a constant amount of energy in a gradually diminishing mass, may be mentioned the cracking of whips, flapping of flags and sails, throwing a rope, and throwing a fly, and I will add three more where the results can be readily calculated.

(1) A heavy flexible cord passes through a hole in a fixed horizontal plate. That part of the cord which hangs free below the plate is given a small horizontal velocity and swings as a pendulum. The cord is then drawn upwards through the plate. Above the plate the cord is stationary, and the energy it contained is transferred to the part still hanging free, the mass of which continually decreases with the length of the free part. Hence the horizontal velocity of that part tends to become infinite when the length vanishes.

(2) A light reel is wound with a few turns of massive but flexible cord and placed on a horizontal table to which one end of the cord is attached. Two forces act on the reel, both tending to make it roll away from the point of attachment of the cord to the table, namely: (*a*) the weight of one half turn of the cord acting at half the radius of the reel, and (*b*) the horizontal component due to the centrifugal force of the mass of half a turn of the cord at the velocity of the rotation of the reel. As the rolling proceeds the cord is left at rest on the table, and the energy is gradually concentrated in the remaining turns. Hence the angular velocity tends to become infinite as the last part of the cord leaves the reel.

(3) An endless massive but flexible belt connects two wheels lying in the same plane. The wheels are given a certain spin, and both parts of the belt are then cut at the same instant half-way between the wheels. What is the subsequent motion of the two parts of the belt? Before cutting, the total momentum is zero. If the line joining the centres of the wheels is taken as the axis of X, the momentum parallel to X remains zero for both parts, but after the cut is made is equal and opposite in direction for the two parts: its amount being the component parallel to Y of those parts of the belt which are in contact with the circumference of the wheels. The centres of inertia of each part remain at a constant distance from Y, but move at a constant speed parallel to Y, one to the right and the other to the left of X according to the direction of the spin. It will be found that the cut parts of the belt assume in succession the shape of alternate right-handed and left-handed pot-hooks, becoming straight lines for a single instant with an infinite terminal velocity parallel to Y.

How very large the velocities attained by the concentration of energy may become in real cases is shown by the crack of a whip, where the few feet per second originally given to the lash rises to explosive velocity at the last instant.

The gradual increase in the height of gentle waves as they approach a shelving beach is familiar to most people, and the same sort of action must accompany the small disturbance which constitutes the tidal wave in deep water as the latter shoals.

What the equilibrium rise and fall relative to the floor of the deep sea really is, is quite unknown either by observation or by theory.

In the *Phil. Mag.* (vol. 50, pp. 228, 278) there are papers by Sir G. B. Airy and Sir William Thomson which touch on this subject and on Laplace's theory of the tides. Airy objects to some of Laplace's work which is upheld by Sir William Thomson.

Laplace's spherical harmonics are so general as (if the restriction is not specially introduced) to cover the introduction or withdrawal of fluid at the poles —the condition of constancy of fluid volume was in

effect introduced by Laplace, and this Airy calls a "singular and unwarranted principle." Sir William Thomson says this unwarranted principle is in fact an "exquisitely subtle" method by which Laplace determined a certain constant, and Airy rejoins, "I look on Laplace's process as a mere sport with symbols and on Laplace's conclusion as a grievous error." Whether, however, Laplace is right or wrong, his conclusion applies to an ocean covering the whole surface of the earth, and would not help to determine the motion of the fluid as actually distributed in the existing seas.

The question of the earth's rigidity also would have to be settled before any theory could give a quantitative estimate of the true amplitude of the equilibrium tide.

Sir William Thomson (Thomson and Tait's "Natural Philosophy") states that unless the rigidity of the earth was at least as great as that of iron or glass, the tidal rise and fall would not be so great as it actually is. In view, however, of the want of deep sea observations and of the amplification which occurs near a coast-line, the necessity for such rigidity does not seem to be proved.

I think the only satisfactory way to ascertain the amplitude of the tides in the deep ocean is by direct measurement, and though this presents some practical difficulties, it ought not to be impossible.

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Evolution through Adaptation.

DR. BATHER'S lecture on "Evolution through Adaptation," printed in NATURE of Mar. 30, bristles with debateable points, but I will select a cardinal one which appears to present a fundamental difficulty in his theory. He speaks of the changes of depth and salinity in the waters which have taken place in geological time and draws the conclusion "that the surroundings of a race are continuously altering; the race has perpetually to catch up with the change." But even if the small changes that have taken place in the oceanic environment could account for the trend of evolution, for example, from an Asteroid to an Echinoid form in the Echinodermata, how could be explained the persistence of the original Asteroid type practically unchanged? The race has not changed, if certain members or groups of it have.

Dr. Bather points out that "there is some tendency for change of form and structure to proceed in a definite direction," but he goes much further in stating that "the direction will accord with the environment." Apart from lethal factors in inheritance and non-viable monsters, what evidence is there that new forms in animal evolution are necessarily more in harmony with their environment than were and are the forms from which they arose? For example, many Echinoid and Asteroid forms share the same environment in the sea, but the Echinoid type is believed to have evolved from primitive Asteroidea. How does the Echinoid trend of evolution accord better than does the Asteroid with the environment which they both share? Migration as a factor in isolation of species can be ruled out, of course, if the original and the 'evolving' line have always shared the same environment.

The mutations required by Dr. Bather's theories can of course be admitted, as they can be seen and investigated, but they only "provide that fundamental premise from which, *in combination with a varying environment* [italics mine], one can deduce irreversibility of evolution . . . and orthogenetic trends." This would be true only if it could be shown that the varying environment favoured the new forms at the expense of the old, but actually the older forms are often as well adapted to the varying environment as are the new ones. Another objection is that, while the slight changes that have taken place in the physical and chemical constitution of the ocean would affect such processes as fertilisation and early development in various ways, it is difficult to imagine how such changes can have directed the general "orthogenetic trends" in adult oceanic forms. Furthermore, the persistence of primitive or early forms in the same environment is evidence against such a view.

J. S. DUNKERLY.

IN speaking of "Dr. Bather's" theory and theories, Prof. Dunkerly pays me too much honour. That portion of my discourse which appeared in NATURE attempted a critical inquiry into other people's theories and a possible explanation of certain difficulties that they presented to my mind. To Prof. Dunkerly's mind the main theory presents yet another difficulty. He admits, apparently, the fact of evolution, and he admits some change of environment; but he urges (I understand), first, that the changes of environment are too slight to produce the great evolutionary changes seen along certain lines; secondly, that if they were a *vera causa* they would have affected all lines of descent in a more equal degree.

It is rather late in the day to be answering arguments of this kind, and space could not be afforded in NATURE for their adequate discussion. May I suggest, first, that Prof. Dunkerly underestimates the differences and the changes in the environment of sea animals? If he derives his conception from a single summarising sentence in my discourse, I would remind him that two-thirds of that discourse (not reported in NATURE) was devoted to an illustrated account of some among the numerous and varied habitats, conditions, and modes of life that a single class of marine invertebrates (and a statozoic class at that) has come to fill during its long history. It was emphasised that a single small patch of sea-floor, which we speak of roughly as sand or sea-weed or reef and so forth, really comprises many habitats. On the other hand, it was urged that, just as one cannot envisage a living creature apart from its environment, so one should not conceive of the environment without the reaction of the creature; further, that the whole creature constitutes the environment of any one of its parts.

Consider 'migrations,' on which Prof. Dunkerly seems to misapprehend me. Surveys of the sea-floor, notably by the Danes, have shown that the immigration or emigration of a single species from or to a faunal assemblage on a small patch must, and does, affect the life of all the other species, although purely physical conditions are unaltered. Or take mutation (which Prof. Dunkerly admits) and consider the Cladocera mutant found by Banta and Wood (see NATURE, Oct. 29, 1927, p. 632); here is a form that can live only at a temperature higher than the normal, and if it does find a warmer pool it will be preserved as a race adapted to a new environment. This does not mean that the original race will perish. Why starfishes should disappear because sea-urchins have (according to Prof. Dunkerly) been evolved from them, I quite fail to understand. They fill different places in the economy of Nature, and to say that any of them "share the same environment" is scarcely so true as would be a like statement about a groom and his horse. I wonder what my friend Dr. W. K.

Spencer will say to the assertion that the original Asteroid type has persisted unchanged.

Prof. Dunkerly tells us that changes in the ocean water would affect fertilisation and early development. I said nothing about this ; but what difficulty is there in supposing that embryonic change affects the adult history ? We all know that it does, and the results might manifest just as much regular seriation as appears in any alleged orthogenetic trend. However, I do not remember touching on this in that part of the discourse which Prof. Dunkerly has been so good as to discuss. F. A. BATHER.

The Fine Structure of the Normal Scattered Molybdenum $K\alpha$-Radiation from Graphite.

IN the September issue, 1928, of the *Physical Review*, B. Davis and D. P. Mitchell reported an experimental investigation of the molybdenum $K\alpha$-radiation scattered by graphite with the aid of an ionisation spectrometer. In their work it is stated that the normal scattered radiation should have a much more

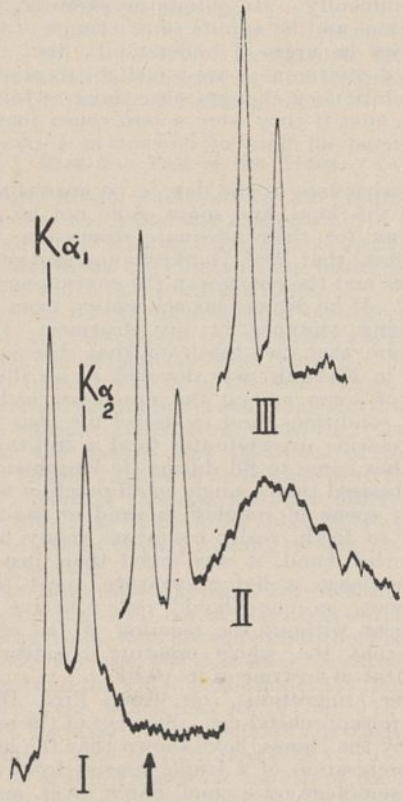

FIG. 1.—Curve I. Normal scattered radiation and Compton scattering. Scattering angle from 25° to 50°. The Compton shift ranges from about 2 to 9 X-units.
Curve II. Normal scattered radiation and Compton scattering. Scattering angle from 45° to 130°. The Compton shift ranges from about 7 to 40 X-units.
Curve III. Direct radiation from molybdenum anticathode.

complicated structure than the primary radiation. Instead of the one $K\alpha_1$-line they find four lines : one in the same position as the $K\alpha_1$ line and three lines shifted to the long wave-length side by 1·2 ; 2 ; 11·3 X-units respectively, the distance between the $K\alpha_1$ and $K\alpha_2$ being 4·28 X-units. As these shifts correspond more or less accurately to the L_{III}-, L_I-, and K-level of the carbon atom, the effect reminds one of the well-known Raman effect in the optical region.

Because of the high theoretical importance of these experiments, we have tried to repeat them, using the photographic method ; but we failed to detect any difference at all between the structure of the primary radiation and that of the 'undisplaced' scattered line. In the meantime, Ehrenberg (*Zs. f. Phys.*, 53, 234 ; 1929) published an analogous negative result. Still, we think it worth while to give a short discussion of our work in view of the importance of the problem in question.

The spectrograph used was of the Siegbahn type, calcite was used as analysing crystal, the dispersion was such that the distance between the $K\alpha$-lines was 0·19 mm. on the photographic plate. The scattering graphite was put on the cathode inside the X-ray tube, the alternating tension was 35 kv. eff., the current 25 ma. By taking control photographs it was ascertained that only the radiation scattered by the graphite could reach the photographic plate. All the photographs taken were registered with a photometer of the Moll type (see Fig. 1). Plate I was taken with the graphite at a distance from 5 to 15 mm. from the anticathode focus. The time of exposure was 35 hours. At the small scattering angles from 25° to 50°, the Compton scattering is confused with the normal scattered lines. At a distance, however, of 11·3 X-units from the normal $K\alpha_1$-line where Davis and Mitchell found their weakest component of the scattered complex line (see arrow to curve I), we see that there cannot be any line with an intensity of more than 2 per cent of that of the scattered $K\alpha_1$-line. Plate II was taken with the graphite at a distance from 15 to 20 mm. from the focus. The time of exposure was 75 hours. On this plate the region between the $K\alpha_1$ and $K\alpha_2$ is wholly free from Compton radiation. In this region Davis and Mitchell found two other components of the complex line. From a comparison, however, of curve II with curve III, which relates to the spectrum of the direct radiation, we conclude that there seems to be no essential difference at all between the normal scattered $K\alpha$-doublet and the direct radiation.

It might be remembered that if there should exist in the X-ray spectrum something analogous to the Raman effect in the optical region, we should expect this to give rise not to lines but to a *continuous* spectrum, which we should not be able to detect with the means used in our experiments.

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Variation of Conductivity of the Upper Atmosphere.

MEASUREMENTS of the height of the base of the aurora in northern Norway by C. Störmer (*Geofys. Publ.*, I., No. 5) and by L. Vegard and O. Krogness (*Geofys. Publ.*, I., No. 1) show that a considerable number of the bases are situated at heights of about 100 km. and about 106 km. (compare the frequency curve, Fig. 18, *Geofys. Publ.*, I., No. 1, p. 101). In treating 1737 base-heights between 90 and 120 km. it was found from the frequency curve that during ebb-tide in the atmosphere the maximum at 100 km. was predominant, while during flood-tide the maximum at 106 km. was predominant. Further investigations have shown that the maxima of the frequency curve are to be considered as displacements of one and the same maximum. From this we conclude that, as regards the locality considered, the mass of air situated above 100 km. at ebb-tide is the same

as the mass of air situated above 106 km. at flood-tide.

When adopting all the assumptions and results given in "The Propagation of Radio Waves" by P. O. Pedersen (Copenhagen, 1927), it is possible to show how the conductivity of the upper atmosphere (130-160 km.) is influenced by the different states during ebb-tide and flood-tide. Let us assume that the mass of air above a certain height varies with height in accordance with an exponential function, and let us consider, within the conducting layer, a thin layer under normal conditions and with a certain conductivity. Then the problem consists in finding the variation of the conductivity caused by the atmospheric tide. On account of the slower decrease in the vertical direction of the mass of air above a certain height, a thin layer with the same electric properties as the above-mentioned thin layer will grow thicker at flood-tide; while at ebb-tide a corresponding thin layer will grow thinner. The total conductivity will therefore vary according to the atmospheric tide. For the place of observation (70° northern latitude), the total conductivity is found to be 4·3 per cent greater at flood-tide than at ebb-tide.

Considering the lunar diurnal magnetic variation as a variation caused in the solar diurnal variation by tidal forces, and supposing proportionality between the conductivity in the upper atmosphere and the magnitude of magnetic variations (S. Chapman), it is found from the variations of the magnetic declination that near the equator (Batavia) the conductivity at flood-tide is 21 per cent higher than at ebb-tide. For latitude 70° an increase of 2·5 per cent in the conductivity from ebb-tide to flood-tide is to be expected. The discrepancy with the above result is removed when, instead of a supposed temperature of the stratosphere of −54° C., a temperature of −78° C. is used; after Dobson (*Proc. Roy. Soc.*, A, vol. 103, pp. 339-342) such a temperature of the stratosphere may be possible during the nights in which the measurements of the base-heights of the aurora have taken place. A consequence of the above is that the height of the conducting layer will vary during the lunar day. In latitude 45° a variation of 25 per cent from the mean height may be expected, a point on which the investigation by radio waves may be able to throw some light.

Summarising, it may be said that the heights of the base of the aurora are able to give information on the tide of the upper atmosphere and thereby on the variation of the electric conductivity in the regions considered; further, that certain observed magnetic variations seem to confirm the result found. The existence of a resulting enormous variation of the height of the conducting layer may be tested by means of radio waves.

J. EGEDAL.

Meteorologisk Institut,
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Mar. 25.

A Violation of the Selection Principle for the Principal Quantum Number.

ONE of the selection principles, for the case of X-ray spectra, states that the principal quantum number must change in any electron transition. A thorough investigation was carried out by Coster (*Phil. Mag.*, **43**, p. 1070; 1922) to determine if lines could be found corresponding to electron transitions between L levels, but no such lines were observed. No violations of the principal quantum number selection rule have yet been found. By using the grating method, Thibaud and Soltan (*Journal de Physique*, **8**, p. 485; 1927. *Phys. Zeit.*, **29**, p. 241; 1928) found two new lines for the elements tantalum (73), tungsten (74), platinum (78), and gold (79), and they also found that the values of ν/R for these lines corresponded approximately to those given by Bohr and Coster for $N_{IV}\ N_{VI,\ VII}$ and $N_V\ N_{VI,\ VII}$ respectively, but, due to the inaccuracy of the values for the energy levels, especially for the O_I and $O_{II,\ III}$ levels, they were not able to reach any definite conclusions. In a later paper, however, Thibaud (*J.O.S.A. and R.S.I.*, **17**, p. 145; 1928) ascribes the origin of the two new lines to transitions between the O (probably $O_{II,\ III}$) level and the N_{IV} and N_V levels.

LINE WITH SHORTER WAVE-LENGTH.

Element.	λ(A).	$\frac{\nu}{R}$ (Obs.).	$\frac{\nu}{R}$ (Cal.).					
	Thibaud and Soltan.	Thibaud and Soltan.	$N_{IV}\ N_{VI.}$	$\frac{N_{IV}}{N_{VI,\ VII.}}$	$N_{IV}\ O_{II,\ III.}$		$N_{IV}\ O_{I.}$	
			Idei.	Bohr and Coster.	Idei.	Bohr and Coster.	Idei.	Bohr and Coster.
Ta (73) .	58·3	15·6	15·9	15·5	15·0	15·4	12·6	12·7
W (74) .	56·0	16·3	16·4	16·2	16·0	15·8	13·3	13·5
Pt (78) .	48·0	18·9	18·8	19·3	20·2	15·9	16·8	17·4
Au (79) .	46·8	19·5	19·6	20·0	21·7	18·1	18·2	18·6

LINE WITH LONGER WAVE-LENGTH.

Element.	λ(A).	$\frac{\nu}{R}$ (Obs.).	$\frac{\nu}{R}$ (Cal.).					
	Thibaud and Soltan.	Thibaud and Soltan.	$N_V\ N_{VI,\ VII.}$		$N_V\ O_{II,\ III.}$		$N_V\ O_{I.}$	
			Idei.	Bohr and Coster.	Idei.	Bohr and Coster.	Idei.	Bohr and Coster.
Ta (73) .	61·4	14·8	15·0	14·7	14·0	14·6	11·7	11·9
W (74) .	59·1	15·4	15·4	15·3	14·9	14·9	12·2	12·6
Pt (78) .	51·0	17·8	17·8	18·0	19·0	14·6	15·6	16·1
Au (79) .	49·4	18·4	18·4	18·6	20·4	16·7	16·8	17·2

I have recently made some careful measurements in the L-series, the results of which make possible a more accurate determination of the values of ν/R for the levels in question. These values, as well as those of Bohr and Coster, are given in the table above with the values of ν/R for the two newly discovered lines. Judged from these new values, it would seem just as likely that the doublets found by Thibaud and Soltan are due to the transitions $N_{IV}\ N_{VI}$ and $N_V\ N_{VI,\ VII}$. This would then be the first experimental evidence of X-ray transitions within levels of the same principal quantum number.

SAKAE IDEI.

Physical Laboratory, Upsala,
Mar. 7.

Combustion of Rigidly Dried Carbonic Oxide-Oxygen Mixtures.

THE paragraph in NATURE of April 13, p. 584, referring to my paper on "The Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures" in last month's *Proceedings of the Royal Society*, contains a statement which, if allowed to pass uncorrected, might convey a wrong impression.

It is scarcely true to say that our previous experiments on the combustion of six-months phosphoric anhydride dried mixtures of carbonic oxide and oxygen had been criticised "on the grounds that inadequate precautions had been taken to remove occluded hydrogen from the platinum electrodes between which the igniting spark was passed," although it may be that in NATURE of Sept. 24, 1927, Prof. H. E. Armstrong had queried whether possibly "hydrogen, imprisoned in the platinum electrodes" had been "extruded into the gas."

In describing, in my recent paper, our further experiments—the object of which was to test whether a prolongation of the phosphoric anhydride drying up to 550, 750, or even 1000 days (instead of the former 170-220 days) would make any difference to the results—I was careful to explain (1) that, in all the previous experiments, the electrodes had been 'glowed out' repeatedly in a high vacuum for many hours (at least 20 in all), so as to remove occluded hydrogen from them, and (2) that, in the further ones, the additional precaution had been taken of electrically 'glowing out' the electrodes in oxygen at low pressure, as well as in a high vacuum, both of which operations were continued many hours.

I do not think there can be any reasonable doubt of the adequacy of the measures taken in the previous experiments to remove occluded hydrogen from the platinum electrodes; in the later ones, the further precaution referred to was taken merely 'to make assurance doubly sure'; and, seeing that the results of the two series did not differ in any material respect, the adequacy of all precautions in both is assured. Indeed, the fact that in both series condenser discharge sparks of anything up to 0·5 microfarad at 1000 volts were repeatedly passed (between platinum-balled electrodes) through the phosphoric anhydride-dried medium, without even the faintest sign of ignition being discernible photographically, may be regarded as a conclusive test, not only of its extreme dryness, but also of the total exclusion of hydrogen from it.

The experimental results now enable us to say quite definitely (1) that a highly purified $2CO + O_2$ mixture which, under all necessary precautions, has been rigidly dried to the utmost limit possible with re-distilled and highly purified phosphoric anhydride, will still explode and propagate flame provided that a sufficiently powerful igniting spark is used, and (2) that with platinum-balled electrodes the minimum condenser discharge spark required is about 0·75 microfarad at 1000 volts (energy = about 0·75 Joule).

WILLIAM A. BONE.

Imperial College of Science and Technology,
London, April 16.

Titanium Oxide Bands in the Orange, Red, and Infra-Red Region.

BANDS in the region of λ5600 to λ8000 have been analysed into at least two systems, distinct from that of the blue-green region, previously analysed by Birge and Christy (*Phys. Rev.*, vol. 29, p. 212; 1927. Abstract. NATURE, vol. 122, p. 205; 1928). One of these in the orange is a singlet system due to the electronic transition $^1P - {}^1S$, the other a triplet system in the red and infra-red due to the transition $^3S - {}^3P$. Of the former only one sequence has yet been found; of the latter, four have been determined, namely, the (0, 1), (0, 0), (1, 0) and (2, 0), the $\Delta\nu$ separations of the triplet heads of the (0, 0) sequence being 66·7 and 74·6 cm.$^{-1}$ respectively.

The molecular constants, determined from the vibrational analysis of the triplet system, show that in the final state the vibrational frequency of the rotationless molecule with infinitesimal amplitude of vibration is the same as in the blue-green system, and that thus their final energy level, ^3P, is the same. Further, since the separation of the triplets of red-infra-red system pertains to this final level, it pertains also to the final level of the blue-green system.

Analysis of the other bands found in the red is in progress.

F. LOWATER.

Imperial College of Science,
South Kensington,
Mar. 28.

Ozone Absorption during Long Arctic Night.

I HAVE been trying for the past ten years to interest the astronomers in having photographs of stellar spectra made during the long arctic or antarctic night, on the chance that the ultra-violet cut off due to ozone may be less powerful, and I mentioned it to Prof. Russell last spring. I have always emphasised the importance of choosing a station so situated that there will be a minimum chance that ozone formed in the illuminated regions will be carried over into the dark region by atmospheric circulation. Information regarding the direction and velocity of the upper atmospheric current will be necessary in choosing the site. It should certainly be nearer the pole than the station occupied by Prof. Rosseland (NATURE, Feb. 9, p. 207), for the sun at noon was only three or four degrees below the horizon, and the air five miles above the surface was in full sunlight, as Prof. Russell pointed out to me. His negative result I do not regard as decisive, though I am not very hopeful that much or any extension of the spectrum will be found, as ozone is fairly stable. An objective prism pointed at the pole star seems the simplest device.

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Lengthened Chain Compounds of Sulphur with Platinum.

IN NATURE (Jan. 22, 1927, p. 124) a lengthened chain compound of sulphur of the formula $BrC_2H_4.(SC_2H_4)_{48}Br$, as also another of sulphonium sulphur having so high a molecular weight as 3472, have been described.

Recently, in collaboration with K. C. Bose-Rây, I have prepared another series of complex sulphur-platinum chain compounds (*Zeit. anorg. Chem.*, Bd. **178**, p. 329; 1929) the first member of which has the formula Pt_3Cl, $2(C_2H_5)_2S_2$, $2NH_3$, $6H_2O$, and the last $Pt_{13}Cl$, $10(C_2H_5)_2S_2$, $2C_2H_5NH_2$, $8H_2O$, with a molecular weight as high as 4050·5. This is perhaps the only example as yet known of a metallic compound synthesised in the laboratory and possessing such a high molecular weight.

P. C. RÂY.

University College of Science and Technology,
Calcutta, Mar. 13.

Science and Hypothesis.

By Sir Oliver Lodge, F.R.S.

RECENT speculations in mathematical physics, and acquiescence in treatment in terms of unimaginable abstractions, have raised a general question about the use of hypothesis as a means of coordinating observations, stimulating experiment, and paving the way for a theory. It is possible to experiment not only in the laboratory with matter, but in the study also, with symbols; and a great deal of modern mathematics is of an experimental character. A hypothesis is boldly made, some indication of its plausibility having been detected by a flash of genius; it is then developed and its consequences worked out. If the consequences are evidently leading astray, it is abandoned; but if like Planck's, like de Broglie's, and like Bohr's—to go no further—they lead in a helpful direction, yielding results that can be compared with metrical determinations, then the hypothetical formula attracts attention and begins to be accepted as the basis of a partial theory, even though its full significance is not understood, the reasons for it only dimly apprehended, and though the agencies with their mode of working are in the main unknown.

Experience has shown that a working hypothesis may be a true guide so far as it goes, even though it has in the end to be so extensively supplemented as to be revolutionised. The precision attainable varies in different branches of knowledge: only in a few subjects can the results be expressed and checked with numerical accuracy. In physics and astronomy we have grown accustomed to these precise modes of verification, though even here the verification may not substantiate every detail of the original hypothesis or prevent its complete recasting in the light of further knowledge. The quantum was appealed to as somehow securing the stability of Bohr's electronic orbits; but further treatment by Schrödinger put a different complexion on the electron; and the final word has not yet been said. Still, the quantitative results attained by Bohr's theory, spectroscopically verified to many places of decimals, were amply sufficient to justify us in enthusiastically welcoming the partial clue provided.

Not often is such numerical precision attainable; sometimes only the order of magnitude can be checked, and sometimes the agreement with fact is not quantitative at all. Even in chemistry the constitution of certain molecular compounds was arrived at by a special instinct, and was accepted long before physicists began to scrutinise the molecules and ascertain that their constitution was more or less in accord with the intuitions of genius. In biology such direct verification is still far off, and seldom can any theories be brought to the test of quantitative determination. In anthropology and sociology, in addition to all the other difficulties, an element of caprice enters in. Humanity is not so amenable to law and order as molecules are, and individual behaviour can scarcely be predicted or specified with anything approaching completeness. A statistical result may be arrived at, and the average behaviour of a large group can be stated with approximate correctness, subject to disturbing causes. Even in molecular physics the laws of probability tend to supersede the accurate dynamics of individual occurrences, and we have to be satisfied with a sort of average uniformity variegated and enlivened by individual eccentricities.

Psychologists and psychiatrists seek to penetrate the meaning of perverse peculiarities, and to ascertain the laws of individual behaviour so far as they can. The introduction of what we call chance and caprice makes a scientific treatment more difficult, undoubtedly, but it does not prevent the subject from being pursued in a scientific spirit. Methods and results must vary according to subject matter; and what would be vague in physics and chemistry may be unusually definite in subjects like biology and psychology. Even in physics an element of indeterminism has recently been suspected: certainly the molecules of a gas are behaving in an apparently lawless manner, while yet their average or aggregate behaviour on a large scale is satisfactorily uniform.

As to the illegitimacy of hypothesis in science, that is absurd. Every theory began as a hypothesis. It is to test a hypothesis that every elaborately planned experiment is made. As a digression it may be worth insisting that Newton himself constantly made hypotheses,—his queries at the end of "Optics" are a collection of them,—and gravitational astronomy itself must have begun as a hypothesis. When engaged in deductively working out results of theory on a mathematical scheme, he did indeed, and very properly, say, "I am not making hypotheses," using the present tense in a perfectly grammatical and intelligible manner; though the sentence is often mistranslated or misinterpreted in a form covering both past and future, as if he had said, I do not make, or I never make, hypotheses. Which would have been merely false.

The ether of space is a hypothesis; rendered necessary by the complex behaviour and properties which have to be attributed to what we call empty space, that is, space empty of matter. Regarded philosophically it seems impossible to imagine the space between atoms and worlds as really empty; it is only empty of everything that appeals to our senses and is amenable to direct experiment. The nature of space is inferred, and has to be inferred, from its effects on matter; but the inference that there must be something literally 'sub-stantial' in space, which is really responsible for cohesion, elasticity, and all the other manifestations, is inevitable; though in expressing such behaviour (electrical, optical, gravitational) it is the results and not the mechanism that we formulate, for the mechanism seems to be unlike any mechanism with which we are acquainted, and is still essentially unknown.

Objections to the ether are really objections to the nineteenth century conception of an ether expressed

in terms of mechanical models. No such ether exists : the real ether is too fundamental an entity to be expressed in terms of the sensory perceptions of material behaviour, which is what we usually mean by explanation. In so far as it is unexplained and not amenable to experiment—so long as it is a sort of hypothesis *in vacuo*—the ether may be disliked ; just as Newton disliked the introduction of vague and ill-understood causes, preferring to have none at all to account for action at a distance rather than some entity of which he neither knew nor could ascertain anything. Electricity and magnetism were a sealed book then, and Clerk Maxwell was far in the future.

There are, however, sciences of which the working hypotheses must be vague. The mental sciences are peculiarly in that condition ; we cannot treat of mind in any quantitative manner. The trivial details of experimental psychology skirt about the fringe of the subject, collecting data rather like those of old-fashioned meteorology, in the hope that perhaps some day a comprehensive generalisation will arise which can reduce them to law and order.

All this preliminary is for the purpose of (perhaps unnecessarily) insisting that science exists in many stages of development ; and that we are not at liberty to turn down a nascent science merely because it is still in an infantile and unmetrical or even a capricious condition. Human activities cannot be denied merely because they are inaccessible to calculation and defy prediction.

To take an extreme example : What is called the spiritistic hypothesis is flagrantly objected to, for it appeals to the activities of unknown agencies which cannot at present be satisfactorily brought to book. The supposed agents have human characteristics, and behave as if they were like ourselves, except that they are for the most part out of touch with matter, save under special conditions which it is our business to investigate if we can ; whereas we ourselves, when acting as agents, are not only conscious mental and spiritual entities, but are closely and continuously in touch with matter for a period of the order of a century. Our action on matter makes our behaviour conspicuous and easy to observe, but it has not yet led to any explanation. The connexion between mind and matter is still an unsolved problem, the mechanism of it is only very partially understood—the link between mind and brain is missing,—but that does not prevent our accepting the activities of, say, engineers and architects and artists as a fact. They do deal with matter, in accordance with their plans and designs, whether we understand the process or not.

So if hereafter we find ourselves still existing and active, after we have escaped from our normal organism,—if it turn out that under certain conditions we are able to use the organisms of others, so as still to affect material particles, especially the complex molecules of living protoplasm, and thus display surviving intelligence,—we should hope to be met, not by an *a priori* objection as to the possibility of such activity, but rather by a willingness to study the evidence and a determination to be guided by the facts, as in any other better established and more reputable branch of inquiry.

Still, it does happen that even after some prolonged and impartial study of the facts, the hypothesis of what may be called posthumous activity is still disliked and still provisionally rejected as an attempt at explanation. For example, my distinguished friend, Charles Richet, accepts all the phenomena that I do, or even more, but the tentative explanation of some of them as due to discarnate activity does not appeal to him ; or perhaps I should rather say is only very gradually beginning to appeal to him. And there are other less well-known members of the Society for Psychical Research who stand out against the spiritistic view and strive after every other sort of explanation,—thereby doing good service and constraining a supporter of the hypothesis to bring forward constantly better and better evidence and to realise more clearly the objections that have to be met.

Again, I suspect that contributors to NATURE, and the majority of its readers, regard both the hypothesis and the phenomena which led to it with serious doubt and unconcealed dislike ; some indeed pour contempt on the whole thing as a savage superstition. But the occurrence of the phenomena amid all races and in all periods, though it may arouse prejudice, is no valid argument against the reality of something responsible for those widespread superstitions. Our business is to disentangle them from superstition and to dissect out whatever element of truth they may enshrine. For it has been our experience that an element of truth often does underlie old legends. Explorers often discover that old beliefs had a foundation after all ; witness Schliemann at Troy, Sir Arthur Evans at Crete, and many other examples known to archæologists and palæographers. An ancient belief can scarcely give any appreciable support to a scientific hypothesis, but the existence of such belief is not really injurious and is by no means fatal to it. On the whole, the existence of a tradition is rather favourable than otherwise. At worst it is neutral.

OBJECTIONS TO THE SPIRITUALISTIC HYPOTHESIS FROM A SCIENTIFIC POINT OF VIEW.

With this preliminary let me comment on a sentence extracted from a paper which will shortly appear in the *Proceedings of the Society for Psychical Research*, in which an automatic writer who himself has produced script purporting to be inspired by a fairly recently deceased and comparatively unknown poet, expresses himself as sceptical about the ostensible and superficial significance of the scripts in the following words :—

"... Regarded as a scientific working hypothesis, spiritism does not seem to me to be a very hopeful avenue of investigation. The spirit hypothesis has a delusive appearance of simplicity, but so also had Kepler's hypothesis of guiding angels. And how remote this was from the complex reality of Einstein's description of gravitation ! In fact, if these supernormal mental phenomena depend on the whims and caprices of departed spirits, then I for one despair of ever being able to discover any law and order in them."

Undoubtedly there is some difficulty, in our present state of comparative ignorance, about specifying or formulating the spiritistic hypothesis in any precise and, so to speak, scientific manner; for it is an appeal to the activity of unknown agents acting by unknown methods, under conditions of which we have no experience, and by means of which we are unaware. We get into touch, or appear to get into touch, with these agencies only when they have affected material objects, for example the brain, so as to produce results which appeal to our normal senses. But the admission that we cannot understand how agents work does not justify our denial of the existence of such working. As I have already hinted, a good deal of modern mathematical physics is in the same predicament. We do not really understand how the properties of the ether, or of what it is now the fashion to call 'space-time,' act in producing the material effect we call weight or gravitation. We know a good deal about it; we can specify with precision the law of 'weight' in so far as it imitates the resultant of an independent and unscreened attraction of every particle for every other. We can say that the earth acts nearly as if its whole mass were concentrated at its centre, that the law of force is different inside and outside, so that it changes abruptly when the surface is penetrated, and that the force attains a peak value at the surface, sloping down differently on the two sides. We can speak of the state of strain or 'potential' to which the force is due, say that it is continuous across the boundary, give the law of its variation with distance, and so on.

Newton, in fact, correctly formulated the whole theory of gravitation considered as action at a distance; but the true mechanism of what seems like a condition of strain or warp in space, brought about by the very existence of matter, was beyond him, as it is still beyond us. In philosophic mood, Newton was never satisfied with his mode of specification. It merely gave the resulting effect of something that simulated the direct attraction of one body on another across apparently empty space; he had to leave the inner meaning of such mysterious action for future discovery.

Einstein discarded the attraction or force exerted by a body at a distance, and replaced it by a geometry of space which would account for, or at least express, the resulting behaviour in a more intimate and, so to speak, less magical manner. An inert body can only be perturbed or guided by something in immediate contact with it; even though the particular modification of that 'something,' which enables it so to act, may be due to the neighbourhood of a distant mass of matter, for reasons which remain to be explored.

The fact that we sometimes have to postulate an unknown agency does not justify our attributing anything capricious to that agency. We are ignorant of how the gravitational agent acts, but we know that it acts in accordance with law and order, so that the results can be duly predicted. Einstein's view (if we may call it Einstein's, though in one form or another it must have been vaguely held by many) is after all *not* so very different from Kepler's asserted hypothesis. What Kepler meant by "guiding angels controlling the planets" (assuming that he used that phrase) I do not know, but I am sure he meant nothing capricious. He must have meant that an unknown something guided the planets in their path; and that is a paraphrase of the modern view. The 'something' is now often spoken of as a warp in space. In so far as Kepler postulated something in immediate touch with a planet and acting directly on it, he had what now appears to be truth on his side; his thesis being perhaps nearer the ultimate truth, though far less practically useful, than Newton's delightfully simple quantitative expression for the indirect action of a distant body.

In order to illustrate direct guidance by contact action, we might take the familiar example of a gramophone needle, which automatically reproduces a prearranged tune, simply by following the path of least resistance. What else, after all, can an inert thing do? That is the meaning of inertia. Animated things are not inert; they need not take the easiest path. A man may climb the Matterhorn for fun. But inanimate unstimulated matter never behaves with any initiative or spontaneity; it is strictly inert. Atoms never err or make mistakes; they are absolutely law-abiding. If they make an apparent error, if a locomotive engine leaves its track, we call it a catastrophe. All machinery works on that principle; every portion takes the easiest path. It is true that to get a coherent result there must have been planning and prearrangement. Certainly! In all cases of automatic working, whether biological or other, that must be an inevitable preliminary. But explorers of the mechanism will detect no signs of mental action by their instruments or their senses. To infer a determining or controlling cause they must philosophise. Indeed, we may go a step further, and emerge from the past into the present, thus: A wireless set talks like a gramophone, and to one accustomed only to gramophones it would seem barbarously superstitious to urge that in the wireless case some (possibly whimsical and capricious) operator was actually in control. Statements may be unpalatable, and yet be true.

Now return to gravitation. Planets behave as if they were attracted by the sun. That is certainly true. But what is attraction? A train is not attracted to its destination: lightning is not attracted to a chimney; but it gets there none the less, by continually taking the easiest path. So it is with a planet. Indeed, one might say that everything inert takes the only path open to it, it has no option. The law is a sort of truism. But the principle, once recognised, has been formulated into a clue; the Principle of Least Action can be expressed mathematically. Once postulate that, and the behaviour of the inanimate portions of the cosmos can be accurately deduced.

The modern statement that the planets move along the line of least resistance, or the easiest path, makes their motion rather closely analogous to that of a railway train guided by the rails. The path and destination of a train are determined by the

continual direct influence of the rails, which make it easier for the train to travel in the right direction than to jump them and go astray. We might, if we chose, admit that the path was laid down or determined by the mentality of the surveyors and designers of the route ; but a Martian spectator with partial information might still wonder at the apparent intelligence which guided one part of a train to Manchester, and another part to Liverpool, in accordance with the wishes of the passengers or the labels on the coaches. If told that an invisible guardian angel switched over the points to produce this result, he might resent the suggestion as absurdly unscientific and preposterous ; as on a purely mechanistic view it would be.

After having studied trains for some time, our spectator might begin to notice the novelty of a motor-car. His first tendency would be to look for the rails in that case also ; and, finding none, he might superstitiously but correctly surmise that a guardian spirit was guiding the car to its destination. In this case, moreover, further experience would soon persuade him that he had to allow for an element of caprice. But even that is not fatal to the truth : he need not throw up his hands in despair. As soon as we introduce the activity of life and mind we get out of mere mechanism, and the results are not easily formulated or predicted. The activities of an animal cannot be expressed in mathematical terms, and yet animal instincts and behaviour are subject-matter for scientific investigation. It is assumed that they obey laws of some kind.

Science is not limited to the accurate data and laws of mathematical physics : and to claim that a hypothesis is unscientific because we cannot formulate it completely, or because we do not understood the method of working, or even because there is a certain amount of capriciousness about it, is more than we have any right to claim. Anthropology and sociology are less advanced sciences than physics and chemistry ; they have to get on as best they can, with a profusion of data, and with the inevitable complications appropriate to live things. Let us not be put out of our stride by the fear of retaining, in modified form, some of the animistic guesses of primitive man. Experience may lead us, as it led him, to contemplate stranger modes of existence, and more whimsical phenomena, than our long study of mechanism has led us to expect. We must put aside prejudice, be guided by the evidence, and strive for truth. The superficial simplicity of materialism has served us well, as a comprehensive covering, for three centuries, and we have made good progress under its protection ; but it is beginning to be threadbare and inadequate, it is not co-extensive with reality, and unsuspected influences are peeping through.

To sum up. A working hypothesis can be followed and developed rationally, without being metrically exact in its early stages. The important question about the spiritistic hypothesis is not whether it is simple or complicated, easy or puzzling, attractive or repellent, but whether it is true. Its truth can be sustained or demolished only by the continued careful critical and cautious method of inquiry initiated by the S.P.R. under the presidency of a guiding spirit or guardian angel called Henry Sidgwick, with the active (and I believe continuing) co-operation of Edmund Gurney and Frederic Myers.

The Supply and Therapeutic Uses of Radium.

By Prof. S. RUSS, The Middlesex Hospital.

THE law of supply and demand is as true for radium as other commodities. Production has often almost ceased owing to lack of demand, only to be renewed as the demand returns, while sudden demands have sent up the price to prohibitive levels until either competition or diminished requirement has brought it down again.

The three main sources from which radium has been mined on any scale are Czechoslovakia, the United States of America, and the Belgian Congo ; Cornwall and Portugal have also been producers, though on a smaller scale. The low grade of the carnotite deposits in U.S.A. made it impossible for America to compete with production from the large deposits of pitch-blende located by the Union Minière du Katanga in its property in the Congo since this rich source has been developed. Czechoslovakia still produces radium, and in Great Britain there is very little difference in the price of radium coming from there or from the Belgian Congo. Unless the amount bought is as much as several grams, the price is at present £12 per milligram of radium element, with extra charges for certificates of measurement and other services connected with the supply. This price is doubtless one which yields a very big profit to the producers, and it is worth while mentioning that the price of the Belgian radium is graded according to the national purse of the buyer—Britain pays more than do her continental neighbours, and America pays more than Britain. There is radium enough in the earth for the world's needs if it can be paid for.

The therapeutic uses of radium are mainly in connexion with cancer, though it is also used for certain other conditions and some dermatological diseases. The outstanding medical interest in radium-therapy is in determining its value and the best methods of application in the treatment of cancer.

Radium-therapy has gone through several phases. In its earliest years, about 1900, success often attended its use in superficial cancers of low malignancy ; this was followed by attempts at dealing with internal growths by implanting radium in platinum or other metal tubes into them. Dominici from 1909 onwards insisted on the necessity of avoiding the use of easily absorbed beta and gamma rays when radium was actually inserted into the tissues, and said that only " les rayons ultra-pénétrants " should be used.

By the year 1914 radium-therapy had already made some progress. The principle of selective action was recognised, and there were several laboratories where the effects of the rays on normal and malignant structures were being investigated. All this work received a set-back during the years of the War, but the ten years that have passed since have been a time of great activity and progress in the subject.

France is the home of radium-therapy (Curie-thérapie they prefer to call it), and it is in no small part due to the systematic researches carried out at the Institut du Radium in Paris, organised by Prof. Regaud, that radium-therapy has reached its present phase. This phase is one in which the definite gains of the past give rise to the belief that radium may be looked upon as a means whereby certain localised growths of cancer can be removed as surely as, and generally with less danger than, by surgery. This is a big claim, and it is one now generally acknowledged, but it cannot seriously be suggested that radium is a cure for generalised cancer. Although a primary localised growth often disappears with radium treatment, in cases where the disease has already spread to glands it is generally true to say that the disappearance of growth in one part of the body has little recognisable effect upon the spread of the disease outside the range of action of the radium.

One of the most important principles that has been recognised during the last five or six years is the significance of the time factor. It is certain that the effect of radiation upon a tumour depends not only upon the dose of radiation absorbed by the tumour and the surrounding normal structures, but also upon the time over which the radiation is spread. This is nowhere exemplified better than in the treatment of cancer of the tongue. For many years these growths, often heavily infected with bacteria, were the despair of those who attempted to treat them by inserting one or two radium tubes, containing perhaps as much as 50 milligrams of the element, and leaving them *in situ* for twenty-four hours. With this treatment it often happened that the local condition was actually aggravated. Since the treatment has been altered and a number of smaller tubes containing only a milligram or two have been inserted and allowed to remain for a week or ten days, so great has been the improvement in the results that, to-day, radium combined with surgery is looked upon as the most suitable treatment for cancer of the tongue and buccal cavity.

An explanation of this difference in biological reaction has been sought on various lines, for while some think that it lies in the greater probability of cells in the vulnerable state of division being irradiated in the longer exposure, others believe that cell growth is more affected by prolonged than by short period irradiations, while the opinion is also held that the effect is largely due to the ability of the host to support a low intensity of radiation more easily than a high one. It must not be lost sight of, however, that the two types of treatment are fundamentally different in the distribution of the radium in the tissues. In the second case the radiation of the region involved is much more uniform and there is more prospect of treating the whole of the growth than in the first case, where one or two tubes containing a large quantity of radium are embedded. This distribution necessarily gives a much too heavy dose to the tissues surrounding the tube, while at the same time much of the growth may be outside the lethal range of action.

Radium is now an acknowledged agent in the treatment of localised cancer, and every year new methods are being devised in order to deal with the more inaccessible varieties of growths (for example, stomach, œsophagus, brain, etc.). But the radium in Great Britain is not enough to treat the numbers of cases of cancer who would probably benefit from its use. It is true that the supplies, especially in the London area, have been considerably increased in the last five years, but in Great Britain generally there is a real shortage. From a national point of view, if an agent is known to be of remedial value in the treatment of any disease, then it would naturally be urged that it should be got, provided there are people enough who know how to use it to the best advantage. These two objects are doubtless in the minds of those who have not only to gauge the nation's radium needs but also to find the means of satisfying them. It is unthinkable that Great Britain cannot really afford the radium that it requires, but the administration of a quantity, let us say a gram per million of population, calls for a good deal of consideration in medical economics. Is the present moment the time for starting a radium centre on the broadest lines where treatment, research, and the teaching of therapy can be carried out? Would it be better to supplement the resources of centres in Great Britain which have already earned a certain reputation? Or would it be better to aim at putting the technique of radium-therapy into the hands of the general practitioners of the country?

The final result, in so far as the economic and efficient treatment of cancer by radium is concerned, is very largely bound up with the decisions of a national character which are likely to be taken in the near future.

In the House of Commons on April 16, Mr. Winston Churchill announced that the Government has arranged for the publication of the report of the Sub-Committee of the Committee of Civil Research on Radium. This Sub-Committee, under the chairmanship of Lord Rayleigh, expressed the opinion that in order to meet the medical requirements of England, Scotland, and Wales, twenty grams of radium should be acquired before the end of 1930. It also recommended the election of 'National Radium Trustees' whose duty it should be to hold the funds provided and to purchase and hold radium for the use of an expert body; this expert body to be called the 'Radium Commission.' Mr. Churchill further stated that the Government has accepted the financial recommendation of the Sub-Committee and that it will be prepared to contribute from public funds, up to a maximum of £100,000, to the extent of £1 for every £1 of private subscription.

Obituary.

SIR GEORGE KNIBBS, C.M.G.

BY the death of Sir George Handley Knibbs at Melbourne, on Mar. 30, science in Australia has lost one of her most forceful and enthusiastic workers.

Sir George was born in Sydney in June 1858. As a surveyor and civil engineer he took an active part in the topographical survey of New South Wales. He then became acting professor of physics at the University of Sydney. In 1906 he was appointed Commonwealth Statistician, and in that capacity brought out the Commonwealth Year Book, which, by reason of its comprehensive and accurate nature, is one of the best statistical publications in the world.

After serving for fifteen years as Commonwealth Statistician, Sir George Knibbs was appointed in 1921 Director of the Commonwealth Institute of Science and Industry, which post he held until his retirement from public life in 1926. The Institute was then reconstructed as the Council for Scientific and Industrial Research. While under his direction, the small staff of the Institute commenced a number of important lines of investigation, some of which have recently passed from success in the laboratory to the sphere of commercial scale tests. These included research into the manufacture of paper pulp from Australian hardwoods, power alcohol production, the eradication of prickly pear, and the utilisation of Australian pottery clays. Knibbs deplored the inevitable whittling away of funds intended for research purposes, due to political indifference, which lessened the value of the Institute to the nation. The constitution of the Institute, however, did not favour its fullest co-operation with the universities and other State bodies; nor did the somewhat autocratic manner of the director attract his Australian fellow scientific workers. Both features were undesirable in a national research body.

Throughout his public life Sir George Knibbs took an active part in social legislation and served on Royal Commissions concerned with education, social and other forms of insurance, taxation of crown leaseholds, trade, and industry. As Commonwealth Statistician, he devised the mathematical formulæ on which the Commonwealth land and income taxes are assessed.

Though his activities were more of an administrative nature, Sir George contributed to the scientific press numerous monographs on pure mathematics, geodesy, and geodetic instruments. His larger contributions include "The Mathematical Theory of Population," "The Census of Wealth," and a recent book, "The Shadow of the World's Future"—a study of the relation of world population growth to food production and migration influences. From a statistical basis, he emphasises the need for modification in national policies to avert the danger of over-population.

Sir George Knibbs was a fellow of the Royal Astronomical Society, an honorary fellow of the Statistical Society, and a member of the International Institute of Statisticians. He attended many international congresses, where his sound knowledge of foreign languages, backed by a comprehensive grasp of scientific affairs, made him an able and worthy representative of the Commonwealth. Although in recent years his health was failing, this disability seems to have had little effect on the keenness and brilliance which he applied to the welfare of Australian scientific organisations. The knighthood bestowed on him in 1923 was regarded in Australia as a fitting recognition of the devoted and brilliant service he had rendered to his country.

SIR HENRY REW, K.C.B.

THE death at his house at Wormshill, Kent, on April 7, at the age of seventy years, of Sir Henry Rew removes a leading authority on agricultural economics and, in the old sense of the word, statistics. For some years prior to 1906 he was in charge of the Statistical Branch of the Ministry of Agriculture and Fisheries, and after his promotion in that year to the post of assistant secretary, his predominant interest lay in the annual reports on agricultural statistics, for which he was personally responsible. To his work in this field is largely due the fullness and comparability of the series of returns on British agriculture. His initiative may be exemplified by the estimates made by a committee of the Royal Statistical Society, from returns from representative dairies and slaughter-houses of the production of milk and meat in the British Isles.

The two addresses given by Sir Henry Rew as president of the Royal Statistical Society were devoted to "The Organisation of Statistics" and to "The Progress of British Agriculture." In the first of these he emphasised that "The real question . . . is not the present defects of the official statistics or the delinquencies of official statisticians, but the deficiencies of the present system and the inadequacy of the available resources." After quoting the several high authorities who at different times had urged the importance of the establishment of a centralised statistical department, he expressed his own conviction of the need for "a general overhaul of official statistical machinery, and for some drastic measure for securing co-ordination." The function of the Royal Statistical Society should be to assist in forming an appreciative, watchful, and well-informed public opinion.

Sir Henry's second address to the Royal Statistical Society was largely a historical account of agricultural statistics leading to the important conclusion that while the statistical data were unable to prove the case, an examination of the statistics so far as they were available pointed to the conclusion that a larger quantity of food was being produced at the outbreak of War than at any previous period, and this in spite of a shrinking acreage.

MR. C. E. BENHAM.

MR. CHARLES EDWIN BENHAM, of Colchester, whose sudden death on April 1, at sixty-eight years of age, we regret to record, was a representative of the type of scientific amateur of which British science has reason to be proud. He followed scientific pursuits, and studied natural processes and events, purely for the love of Nature in all her ways, and by faithful observation and original mind he was able to make some notable contributions to knowledge.

Mr. Benham was for many years editor of the *Essex County Standard* and spent most of his life in the town of Colchester, where he took a leading part in educational and other movements. It is not surprising that "William Gilbert of Colchester" should have attracted his literary and scientific attention, for Mr. Benham's methods were of the same experimental and independent character as those of Queen Elizabeth's learned physician. In an excellent little book published in 1902 he showed what manner of man Gilbert was, wherein lay his genius, and the spirit of his work, which was "that all scientific knowledge must be founded on practical experiment and observation alone, instead of upon speculations and theories evolved out of inner consciousness."

In 1895 Mr. Benham devised a colour-top by which a curious optical illusion is produced which is not easy to explain. Half of a white cardboard disc is coloured black and on the other half a number of black lines are drawn as arcs of a circle. On rotating the disc, and viewing it in a bright light, the arcs of some of the circles appear coloured. On reversing the rotation the order of the colours reverses. The subjective colour effects then exhibited were the subject of a number of letters in NATURE at the time the top was produced, and Mr. Shelford Bidwell devoted a paper to them which was published in the *Proceedings of the Royal Society* of Dec. 17, 1896.

On the experimental side also, Mr. Benham developed the twin-elliptic pendulum and published a number of papers on harmonic vibrations and vibration figures. He was the author of many communications published in NATURE, *Knowledge*, *Science Progress*, *Engineering*, and other scientific journals, and the subjects covered a wide range of practical inquiry, including thermographs, atmospheric electricity, electroscopes, alarum sundials, and iridescent glass. Mr. Benham was in addition an artist whose water-colour drawings are of real distinction, and the author of works on local Essex dialects and the history of Colchester. He was an ardent lover of knowledge in all its highest aspects, and his death will be regretted by a wide circle of students who have been stimulated by his work, as well as by his numerous personal friends.

PROF. F. KEHRMANN.

DR. FRIEDRICH KEHRMANN, professor of organic chemistry at the University of Lausanne, died on Mar. 4. We are indebted to the *Chemiker-Zeitung* for the following details of his career. Born at Coblenz in 1864, Kehrmann became deeply interested in chemistry while still a boy, but being at first unable through lack of means to attend regular classes, he studied by himself. He became so proficient in analytical work that he obtained a post as analytical assistant to Fresenius at Bonn. In 1887 he graduated at Basel under Nietzki, with whom he carried out an investigation of quinones. After graduation he became assistant to Claus at Freiburg, where from his observations upon di-ortho-substituted quinones he formulated the well-known hypothesis of 'steric hindrance,' a generalisation which has been very extensively applied in the study of other branches of organic chemistry.

Kehrmann's hypothesis was based upon the hindering effect of two ortho-substituents upon oxime-formation, and in support of his idea he quoted many other well-known examples of inhibited reactions, which had hitherto remained unexplained. He was even able to foresee the discovery of steric hindrance in the ortho-substituted benzoic acids. This prediction was verified shortly afterwards by the work of V. Meyer, but for some reason or other Kehrmann's claim to priority seems to have been overlooked.

Kehrmann moved to Aix-le-Chapelle and thence to Geneva, where he found in Graebe's laboratory a congenial atmosphere and inspiring companions. At Geneva his chief interest was in dyestuff chemistry, to which he made many notable contributions, particularly in the field of azines, thioazines, and oxazines. To him may also be attributed the origin of the theory of the oxonium salts. For a short time he held a post with the firm of Casella and Co., but ill-health compelled him to relinquish it. Later he took up a teaching appointment at the Municipal School of Chemistry at Mülhausen in Alsace, and in 1910 he was appointed to the chair of chemistry at Lausanne. His collected works, which include the spectroscopic examination of whole classes of dyestuffs, have been published in five volumes.

WE regret to announce the following deaths:

Mr. W. Worby Beaumont, honorary consulting engineer of the Royal Automobile Club, for ten years a joint-editor of *The Engineer* and author of several well-known books on motor car engineering, on April 14, aged eighty years.

Prof. F. S. Earle, sugar cane technologist at the Tropical Plant Research Foundation at Herradura, Cuba, and president in 1906 of the American Botanical Society, on Jan. 31, aged seventy-two years.

Mr. Charles Hunt, an honorary member and past president of the Institution of Gas Engineers, aged eighty-six years.

Prof. Clemens von Pirquet, professor of pædiatrics in the University of Vienna, known for his studies of the mathematical relationship of body measurements to nutritional requirements and for his cutaneous tuberculin reaction, aged fifty-four years.

Dr. Paul Sarasin, president of the ethnographical section of the Natural History Museum of Basle, on April 7, aged seventy-three years.

News and Views.

SIR ALFRED EWING, Principal and Vice-Chancellor of the University of Edinburgh, was presented on April 18 with the freedom of the City of Edinburgh in the Usher Hall in the presence of a large and representative assembly. The honour was conferred, as stated in the Burgess Ticket, as a mark "of the high esteem in which he is held by the citizens of Edinburgh, in testimony of his valuable services to the city and the State, and in recognition of his brilliant and distinguished career as Principal of the University of Edinburgh during a period marked by exceptional difficulty on account of the War and the policy of unprecedented development and expansion of the University." The Lord Provost, Sir Alexander Stevenson, who presented the silver casket containing the Burgess Ticket, spoke of Sir Alfred's distinguished career, of his services to the University and his efforts to make the University a living force in the City, and of his work at the Admiralty during the War as creator and organiser of the department which achieved great success in intercepting and deciphering enemy wireless messages. In his reply, Sir Alfred referred to some of the important developments in the University during the thirteen years of his principalship, and at the end stated that he had received from Sir Alexander Grant a cheque for £25,000 and a promise of a like amount within twelve months for the building of a new department of geology. After the ceremony, Sir Alfred, accompanied by the president of the Students' Representative Council, was conveyed from the Usher Hall by way of Princes Street to the City Chambers in a gaily decorated open carriage drawn by students.

IN 1923 a large wooden building, which was erected in 1917 in St. Andrew Square, Edinburgh, for the use of American troops, was purchased by the University and rebuilt on the new campus near the southern edge of the City adjacent to the Department of Chemistry. Early in the following year the Department of Geology was transferred thereto from inadequate premises in the Old College. The wooden building is now approaching the limit of its existence, and Sir Alexander Grant's generous gift relieves an anxiety which was becoming acute as to the housing of the Department of Geology. This is the second benefaction the University has received from him, for about four years ago he contributed a sum of £50,000 towards the extinction of the debt on the Department of Chemistry. In June 1923 he gave £100,000 towards an endowment fund for the Scottish National Library, and in July of last year a further sum of £100,000 for the erection of a suitable building in which to house the Library. He was also one of the chief contributors to the fund for the Scottish National War Memorial. His name, as Sir Alfred Ewing said, is in Edinburgh a synonym for generosity.

WHEN a journal has been for thirty years in charge of one man, the reputation of the journal reflects the merits of the editor. The case in point is that of *The Mathematical Gazette* and Mr. W. J. Greenstreet. Founded and maintained in the interests of school teachers, the *Gazette* has pedagogy in plenty, abundant notes on scholarship mathematics, and reviews which endeavour conscientiously to appraise schoolbooks as they issue in bewildering streams from the publishers. But it aims also at helping its readers to understand how mathematics has grown since their own university days, and nowhere are important mathematical treatises subjected to more valuable analysis or more authoritative criticism: Keynes has been reviewed by Russell, Eddington by Newall, Weierstrass by Carathéodory, Schrödinger by Fowler, Knopp by Bromwich. While Mr. Greenstreet has secured for a journal which grew out of the annual reports of a teachers' association the standing implied by such names as these, he has also poured into its pages a wealth of biographical and historical knowledge which has made the *Gazette* the most readable mathematical periodical in the world. A testimonial in appreciation of Mr. Greenstreet's long and successful editorship has been organised by the Council of the Mathematical Association, which invites the co-operation of everyone who feels that such work as his deserves recognition. Because of a severe illness which drained his resources two years ago, the testimonial is to take the form of a cheque, accompanied by the names of subscribers but not by a list of amounts. The expenses of the fund are being borne by the Mathematical Association, and the work involved has been undertaken by Mr. C. Pendlebury, 39 Burlington Road, Chiswick, London, W.4, to whom donations should be sent.

THE pioneers of New Zealand geology include von Haast, James Hector, F. W. Hutton, and Ferdinand von Hochstetter, the last of whom was born on April 30, 1829. The son of an Austrian pastor, Hochstetter took the degree of Ph.D. and in 1853 joined the Geological Survey of Austria. Four years later he became geologist to the famous *Novara* Expedition and on Dec. 22, 1858, arrived at Auckland, where his services were at once secured by the Government. Von Haast, the German geologist, had arrived the day before, having been sent out to report on the suitability of the country for German emigrants. Together, Haast and Hochstetter carried out extensive geological explorations and both published works on the geology of New Zealand. Returning to Europe in 1861, Hochstetter settled at Vienna and for many years held the chair of geology and mineralogy at the University there. He died on July 21, 1884, and a memoir of him was written by Haast, which was reviewed in our columns on Nov. 20, 1884.

PROF. E. V. APPLETON, Wheatstone professor of physics at King's College, London, has been awarded the Morris Liebmann Memorial Prize for 1929 by the American Institute of Radio Engineers. This prize is awarded annually by the board of directors of the Institute to the worker responsible for the most important contribution made to wireless progress during the preceding year. Prof. Appleton has for

some years been engaged in the study of the scientific problems of radio telephony, chiefly on behalf of the Radio Research Board and the Department of Scientific and Industrial Research. In 1924, working in conjunction with Dr. Barnett, he was the first to put forward acceptable experimental evidence for the existence of the so-called Heaviside layer and the value of its height above the ground. More recently, work on similar lines has been carried out under Prof. Appleton's direction, in the most part at the Peterborough Station of the Radio Research Board, and at King's College, London, where wireless methods have been developed which have led to a great increase in our knowledge of the electrical properties of the upper atmosphere. It may be recalled also that Prof. Appleton made an announcement in NATURE of Mar. 23 last, of the discovery of what is probably a second Heaviside layer. He was recently awarded a Wireless Premium by the British Institution of Electrical Engineers for his researches on the causes of wireless signal fading and directional errors.

A MOVEMENT to commemorate in an appropriate way the pioneer work of the late Mr. W. H. Dines in the exploration of the upper air and in other branches of practical meteorology was initiated a few months ago by the Royal Meteorological Society. The Council of the Society believes that the most suitable form of memorial would be the publication of a collection of Mr. Dines's scientific papers in a single volume, and a circular has just been issued inviting promises of subscription to such a volume of about 600 large octavo pages, to be published at a price not exceeding thirty shillings. The papers consist almost exclusively of contributions to the publications of a number of scientific societies extending over a period of fifty years; and their re-issue in a collected form would not only be a tribute to Mr. Dines's original and fruitful work but also would be of real service to science in general and students of meteorology in particular. Intending subscribers to the volume should communicate with the secretary of the Royal Meteorological Society, 49 Cromwell Road, South Kensington, S.W.7. We trust that the promises to purchase the volume when published will be numerous enough to relieve the Council of any anxiety which may be involved in the cost of publication of a work worthy of one whose researches began a new epoch in the history of meteorology and have led to developments of great practical value.

THE American Association for the Advancement of Science held a very successful meeting in New York during the last week of December. On behalf of the fifty educational and scientific organisations of the city, Prof. Henry Fairfield Osborn, the president, welcomed the Association, which now includes more than 17,000 members, and gave an indication of the programme set for the meeting. A reprint of his address has now reached us. The programme seems to have been arranged with great regard to the convenience of the public and the scientific worker of wide interests, for separate days were set aside for general sessions each on one particular science, so that geology, physics, biology, chemistry, and anthropology each had its day, and on the evening of the same day a reception and address followed in the corresponding department of the American Museum of Natural History. Following the excellent precedent of the British Association, these evening addresses were of a semi-popular character designed to attract and stimulate the rapidly growing interest in science manifested in the city of New York and throughout the United States and Canada. "The leading *motif* of this science week programme was to offset some of the extreme specialisation of the present day by a more general prospectus of the unity and harmony of various sciences such as prevailed in the unified spirit of the great founders of the Association eighty-five years ago." It is a leading *motif* which deserves serious consideration in arranging the programme of the British Association. Advantage was taken of the occasion of the meeting to celebrate the centenary of the epoch-making glacial theory of Louis Agassiz, one afternoon session being devoted to a symposium of addresses on various aspects of glaciation.

ONE of the interesting evening addresses was delivered by Prof. W. M. Wheeler, of Harvard University, on "Present Tendencies in Biological Theory," and this has since appeared in the February *Scientific Monthly*. Prof. Wheeler makes a strong protest against the critics of biological theory, who find that "biology has been steadily going to the dogs ever since the Renaissance," or that "biology has about reached a stage corresponding with pre-Copernican astronomy and physics, and that biologists have not yet discovered a single law, since what they have been fondly calling laws are merely rules or generalisations." He considers that there are at least three recent theories, which, with some mutual adjustment, might yield a provisional synthesis, or at any rate clarify the conflict between the mechanistic and vitalistic points of view. These are the theory of emergence or 'holism' propounded by Prof. S. Alexander, Prof. C. Lloyd Morgan, and General J. C. Smuts; the configuration or 'Gestalt' theory; and behaviourism. Each of these theories deals with wholes, from different aspects; the first emphasising that the whole has a novel import not apparent in any mere sum or aggregate; the second being more interested in the peculiar irreducibility of wholes as patterns either in space or time than in their novelty; and the third concerned with the action-patterns of the whole organism in response to its environment. While admitting that certain oppositions must remain in biological theory from the nature of the emergence levels of organisms, Prof. Wheeler thinks that many of the oppositions among theories may be elucidated and toned down "by the rejection of a lot of adventitious and mystical notions foisted upon the biological sciences by historians and philosophers."

AN outstanding feature in the recent history of the British Research Association for the Woollen and Worsted Industries is the retirement of the chairman, Sir James P. Hinchliffe. Sir James, who is well known for his public services in Yorkshire, is a

distinguished figure in the textile industry, and he has, in large measure, been responsible for the development of the present high degree of efficiency of the Association. He is succeeded by Lord Barnby, who, in addition to being governing director of one of the largest wool firms in the world, has already rendered much service through the Federation of British Industries and elsewhere, by his advocacy of the importance of the application of scientific method in the development of British industry. The Report of the Association for the year 1928–29 contains a complete survey of its activities. The effects of selection, breeding, nutrition, climate, and pasturage on particular breeds of sheep, and the consequent effects upon the wool produced, are being investigated, with the financial assistance of the Empire Marketing Board, in conjunction with the Dominions overseas. Physical and chemical problems continue to provide an extensive field of investigation. Much of this work has already been described in previous reports by the Association. The joint research with the Society of Dyers and Colourists upon fastness of dyestuffs and fading of fabrics due to light, perspiration, and other agents, is being continued.

THE extent and complexity of the purely scientific problems which confront the textile industry at the present time are clearly described in the Report referred to above, and the difficulty of the dissemination of the results of the purely scientific work of the Association in the industry itself has received timely emphasis. The better utilisation of research, not merely in the textile industry, but also in British industry generally, is probably one of the most urgent needs of the present time. The final Report of Sir Arthur Balfour's Committee on Industry and Trade sounds a warning note upon this point when it states that before British industries, taken as a whole, can hope to reap from scientific research the full advantage which it appears to yield to some of their most formidable trade rivals, nothing less than a revolution is needed in their general outlook on science ; and in the case of some industries at least this change of attitude is bound to be slow and difficult, in view of old and deeply rooted industrial traditions. The work of the research associations generally will be immensely facilitated if this view gains a wider appreciation amongst all those engaged in industry to-day.

IN his Friday evening discourse, delivered on April 19 at the Royal Institution, Prof. O. T. Jones described a visit to the Grand Canyon, Yellowstone National Park, last summer. This is the largest of the national parks in the United States, and is chiefly remarkable for its geological and physiographical features. Volcanic accumulations of the Tertiary period make up a large area of the Park and attain a thickness of many thousands of feet. The large number of existing geysers and hot springs indicates that the volcanic phenomena are not yet quite extinct. Among the most striking of the physiographic features of the area is the great canyon carved by the Yellowstone River on its way from the Yellowstone Lake to join the Missouri. Physiographers have usually regarded the Grand Canyon as a product of erosion since the glacial period. An examination of sediments in the wall of the Canyon near the Great Fall has shown that they are sands, muds, and conglomerates extending in different places from the rim of the Canyon nearly to the bottom. These prove beyond doubt that the Canyon since its excavation has been dammed at some point below, and in the lakes resulting from this process the sediments have accumulated, filling the Canyon to the brim. Further investigations have established that the Canyon since its excavation has been dammed by great flows of lava which entered the Canyon from the north and flowed against the drainage of the Yellowstone and its main tributary, the Lamar River. A consideration of the profiles of the drainage system shows that prior to the damming episode the Canyon had been eroded in three or four stages or cycles of erosion ; each new stage being initiated by uplift of the region. The lava flows entered the Canyon while the last cycle of erosion was in progress. The results of these discoveries have thrown an entirely new light on the volcanic history of the Park, which will have to be examined anew.

THE Society for Experimental Biology met at the University of Manchester on April 19 and 20, the meetings being held in the Physiology Department through the kindness of Prof. H. S. Raper. Among the numerous contributions were an account of the growth and development of different types of bulbs by Prof. F. E. Weiss, and a stimulating discussion which followed the statement, by Prof. D. Thoday, of the principles underlying the causal interpretation of plant anatomy. Mr. M. A. H. Tincker described the effect of varying the daily light duration upon the time of flowering, form, and chemical composition of plants, while Mr. E. J. Collins outlined some experiments on the ' breaking ' of tulips. Prof. H. S. Raper gave an account of melanin formation among animals, pointing out that a similar mechanism appears to underlie all the cases explored, with possible exceptions among vertebrates. Mr. J. Needham discussed the evolution of the egg and the metabolic limitations which it imposed upon the embryo. Prof. T. H. Pear described his work upon the transfer of training in the acquisition of manual dexterity. Mr. A. D. Ritchie introduced an interesting discussion on the acid-base equilibrium in muscle.

THE Prime Minister of the Commonwealth has appointed a committee to take charge of the general arrangements for the proposed Australian Antarctic Expedition under Sir Douglas Mawson. Sir George Pearce, vice-president of the Executive Council, is chairman of the committee, and the other members are Sir Douglas Mawson (or, in his absence, Capt. J. K. Davis, who will be second-in-command of the expedition), Sir David Masson, Rear-Admiral W. R. Napier, Dr. A. C. D. Rivett, and Dr. W. Henderson. The expedition will undertake a coastal survey of the Antarctic continent south of Australia between longitudes 160° and 45° east, the *Discovery* having been placed at its disposal by the British Government.

It is anticipated that the ship's complement will number twenty-six, and that the scientific staff, including a press correspondent, will be twelve. The starting-point of the expedition has not yet been determined, but operations will probably begin late in November and continue until the end of April 1930. It is very probable that a second season will be necessary to enable the whole programme of the survey to be carried through.

IN the article on Christian Huygens in our issue of April 13, p. 575, reference was made to the object glass of 122 feet focal length which, according to Weld, was given to the Royal Society by Huygens in 1691. Weld also states that two other object glasses of Huygens' were afterwards presented to the Society by Sir Isaac Newton and the Rev. Gilbert Burnet. From Prof. R. A. Sampson, Astronomer Royal for Scotland, we learn that the real donor of the first and the maker of all three lenses was Christian's elder brother, Constantine Huygens (1596–1687); and that, collaborating with Prof. A. E. Conrady, Prof. Sampson has recently communicated to the Royal Society a paper containing a critical account of these historical lenses. Weld's "History of the Royal Society" was published in 1848, but the mistake about the lenses had been pointed out by Uylenbroek ten years before. From the *Times* of April 22, we learn that the tercentenary of the birth of Huygens was celebrated the previous week at Leyden, the commemoration being organised by the Royal Academy of Sciences in conjunction with the University of Leyden and various scientific associations. A souvenir account of the proceedings is to be published at Amsterdam.

THE issue of *Vox* for Mar. 1, edited by Prof. Calzia, of the University of Hamburg, contains an official communication of the International Society of Experimental Phonetics giving an account of the Conference to be held on July 24–31 next in Hamburg, with a list of addresses and demonstrations and an announcement that opportunities will be given for practical training in the methods of the science. The published list of members includes experimental phoneticians from nearly every country in Europe and also from America and Asia. An account of a new and very practical form of stroboscope for observing the vocal cords is illustrated in detail. *Vox* is the official organ of the Phonetic Laboratory of the University of Hamburg, the Phonetic Institute of the University of Vienna, and the International Society of Experimental Phonetics. It is sent without charge to members of the International Society.

DR. MILLAIS CULPIN has contributed an article on noise and hearing, considered from the psychological point of view, to a recent issue of *The Nineteenth Century* (vol. 105, No. 626). Few of those who most volubly protest against the noises of modern life are content to base their objection on the simple fact that unnecessary noise is irritating to most people, and that certain temperaments may find that irritation harmful to health. Instead, a pseudo-scientific terminology is used to describe fantastic happenings to the central nervous system. Dr. Culpin discusses the problem of nervousness, the relation of the nervous temperament to the degree of suffering from noise, the bewildering array of personal peculiarities that confronts any investigator of noise, the domain of the physiological injury when such can be proved to exist. The frequently urged view that energy is used up in ignoring noise, sounds plausible, but as it can neither be proved nor disproved it leads nowhere; arguing by analogy, however, there seems no reason to suppose that lack of attention to certain auditory sensations can be of any more danger to the organism than lack of attention to any other sensory stimulation. The article is a very timely and necessary corrective to the loose thinking and over-simplification characteristic of many writers on the subject. Dr. Culpin also makes the subject much more valuable by treating it in relation to other problems and not as an isolated phenomenon.

AN authoritative committee, composed principally of veterinary surgeons in charge of slaughter-houses, recently held at Leeds a trial of the Weinberg casting pen, the object of which is to ensure that no suffering shall be inflicted when beasts are cast for slaughter by the Jewish method (shechita). It is therefore satisfactory to know that the report of the committee is entirely favourable. The chairman was Prof. F. T. G. Hobday, principal of the Royal Veterinary College, and the honorary secretary Capt. C. W. Hume, of the University of London Animal Welfare Society. The members included Prof. Lovatt Evans, five veterinary surgeons in charge of large abattoirs, and two representatives of animal protection societies. It is understood that two further machines having the same object are to be tried out in the near future. The subject is one upon which feeling runs very high in some slaughter-houses, and in these circumstances it is not easy to ensure the scientific character of the trials by eliminating incalculable human factors. The committee will doubtless, however, be fully alive to this consideration.

IN a recent address to the Institution of Electrical Engineers, Mr. J. Swinburne gave an account of Sir Joseph Swan's inventions in connexion with the carbon filament electric lamp. In the April *Journal* of the I.E.E., Mr. A. Campbell Swinton has a note on the part played by Lane Fox Pitt in the invention of this lamp. He thinks that neither Mr. Swinburne nor Sir Ambrose Fleming in his 'personal recollections,' published in the February issue of the *Journal*, do justice to this inventor, and points out that he was the first patentee of the method of 'flashing' used in making carbon lamps, and was the inventor of the constant voltage system of public lighting with the lamps in parallel. In the same journal Mr. Swinburne replies that he does not know who invented the method of 'flashing.' In his address he was discussing Swan's work, and as Swan got no help from Lane Fox Pitt's work, it was unnecessary to discuss the work of the latter. He mentioned, however, in his address that Pitt did take out a patent on parallel distribution a year before Edison, which, although bad

in law, propounded with luminous clearness parallel distribution, and dispelled for ever the fog about 'the subdivision of the electric light.'

AT a meeting held in the Natural History Theatre of the University of Manchester on Feb. 23, a provisional committee was appointed to draw up a scheme for co-ordinating the work of the scientific societies, especially those following biological lines of research, in north-western England and Wales. The committee has now issued a circular with suggestions for the establishment of a "North-Western Naturalists' Union," which will, it is hoped, be definitely inaugurated in June. Membership of the Union will be open to individuals as well as to societies in the area proposed, which includes the English counties from Cumberland to Staffordshire and Shropshire, North Wales, and the Isle of Man. It is believed that such a Union may be of great service to the local societies, by holding a yearly general meeting and conference, by arranging exchanges of lecturers between the various centres, and by facilitating the publication of papers. For many years past there has been at work a strong naturalists' union in north-east Lancashire, and it is hoped that the more comprehensive union now proposed will be a means of help and encouragement to the large number of earnest Nature-lovers who pursue their studies in the busy industrial towns and the countryside of the north-west of England.

THE Australian National Research Council has elected Sir Thomas Lyle, formerly professor of natural philosophy in the University of Melbourne, to the office of president in succession to the late Mr. R. H. Cambage.

AT the meeting of the London Mathematical Society on Thursday, May 16, at 5 P.M. at Burlington House, Prof. C. G. Darwin, of Edinburgh, will deliver a lecture on "The Refraction and Scattering of Light." Members of other scientific societies who may be interested are invited to attend.

SIR OLIVER LODGE is to deliver the nineteenth annual May Lecture before the Institute of Metals on Tuesday, May 7. The title of the lecture will be "Some Ideas about Metals." Cards of invitation to the lecture can be obtained by sending a stamped and addressed envelope to the secretary of the Institute of Metals, 36 Victoria Street, London, S.W.1.

IT is announced in *Science* that Prof. Frank Schlesinger, director of the Yale University Observatory, has been awarded the Bruce Medal of the Astronomical Society of the Pacific for his work on photographic parallaxes and in other departments of astronomy. The medal is awarded on the recommendation of the directors of the Harvard Observatory, Lick Observatory, Yerkes Observatory, the Observatory of Berlin, the Observatory of Greenwich, and the Observatory of Paris.

THE Council of the Institution of Automobile Engineers has awarded the medal of the Institution to Capt. J. S. Irving in appreciation of his brilliant work in connexion with the design of the "Golden Arrow," which, coupled with the courage and skill of Major Segrave, has resulted in the world's speed record being once more held by Britain, and this time by a very large margin. The medal was established in 1922 as a recognition of technical achievement likely to have special influence on the advancement of automobile engineering.

THE annual congress of the South-Eastern Union of Scientific Societies will be held at the Royal Pavilion, Brighton, from Wednesday, June 5, until Saturday, June 8, inclusive, by invitation of the Brighton and Hove Natural History and Philosophical Society, and the Worshipful the Mayor and Corporation of Brighton. Sir Arthur Keith has consented to serve as president in succession to Sir Martin Conway. The honorary general secretary of the Congress is Mr. E. A. Martin, 10 Avenue Road, South Norwood, S.E.25, and the assistant hon. secretary is Mr. R. W. Strickland, 5/6 Clements Inn, W.C.2.

WE learn from a *Daily Science News Bulletin* (Science Service, Washington, D.C.) that the United States Senate has passed a bill providing pensions of 125 dollars per month for the Army officers and enlisted men, or their widows or heirs, who took part in 1900 in the yellow fever investigations carried out in Cuba under Major Walter Reed, which demonstrated conclusively that yellow fever is not infectious or contagious in the ordinary sense. Further, the names of the 22 men (of whom 14 survive) of the expedition are to be published annually in the Army Register as a roll of honour, and each of the men or their heirs is to be presented with a commemorative gold medal.

AT the annual general meeting of the Physical Society of London, held on Mar. 22, the following officers were elected:—*President:* Dr. W. H. Eccles; *Vice-Presidents:* Sir Oliver J. Lodge, Sir Richard Glazebrook, Prof. H. L. Callendar, Sir Arthur Schuster, Sir J. J. Thomson, Prof. C. Vernon Boys, Prof. C. H. Lees, Sir William Bragg, Dr. Alexander Russell, Dr. F. E. Smith, Prof. O. W. Richardson, Mr. R. W. Paul, Dr. J. S. G. Thomas, Prof. A. O. Rankine, and Prof. F. L. Hopwood; *Hon. Secretaries:* Dr. Ezer Griffiths and Dr. Allan Ferguson; *Foreign Secretary:* Prof. O. W. Richardson; *Hon. Treasurer:* Mr. R. S. Whipple; *Librarian:* Mr. J. H. Brinkworth.

A PRIZE consisting of a medal and the sum of £500 is offered by the British Empire Cancer Campaign to the person, or group of persons, who shall submit the essay embodying the results of original investigations which, in the opinion of the judges, is the best contribution towards the early diagnosis of cancer. The competition is open to British subjects of either sex, resident in the British Empire or the Dominions, who can obtain a copy of the rules and regulations relating to the prize by writing to the secretary of the British Empire Cancer Campaign, 19 Berkeley Street, W.1. The latest date for the receipt of essays is Dec. 31, 1931. The award will be made early in the following year.

AN interesting article by Prof. Luigi Devoto on the results which have followed the institution of 'summer

time' appears in the *Rendiconti* of the Royal Lombardy Scientific and Literary Institute for last year. This question was discussed at the seventh Italian National Congress of Industrial Medicine, held at Parma, following a paper by Prof. Gaetano Pieraccini, who considered more particularly its hygienic aspects. Pieraccini's conclusions, given *in extenso*, indicate whole-hearted accord with daylight-saving, which has resulted in the checking of various maladies favoured either by lack of light or by the use of artificial illumination.

A CATALOGUE (No. 8) of miscellaneous second-hand books of science, mainly of botanical and zoological interest, has been received from Mr. J. H. Knowles, 92 Solon Road, S.W.2.

READERS interested in West Africa may like to have their attention directed to a short catalogue of second-hand books relating to that part of the world which has recently been issued by Messrs. Francis Edwards, Ltd., 83 High Street, Marylebone, W.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A senior curator of the Museum of St. Bartholomew's Medical College—The Dean of the Medical College, St. Bartholomew's Hospital, E.C.1 (April 29). A research studentship at St. Mary's Hospital Institute of Pathology and Research—The Secretary, Institute of Pathology and Research, St. Mary's Hospital, Paddington, W.2 (April 30). A lecturer in engineering, with special qualifications on the electrical side, at the Plymouth and Devonport Technical College—The Secretary for Education, Rowe Street, Plymouth (May 4). A junior scientific officer in the Admiralty Scientific Pool—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (May 4). A lecturer in engineering at the Widnes Municipal Technical College—The Clerk to the Governors, Town Hall, Widnes (May 6). A male assistant at the Low Temperature Research Station, Cambridge—The Superintendent, Low Temperature Research Station, Cambridge (May 6). An inspector of weights and measures under the Surrey County Council—The Clerk of the Surrey County Council, Public Control Department, County Hall, Kingston-upon-Thames (May 6). A first assistant in the Clinical Laboratory of the Manchester Royal Infirmary—The Gen. Supt. and Secretary, Royal Infirmary, Manchester (May 8). A pathologist and bacteriologist at the Northern Infirmary, Inverness—The Hon. Secretary, Northern Infirmary, Inverness (May 8). The Anderson lectureship in comparative psychology in the University of Aberdeen—The Secretary, University, Aberdeen (May 28). A professor of anatomy at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, S.W.7 (May 30). A professor of mathematics at Canterbury College, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (July 31). A junior assistant under the Directorate of Metallurgical Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. A senior biology master at the Cambridge and County High School for Boys—The Education Secretary, County Hall, Cambridge. A full-time teacher of electrical engineering at the Barnsley Mining and Technical College—The Principal, Harvey Institute, Barnsley. A woman biochemist at the Wellcome Physiological Research Laboratories—The Director, Wellcome Physiological Research Laboratories, Beckenham.

Our Astronomical Column.

HALLEY'S COMET AND THE AQUARID METEORS OF MAY 2–6.—One of the greatest of English astronomers was Edmund Halley, who acted as Astronomer Royal about two and a half centuries ago. Amongst the most important of his achievements was the discovery that a bright comet, visible in 1682 and first seen by an assistant of Flamsteed, revolved around the sun in about 76 years and had been observed in the years 1531 and 1607. He predicted its return in 1759, and this was realised.

Since Halley's day, further investigations have elicited the fact that the comet has been in existence and visiting the sun during more than 2000 years. It was last observed in 1910, and will probably reappear in about 1986. One of the occasions on which it returned was the momentous year 1066. Certain disasters and historical events were formerly connected by superstitious people with its visits.

This remarkable object is the largest of all the periodical comets, and it is notable as being the source of a meteoric display which occurs during the first week in May. Capt. Tupman discovered it about sixty years ago, and it has been reobserved on many occasions since, though it has never furnished a really great abundance of meteors. But the objects derived from this comet are unequalled in splendour and length of flight by any other meteoric display in the heavens. The earth and comet do not encounter each other centrally, for their orbits at the points of nearest approach are separated by several millions of miles of space. The meteors, therefore, which the earth encounters are only those placed on the outer fringe or outskirts of the system. Some of the large fireballs belonging to it may possibly be observed in the morning twilight of May 2–6 next, between about 1 A.M. and 3 A.M. The conditions prevent their apparition during the earlier hours of the night.

QUANTITATIVE ANALYSIS OF THE SUN.—Prof. H. N. Russell contributes an interesting article on this subject to the *Scientific American* for April. He gives a sketch of various stages in the history of spectroscopy. The earliest stage lay in the simple recognition of the presence of various elements in the sun and stars. Then followed the stages of the study of radial velocities, and of the detection of magnetic fields. Attention is now being given to the contours of lines—curves indicating the gradations of intensity throughout their widths and deductions as to the density with which the atoms are packed in the course of the ray of light. It is stated that the weakest lines on ordinary stellar spectrograms (of intensity 1 on Rowland's scale) could be produced by 2×10^{13} atoms per square centimetre, which is a millionth of the number in a cubic centimetre of air; further, that the whole amount of gas in the sun's atmosphere, if condensed to the density of our air, would form a layer between 10 centimetres and 1 metre in thickness.

Research Items.

LOVELOCK CAVE.—In 1911, during mining operations for bat guano, numerous ancient Indian objects were discovered in the Lovelock Cave in the Humboldt Valley of West Central Nevada. Further excavations were carried out under more favourable conditions in 1924 by Mr. M. R. Harrington and Mr. Loud, which are now described in a fully illustrated monograph issued as No. 1 of Vol. 25 of the *University of California Publications in American Archæology and Ethnology*. To the description of the recent excavations Mr. Loud adds an account of the objects obtained in 1912. Originally Lovelock Cave was a long shed-like rock shelter about 150 feet in length and 35 feet wide. Earthquakes and other natural agencies caused masses of rock to fall from the roof blocking the opening in front, converting it into a cave. The local Indians, the Northern Paiute, have a legend that the inhabitants were Pit River Indians whom they drove out. The cave had undoubtedly been used as a dwelling-place, and not solely as a cemetery and place of ceremonial deposit, as has been suggested. The earliest horizon of occupation belongs to the Basket-Makers of possibly three to four thousand years ago, with possibly sixty burials in the cave, and as the cave refuse lies directly on the lacustrine deposits it begins possibly within a hundred years of the subsidence of Lake Lahontan. The deposits of human origin show no bones of the sabre-tooth tigers, horses, or camels found in the lake-shore gravels. The culture of the earliest occupation resembles, but is poorer than, that of the Basket-Makers, nor was there any knowledge of agriculture. It resembles the hypothetical 'basic culture' of the south-west. After a deposit of five feet, a foreign influence creeps in, forming a transition period, and finally, as it grows stronger, the bow and arrow appear. Then begins a 'Later Period,' possibly about A.D. 1000, containing many articles which have their counterpart among the modern Paiute. The cave dwellers would thus appear the cultural, if possibly not the linguistic, kinsfolk of the Northern Paiute.

THE AUSTRALIAN ABORIGINAL BRAIN.—Prof. Woollard (*Jour. Anat.*, vol. 63, pt. 2, pp. 207-223) gives an account of four brains of aboriginal Australians. He finds that the aboriginal Australian brain is a small brain, extremely dolichocephalic, in which the insula tends to be exposed and the primitive features in the organisation of the striate area to be retained. His observations offer no ground for supposing that the aboriginal brain discloses any peculiar simian features or that it resembles microcephalic brains of European origin, or that it retains any special features of the fœtal human brain. He finds that the variations in the indices of the aboriginal brain present no peculiar features, and the differences between it and the European brain are adequately accounted for by the extreme dolichocephaly. The proportion of grey to white matter in the hemispheres is the same as in the European brain, and there are no significant differences between the right and left hemispheres. The total weight of the brain and the weights of the hemispheres are smaller than in the European brain.

NERVOUS SYMPTOMS AND VOCATIONAL SELECTION.—In the *Revue de la Science du Travail* (Tome I., No. 1), Dr. Toulouse directs the attention of students of vocational selection to the problem of the nervous person in the industrial world. He maintains that slight nervous troubles are infinitely more common than any one is aware of, and that their action on the output of the worker is disastrous. He contrasts the limited and ascertainable effect on output of an organic disease, with the irregular and incalculable effect of nervous symptoms. There is here no question of the intelligence, which might be of the highest order, but of an emotional or temperamental instability, over which the person has little control, leading to erratic work curves and long sickness absenteeism. He pleads for a greater recognition of this factor by those doing mental testing and for a periodic examination of employés during their industrial career. The nervous condition which in the typist may involve an unusual number of errors may in a signalman lead to a disaster. It is probable that behind an accident is an emotional instability and not a defective sense organ or intellectual weakness. A similar conclusion was reached by the Industrial Fatigue Research Board after an investigation of telegraphist's cramp: it was shown that those who suffered from that disorder, which essentially involved even in the earlier stages a diminished output, were of the temperament popularly called 'nervous.'

SEA-TROUT IN SCOTTISH WATERS.—In his paper "Sea-trout of the River Ailort and Loch Eilt, Part 2, 1920 and 1925–27. With an Appendix on Ailort Salmon" (Fishery Board for Scotland. Salmon Fisheries, 1928, No. 9), Mr. G. Herbert Nall continues his work based on scale reading, the first part of which was published in 1926. The present part embodies the results obtained by analysing both the old and the new material, a résumé being made of the whole. The sea-trout of this district, like most of those of the west-coast rivers, have a more uniform type of life than those of the east-coast rivers, the chief features in the river Ailort being the big runs, beginning as early as March and mainly composed of fish which have spawned in the previous winter, and the high average size of the fish, a few of which attain a great weight. The size is mainly due to good feeding and favourable conditions both for the parr and the sea-fish, giving rise to a vigorous stock. The Ailort fish survive to a greater age and weigh more than do those of the east-coast rivers, and maturity is reached rather later. Early spawners seldom survive the tenth year from hatching, whilst amongst those which spawned later in life some exceed fourteen years, and the percentage of survivors rises with the increase in the number of sea years before maturity is attained. Spawning retards growth, but to a less degree than in the salmon. Salmon smolts usually migrate after two years of river life, those of the sea-trout after three years. Salmon smolts at migration are about two inches shorter than those of the salmon-trout of the same age. During this river life the salmon parr grow more slowly than those of the sea-trout, but after migration the growth-rate of the salmon is by far the larger. It has often been suggested that some of these large Ailort sea-trout are hybrids between salmon and sea-trout, but although experiment has proved that salmon eggs can be fertilised by sea-trout milt and vice versa, the author is of the opinion that there is no indication of hybridisation between salmon and sea-trout, nor are there two or more distinct races of the latter in the Ailort.

PARASITES AND PREDATORS IN BIOLOGICAL CONTROL OF INSECT PESTS.—In the *Bulletin of Entomological Research*, vol. 19, March 1929, Dr. W. R. Thompson discusses this important subject. As he points out, both predaceous and parasitic insects practically always kill their hosts. The question of their relative

value as controlling factors is, however, somewhat obscure. That insect predators are numerous and beneficial is generally acknowledged, but that they are as valuable in these respects as parasites is not by any means universally believed. This subject is ably discussed by Dr. Thompson, who advances theoretical conclusions, partly based upon calculations of the length of time necessary for the annihilation of a given host population by given populations of gregarious parasites, solitary parasites, and predators. His theoretical conclusions indicate that the value of predators has been underestimated by practical entomologists, and they are supported by the history of the practical application of biological control. As examples, he quotes the efficiency of such predators as Coccinellidæ in controlling certain scale insects and mealy bugs: the utilisation of the carabid beetle *Calosoma* in controlling the gipsy moth in New England and the extraordinarily valuable results attained by the introduction of the capsid, *Cyrtorhinus mundulus*, in controlling the sugar-cane leafhopper in the Hawaiian Islands. He concludes that predators are worthy of more careful attention than has so far been accorded them, but that the relative values of parasites versus predators in any given case can only be decided by critical investigation in the field.

PRE-CAMBRIAN LIFE.—Some months ago it was announced in the daily Press that a pre-Cambrian fauna had been discovered in South Australia. Some details of this have now been given by Sir T. W. Edgeworth David in "Notes on newly discovered fossils in the Adelaide Series (Lipalian ?), South Australia" (*Trans. Roy. Soc. S. Australia*, **52**, pp. 191-209, pls. xiii-xviii; 1928). He considers that he has found the remains of Algæ, polychætous annelids, brachiopods, and eurypterids in the Adelaide Series at horizons ranging from 2000 to 12,000 feet below the oldest rocks in which undoubted Lower Cambrian fossils have been traced. The age may be (1) basal Lower Cambrian *or* (2) Lipalian, that is, belonging to the time represented in North America by the unconformity between the Keeweenawan and the base of the Cambrian, *or* (3) Proterozoic (Algonkian). Without seeing the specimens on which Sir Edgeworth David's views are based, it is almost impossible to express an opinion as to their nature. The figures which he gives are not convincing. If he has really found eurypterids in beds of pre-Cambrian age, it is difficult to account for the fact that scarcely any undoubted representatives of that group of arthropods have been discovered in the Cambrian.

TROPICAL AGRICULTURE.—The Imperial College of Tropical Agriculture, Trinidad, has issued its report for 1927–1928 together with the prospectus for 1929–1930. Developments have been made in all directions, and further extensions are hoped for in the near future. An estate is specially needed for research, principally into biological problems, as the existing grounds are required for the instruction and training of students. The power station is now in use and the new building for low temperature research and cold storage is completed, although the interior fittings of the latter are not yet finished. The construction of a new chemical block is proceeding, and alterations and additions have been made in the sugar factory. In research work good progress has been made. With regard to bananas, the main objects are to secure good marketable varieties immune from Panama disease (a problem which necessitates a study from both the pathological and phsyiological point of view), and further to investigate the ripening process in order that the fruit may be successfully marketed overseas. The new cold storage chamber will prove of special benefit in these problems. Soil research with reference to the sugar-cane crop has been successfully carried out. The lime content of the soil, and particularly the proportion of adsorbed calcium ions, has been shown to be correlated with the resistance of the plant to froghopper blight. A practical outcome of this work is that the College is now able to advise growers as to the amount and kind of lime to apply to their fields, and the methods of application to employ. On the other hand, insecticide work has also proved successful, and the froghopper pest can now be kept under control if the proper executive arrangements are made at the right time, the cane growers acting collectively. The main objects of research in the coming year are problems dealing with tropical fruits such as bananas and citrus, biological investigations of cacao, and genetical and fertiliser trials with sugar-cane.

ISO-ELECTRIC POINT OF CELLS AND TISSUES.—In a recent number of *Biological Reviews* (**4**, p. 1) H. Pfeiffer has contributed a comprehensive review of the now voluminous literature bearing on this subject, in which he points out that the original conceptions of the iso-electric point (IEP) are tending to develop both in physical chemistry and in biology. Cells and tissues of plants, and perhaps of animals, show many analogies with ampholytes, probably owing to the presence of these substances at the cell surfaces, and at the internal boundaries of the protoplasm. From the observed effects, attempts have been made to determine the IEP in the case of a given tissue, and also to explain the regulatory effects of the cells upon external solutions. Pfeiffer points out that most biological work has been concerned not with the *true* IEP, which is given by the stationary phase in electro-cataphoresis, but with the *apparent* IEP (as found, for example, from minima of swelling, viscosity, and osmotic pressure), which depends primarily on the reaction at which there is a maximum of neutral molecules. The apparent IEP determined in this way may be displaced owing to salt formation, and this is particularly likely to happen in the case of protoplasmic ampholytes. Further, the presence of two or more ampholytes in protoplasm does not, on present conceptions, necessarily lead to the establishment of a collective IEP as it may tend to do *in vitro*. There may, in cases known, be signs of a number of apparent iso-electric points. The relation of the apparent IEP to growth and physiological functions of the organism is discussed, and the author emphasises the view that further work is required on the effect of these phenomena on ion movement and the electro-histological behaviour of protoplasm, and on the mechanism of such functions as protoplasmic streaming.

CYCLONES AT MAURITIUS.—Mr. R. A. Watson, Director of the Royal Alfred Observatory, Mauritius, is to be congratulated for producing "The Cyclone Season 1927–8 at Mauritius," which is to be the first of an annual series of publications summarising the information collected at that Observatory about the cyclones occurring in the neighbourhood during each cyclone season. The cyclone season in Mauritius extends normally from November to May; the one under discussion was one of the stormiest on record, and was remarkable also for the fact that the tracks were farther west than usual, to which peculiarity the absence of gales at Mauritius itself is to be referred. The weather reports from neighbouring islands were supplemented by information supplied by ships calling at the island. In two instances enough observations were available to allow of the construction of diagrammatic systems of wind arrows in which the wind represented is the wind relative to the moving centre, the isobars being shown in the usual way. It is interesting to

find some evidence of a discontinuity of wind along the actual track in front of the centre, and not, as was found by Cline in the case of West Indian hurricanes (NATURE, Dec. 24, 1927, p. 909), between the winds of the two quadrants on one side of the track. Allowing for the reversal of the circulation as between storms of the northern and southern hemispheres, the analogue for Mauritius of the 'right rear' and 'right front' quadrants, between which the discontinuity was found by Cline, would be the 'left rear' and 'left front' quadrants. These diagrams are of interest also in that they show some flattening of the isobars in a direction parallel with that of the track, and constitute additional evidence of a lack of that symmetry of wind circulation usually attributed to the tropical cyclone in meteorological text-books.

THE AURORA.—The investigation of conditions in the upper air which has been made by E. O. Hulburt and H. B. Maris in connexion with their theory of the aurora and of magnetic storms (*Physical Review*, vol. 33, pp. 412-431; see also NATURE, Nov. 24, 1928, p. 807) is remarkable for the importance which is attached to the influence of the ultra-violet radiation from the sun. The wave-lengths which are absorbed at heights above about 450 kilometres are supposed to produce indirectly, by processes of excitation and ionisation, a kind of spray of highly rarefied matter which extends outwards for upwards of forty thousand kilometres. Collisions are very infrequent at the low pressures involved, and the molecules can describe practically free orbits in the earth's gravitational field. If one is ionised by further absorption of ultra-violet light, both the liberated electron and the residual positive ion will return to the lower air in helical paths, the axes of which are determined by the earth's magnetic lines. The aurora is associated with the downward currents, and its distribution over the surface of the earth can be predicted immediately from the magnetic field of the latter. This theory, which has been developed on quantitative lines, seems to account adequately for the main phenomena both of auroræ and of the complicated changes which occur in the magnetic elements during a magnetic storm, and the greatest difficulty in its further development is likely to arise from incomplete knowledge of the precise nature of the atomic processes of excitation and ionisation. The authors mention incidentally that good direct short-wave communication was maintained between the U.S. Naval Research Laboratory at Washington and the Byrd Antarctic expedition.

EFFECT OF HEAT ON THE SENSITIVITY OF PHOTOGRAPHIC PLATES.—The results of an investigation of the effect of heat on the sensitivity of photographic plates are described in two papers by O. Masaki in the *Memoirs of the College of Science, Kyoto*, Series A, vol. 12, No. 1. It was found that the sensitivity of panchromatic and other slow emulsion plates increased with rise of temperature, the sensitisation being greatest towards the red part of the spectrum. In the case of high-speed plates, rise of temperature produced a decrease in sensitivity, especially in the violet region. For all kinds of plates, heating increased the contrast, and in panchromatic and orthochromatic plates this change was particularly marked for rays of long wave-lengths. The sensitising action of heat was retained for some hours after the temperature had been reduced to normal and was much greater than that produced by mere drying of the plates. An expression giving the relation between the density of the developed image and temperature was obtained and holds from 10° C. to 80° C.

FLAME- AND SPARK-SPECTRA FROM SALT SOLUTIONS.—In the *Chemiker-Zeitung* of Mar. 16, Dr. W. Hirschel describes some quantitative results which he has obtained with the apparatus first described by him in 1916, in which minute amounts of salt solutions are pulverised by means of a spark before being introduced into the Bunsen flame. The resulting flame can be maintained for an hour with the consumption of only a few milligrams of salt, and the flame is so intense that its spectrum can easily be photographed. The apparatus has hitherto been used for the visual examination of spark spectra, but it has now been found possible to photograph the latter. This has necessitated the use of much stronger sparks than were possible in the original apparatus. A device for cooling the anode with cold water has been introduced, and instead of a large induction coil and battery of cells, a simple Wehnelt-Simon-Caldwell interrupter is used with an alternating current at 115-220 volts and a small coil.

ATOMIC WEIGHT OF COPPER.—A communication by T. W. Richards and A. W. Phillips in the February number of the *Journal of the American Chemical Society* describes experiments on the atomic weight of copper from different sources. No difference was found in the atomic weights of specimens of copper from mines in the Lake Superior region and from Chile. The ratio of the atomic weights of copper and silver was found by analysis of pure cupric chloride. On the basis of Ag = 107·880 the atomic weight of copper was found to be 63·557. Copper is known to have at least two isotopes and its atomic weight was in need of confirmation. The Lake Superior material was not later than Cambrian; that from Chile was from lodes intrusive in Jurassic strata.

SIZE LIMITS OF TURBO-GENERATORS.—During the last few years there has been a remarkable increase in the size of the turbo-generators used in electric power stations. The size of the machines which run at 25 revolutions per second is now only limited by the transport facilities available to their destination. The desirable size of the machines which run at the standard speed of 50 revolutions per second is about 60,000 kilovolt-amperes at the present time, but in a few years machines of double this capacity will probably be running. The uncertain factors are the strength of the forgings forming the rotating part and whether the journals for such heavy machines would be safe. The centrifugal forces and the consequent enormous stresses in the rotating parts at these high speeds make it necessary to use only forgings of the greatest mechanical strength. In a paper read by J. A. Kuyser to the Institution of Electrical Engineers on Mar. 21, it was stated that a steel containing about 2 per cent nickel with a very small percentage of chromium, when properly annealed, has the necessary tensile strength. On the Continent the alloy used for high-speed machines has a much larger percentage of nickel and chromium, and is hardened in oil. However, experiments carried out by Metropolitan Vickers led to the conclusion that the oil hardening of this steel produces a high radial stress which when the machine is running is added to the centrifugal stress. A significant fact is that on the Continent during the last three years there have been four explosions, with several fatalities, of high-speed machinery made of this steel. It was stated that several of the older types of machines are operating with parts of their core at 200° C. These high temperatures cause relative displacements of the copper and the mica insulation, as the temperature coefficient of copper is 50 per cent greater than that of mica.

Mimicry.

By Dr. G. D. Hale Carpenter, Entebbe, Uganda.

THE phenomena of mimicry, by which is meant the deceptive resemblance of one creature to another, were first made known among butterflies, and it is natural that the subject should have been further investigated in the same group of insects. But it has suffered thereby; for the narrowing of the field of inquiry has resulted in attempts to account for the phenomena which do not bear criticism in the light of wider knowledge and more detailed investigations into geographical distribution.

Mimetic resemblances are undoubtedly most convincingly explained as the result of the operation of natural selection upon such variations as may be produced from time to time. We may in this connexion quote the words in which Darwin, writing to Ara Gray, expressed his confidence in natural selection as the motive cause of evolution. "I cannot possibly believe that a false theory would explain so many classes of facts as I think it certainly does explain. On these grounds I drop my anchor, and believe that the difficulties will slowly disappear."

Since H. W. Bates first published his memoir on mimicry in 1862 an immense number of field observations have been recorded and a large amount of work has been expended upon museum specimens, but the theory of natural selection still offers the most convincing explanation of the facts.

Attempts have been made to account for mimetic resemblances by the similar results produced by climatic or other external influences upon different species in the same locality; and such an explanation is given by Prof. E. W. MacBride in his essay on "Zoology," p. 211, in the collection of papers published in 1925 by Messrs. Blackie and Son under the the title of "Evolution in the Light of Modern Knowledge."

Prof. MacBride observes: "We have given to our readers strong reasons for disbelieving altogether in random variations, and therefore what we have to explain is why evolution has set in such a direction as to cause these insects to resemble one another. Now, Eimer has shown that the changes in coloration which the mimic is supposed to have undergone, in order to increase its resemblance to the model, are of a kind which supervene independently in all families of butterflies and moths as *a reaction to climatic conditions*. These changes take place in some families more quickly than in others, and what happens in real 'mimicry' is apparently that individuals which have reached a certain stage in this process are favoured by natural selection."

Mimetic resemblance is thus believed to have been caused by an inherited response to environmental influences. "Just as in the formation of habit the action becomes easier with every repetition, so as the generations succeed each other the response to the same environment becomes more readily called forth." Prof. MacBride alludes later to "the vast sea of facts which tell in favour of habit as being the prime cause of evolution." He acknowledges the unsatisfactory nature of this as an explanation of mimicry; how unsatisfactory it is and how completely it fails to account for recently discovered facts it is the purpose of this article to show.

Let us first consider some examples from among the butterflies alone, as this explanation was founded on a study of their patterns.

1. The effects of intrusion of a foreign species upon the indigenous inhabitants.

(*a*) A very good example is that of the 'Monarch,' a Danaine butterfly belonging to an Asiatic group which invaded North America in comparatively recent times, and is there mimicked by an indigenous butterfly, the 'Viceroy,' closely related to our 'White Admirals' of Europe. Clearly, if these resemblances are the result of local climates, the 'Monarch' ought to have mimicked the 'Viceroy'!

(*b*) Again, in the eastern Fijian islands a group of Euplœine butterflies is characterised by a dark ground-colour with a feeble or obsolete white marginal pattern, while the same species are represented in the western islands of the group by forms with a strongly marked pattern. Prof. E. B. Poulton has suggested that these facts are to be explained by an earlier invasion of Fiji by the dark Euplœas and a later powerful invasion by a strongly patterned *Euplœa*, which has reached the western islands in numbers and has become the model mimicked by the older darker species.

2. The phenomena of mimicry, even among butterflies, cannot be disposed of so easily as Eimer's explanation suggests; they are much too complicated. The study of geographical races is all-important in this connexion.

(*a*) A typically aposematic or warningly coloured species of the Acræine genus *Planema* (*P. epœa*) has in West Africa a black and orange male and black and white female. In the Uganda race *epœa paragea*, however, the sexual dimorphism disappears and the coloration of both male and female is grey-brown with a pattern of cream-colour. Both these races are mimicked by the females of *Papilio cynorta*, which in West Africa resemble the black and white females of *epœa*, and in Uganda both sexes of *epœa paragea*. The *Papilio* male retains the same appearance in both areas. On the other hand, a Nymphaline butterfly in Uganda, *Pseudacrœa eurytus*, allied to our 'White Admirals,' has developed a form *obscura* in which both sexes mimic *epœa paragea*. Climate, according to Eimer's hypothesis, has caused one sex of the *Papilio* to resemble the model but both sexes of the Nymphaline. This, however, is far from the end of the story. *Pseudacrœa eurytus* occurs all over tropical and subtropical Africa in a bewildering variety of forms, sometimes with sexes alike, as in the form *obscura*, sometimes unlike. Wherever these *Pseudacrœas* occur they are mimetic of the local species of *Planema*, sex resembling sex when the sexes of the model are unlike. But in Uganda some of the *Planema* models, such as *epœa paragea*, have the sexes alike, while in others they are different, and the local forms of *eurytus* mimic both types. Hence in the same area, and therefore subject to the same climatic influence, most surprisingly complicated and contrasted results have been developed. It may be argued that equally complicated results have arisen among the models in the same area; but there is this essential difference—the Planemas are of entirely different species, whereas the mimetic forms of *eurytus* belong to a single species, so that mimics with sexes different and with sexes alike form a single interbreeding community and may appear side by side in a single family.

(*b*) Equally difficult to explain by Eimer's theory are the intricate mimetic resemblances between members of the fine genus *Charaxes*. Some of the larger species which act as models for the smaller are themselves mimics of other large species, and one sex of a species may be a mimic while the other is a model. Yet another species (*etheocles*) has a non-

mimetic male which varies little, but the females occur in strikingly different forms which mimic the males, others the females, and others again both males and females of larger species.

3. Explanations of mimicry are too often based on consideration of colour and pattern alone. Any naturalist familiar with mimetic resemblances in the field has found by practical experience that colour and pattern are only part of the factors which make up the deception; behaviour is of great importance. Even among butterflies themselves the difference of behaviour between models and some mimics is characteristic, if the mimic belongs to a family less well protected than the model. For example, the Acræine models of the genus *Planema* can often be picked from flowers by the fingers, while the mimetic forms of *Pseudacræa eurytus* are shy, and require to be approached with caution if they are to be caught. If frightened they dash away, whereas the *Planema* will only flutter just out of reach and often boldly return to the same spot.

Even if it be admitted that the action of climatic conditions is effective in causing different species of insects to develop the same variations in coloration, it cannot be held to explain instances of mimicry drawn from a much wider field than that from which Eimer drew his examples. How could the likeness of certain spiders to ants be put down to this cause? Many instances have been recorded where the mimicry has completely deceived experienced field naturalists. Climate in this case must be supposed to have altered profoundly the characteristic shape of spiders so as to produce the 'waisted' effect of an ant; to have altered gait in such a way that one pair of legs is not used for progression but is held up in the air and waved about to resemble the sensitive antennæ of an ant, and even, in certain spiders, to have suppressed, except in very special circumstances, the habit of jumping that is characteristic of the family to which most ant-like spiders belong.

Spiders, having no metamorphosis, are generally exposed to similar conditions at all stages of their existence. Insects which undergo complete metamorphosis are exposed to conditions during their immature stages which often differ as completely as possible from those to which the adult stages are exposed. The close resemblances often found between adult insects cannot possibly be explained as due to the action of absolutely dissimilar conditions upon their respective larvæ. For example, the mimetic resemblance of the common drone-fly to the hive-bee deceives even a monkey, as I have found by experiment in Africa. The larva of the fly lives in mud and foul fluids among which it feeds in the open, freely exposed to changes of light, temperature, and oxygenation. The bee's grub is enclosed in a small cell in the hive, among surroundings as uniform as the bees can make them, feeding on food supremely different from that of the fly's larva. Malacoderm beetles of the family *Lycidæ* all over the tropics are mimicked extensively by insects of such diverse habits, and feeding in such different ways as larvæ and adults, that no explanation based on the influence of external circumstances can account for the well-known mimicry of these conspicuous beetles, which have been abundantly proved to be distasteful to birds and other animals.

4. Mimics differ from their models not only in behaviour but also in other respects. A typically aposematic insect such as an Acræine or Danaine butterfly, or a Lycid beetle, is of an extremely tough physique. It will be uninjured by treatment which would break the wings of another butterfly such as the Nymphaline or Papilionine mimic, and it will also resist the poisonous fumes of a cyanide bottle to a surprising extent. This resistance to injury is part and parcel of the process whereby an aposematic insect teaches an enemy that it is harmful or unpalatable. It almost invites attack, and if it is seized and handled, suffers little injury, and when released after a pinch or a lick is often undamaged. This difference in physique and temperament, coupled with similarity of superficial appearance, is difficult to explain by climatic action.

5. Another class of facts telling against the argument now discussed is the production of the same effect in a variety of ways. The thin 'waists' of Hymenopterous insects are frequently mimicked in stout-bodied insects of other orders by either white colour or dense white pubescence which at a little distance effectively 'paints out' part of the body, leaving only a thin waist visible.

6. It is usually found that mimetic resemblance only goes so far as is necessary to produce a *superficial* deceitful appearance; often the characteristic appearance of the group to which the mimic belongs may be found in or on parts which do not interfere with the mimetic resemblance.

The antennæ of beetles which mimic other beetles might often be a hindrance; for whereas in the mimic the characteristic antennæ of its family may be long and thin, the antennæ of the distasteful model may be short and stout. This difficulty is surmounted in the mimic by a thickening of the antennæ for a distance approximately equal to that of the thick antennæ of the model, the remaining segments of the long antennæ being thin and relatively inconspicuous. The influence of external circumstances must here be very patchy!

7. Such examples of mimicry as the resemblance of large Sphingid caterpillars to some terrifying reptile with large eyes can scarcely be explained by the influence of climate.

8. It is somewhat difficult to understand why the explanation of mimicry by the action of natural selection has been a stumbling-block to many. The fact that many insects escape their enemies by minutely resembling objects that are of no interest to them, such as a bird-dropping, is usually accepted as an example of the working of natural selection. Yet when the object that is of no or relatively little interest to the insectivorous creature is another insect, it has been claimed by some writers that natural selection cannot be the agent which has effected the resemblance. Mimetic resemblances, as was long ago shown by Prof. Poulton, are only one example of various types of deceitful resemblance. Natural selection will account for them all as well as for the examples of conspicuous 'warning' colours. Why, then, should it be thought necessary to invoke an explanation for one set of resemblances which is supposed to be powerless to account for others?

9. Prof. MacBride, in the article alluded to earlier, remarks that "it is assumed, often on very insufficient evidence, that the one of the two animals which is the commoner (*i.e.* the model) has some peculiar feature which makes it dangerous to the animals which would attack it, and that these learn to recognise it and avoid it."

It is true that when the theory of mimicry was first propounded there *was* very little direct evidence, but critics of the theory often seem to be unaware of the body of experimental and observational evidence that has been accumulated during recent years in the publications of the Entomological Society and others.

It is sometimes a stumbling-block to critics that insects which are supposed to act as models have been seen to be devoured freely by certain enemies. For

example, I have myself obtained evidence that ants are a very important element in the food of Agamid lizards, and Danaine butterflies have been seen to be devoured by certain birds. In this connexion the old adage should be remembered, "One man's meat is another man's poison." It is important also to remember that not even the most enthusiastic supporter of mimicry claims that models are at all times and in all circumstances exempt from being devoured. I have seen the foul-smelling and evil-looking black 'Devil's coach-horse' beetle pulled out from among dead leaves by a wren in a wood and devoured in mid-winter. Edibility is entirely a question of the relative abundance of food: it is not without significance that mimetic resemblances reach their highest development in those parts of the world where insect life is most abundant.

10. Another stumbling-block may be given in Prof. MacBride's words: "It is held that the predatory animals mistake the defenceless species for the dangerous one, and that so the defenceless one escapes."

I do not think it is necessary to suppose this: all that is required for the protection of *B* is that it should sufficiently resemble *A* to remind the enemy of an unpleasant experience connected with an attempt to eat *A*. When food is abundant a very slight degree of resemblance to a creature known by previous experience to be unpleasant may save the life of another. This is within the bounds of human experience. Many people intensely dislike worms "because they wriggle so." Why should a wriggling movement be more unpleasant than, for example, the sudden leaping of a frog? Surely, because of man's origin, in countries where an instinctive dread of a snake was a criterion of life and death. It is not that we think worms *are* snakes, but they remind us of them. This point of view makes it much easier to understand cases where a mimic is much larger or smaller than its model, or where the resemblance is very elementary, or even depends but little upon colour but rather upon some trick of movement or posture.

In all such cases there is nothing in the theory of mimicry produced by selection of variations to prevent further improvement of the resemblances, nor on the other hand, is there any reason why a slight degree of resemblance *must* be perfected; all that is necessary is that the resemblance should remind an enemy of some previous unfortunate or unpleasing experience. Thus perfect and imperfect mimetic resemblances may exist together.

11. Finally, I would allude to the wonderful deceptive resemblances of the eggs of cuckoos to those of the nest in which they are placed.[1] In this case the enemy is the parent of the eggs resembled, which are the models. The phenomena are analogous to mimicry; there is a resemblance to something which the enemy will not attack; one theory will explain the evolution of both these classes of deceptive likeness. Can it possibly be claimed that these minutely detailed resemblances between eggs of birds are of a kind which supervene independently in the eggs of cuckoos and host-birds as a reaction to climatic conditions? The answer is, surely, 'No,' and the same answer may be given to the claim that "What happens in real 'mimicry' is apparently that individuals which have reached a certain stage in a reaction to climatic conditions are favoured by natural selection."

[1] See the papers by E. C. Stuart Baker, *Proc. Zool. Soc.*, 1923, p. 277, and F. C. R. Jourdain, *ibid.*, 1925, p. 639. See also presidential address to Ent. Soc. Lond., Jan. 20, 1926, by Prof. E. B. Poulton.

Diamond Jubilee of the Iron and Steel Institute.

THE May meeting of the Iron and Steel Institute, to be held this year on May 2 and 3, is of special significance inasmuch as the Institute is celebrating its diamond jubilee. The proposal for the formation of the Institute originated at a meeting of the Northern Iron Trade, held at Newcastle-on-Tyne on Sept. 29, 1868, and a committee was appointed with the object of giving effect to this suggestion. Mr. Isaac Lowthian Bell (as he then was) took a prominent part in the proceedings from the very beginning, and it was largely through his influence and efforts that the Institute took shape.

A provisional meeting was held in London in February 1869, at which the Institute was formally constituted, the Duke of Devonshire consenting to accept the position of president for the first two years. The inaugural meeting was held on June 23, 1869, in the Hall of the Society of Arts, when the noble president delivered a most interesting inaugural address, in which he traced the development of iron and steel manufacture. The next meeting of the Institute was held at Middlesbrough on Sept. 22 and 23 of that year, the first paper, appropriately enough, being by Mr. Isaac Lowthian Bell.

The Institute was by this time fairly formed, the first secretary being Mr. J. Jones and the first treasurer Mr. (afterwards Sir) David Dale. At the end of that year the Institute numbered 292 members; to-day the membership is just over 2700, and this numerical increase is good evidence that the work of the Institute has met a real need in the iron and steel industry. The object of this, as indeed of all similar technical societies, could scarcely be better stated than it was by the president in his inaugural address, when he declared the object of the Institute to be "the promotion of science in its practical applications rather than in its purely intellectual aspects," and it may fairly be said that this principle has been the dominating principle of the Institute.

The jubilee of the foundation of the Institute was celebrated by a banquet in the Guildhall on the evening of May 8, 1919, at which the then president of the Institute, Mr. Eugene Schneider, of the famous Creusot Works, presided, supported by a very distinguished company. As was not unnatural in the spring of 1919, the conclusion of the War was the thought uppermost in men's minds, and this fact so overshadowed the fact that this was the jubilee meeting of the Iron and Steel Institute that relatively little attention was paid to the fact that the Institute had then attained its half-centenary of existence. On this account the celebration of the diamond jubilee this year is likely to assume an even greater importance than it otherwise would.

It is interesting to note that there are still three members whose membership dates from the inaugural meeting of the Institute in London, namely, Sir Hugh Bell, Bart., himself a past-president and a Bessemer medallist, who joined the Institute at the same time as his father, the late Sir Isaac Lowthian Bell, Bart., who, as already pointed out, took a prominent part in the formation of the Institute; Mr. J. J. Bleckly, of the Pearson and Knowles Coal and Iron Co., Ltd.; and Mr. John Neilson, a nephew of the late James Beaumont Neilson, the inventor of the hot blast, which practically revolutionised the blast furnace practice of the world. The Institute can fairly claim to have counted among its list of members every one of the men who have been distinguished in the iron and steel industry for the last sixty years, and

the history of that industry and of its wonderful development is to be found in the *Journal* of the Iron and Steel Institute.

No one can doubt that the Institute will continue to go forward and prosper along the same lines traced out for it by its founders, which it has so consistently followed throughout the whole sixty years of its existence, and it seems almost superfluous to wish for a continuance of its prosperity for many years to come. This wish will indeed be fervently re-echoed by everyone in Great Britain, seeing that the prosperity of the Iron and Steel Institute is bound up with the prosperity of the iron and steel industry, which in its turn is the foundation of the prosperity of the nation.

The Stone Age in South-Eastern Asia.

RECENT research appears to point to more or less uniformity in the characteristics of the stone age cultures of south-eastern Asia. Investigations in French Indo-China by MM. Mansuy and Patte and Mlle. Colani in the caves near the Bac-Son massif (Tonkin) yielded a large number of implements which these investigators regarded as relics of the oldest known stone age of Indo-China, classifying them as lower neolithic. Cord-marked pottery was also found, but regarded as belonging to a later phase of the neolithic. Evidence of similar stone age industries has been found in kitchen middens about twenty kilometres from Medan in the east coast province of Sumatra, and on the plains and lower hills of this province at sites always on the banks of rivers.

In the *Journal of the Federated Malay States Museums*, vol. 12, Part 6, Mr. I. H. N. Evans reviews this material critically in relation to the results of recent excavations in caves in Perak. The hypothesis of the French archæologists is that an early neolithic people, using roughly chipped implements only, came into contact with a people using polished implements, and from them adopted the practice of polishing the edges of their implements. Mr. Evans, however, regards the chipped implements as a truly older palæolithic culture, surviving in association with the forms with polished edges which are proto-neoliths, the latter developing more and more to become a high neolithic culture. In Sumatra, iron weapons of a type still in use in north Sumatra in a layer immediately above that containing bouchers, with no sign of transition, pointed to a very late survival of a palæolithic culture.

In Perak, Mr. Evans, excavating with Dr. P. U. Van Stein Callenfels, of the Archæological Service of the Netherlands Indies, who carried out the investigations in Sumatra, found similar stone age cultures in caves near Lenggong (Upper Perak) and Padang Rengas (Kuala Kangsar). In the latter area the rock shelter, Gua Kĕrbau, contained human remains at a depth of 3·18 metres and below. Shellfish formed a large part of the diet of the inhabitants throughout the occupation. Flakes and chips occurred throughout, but the first palæolith was found in deposit *B*, the most common type being the *coup de poing* of almond shape. The first fragment of a proto-neolith occurred in layer *D* at a depth of 2·40 metres. The lowest was found at 5·74 metres. The proto-neoliths showed different stages of development. One might be classified as a middle neolith. Grinding stones, grinding slabs, shells, some clearly, others probably, for use as amulets, and pottery in the upper layer were found.

Certain conclusions are offered tentatively: Palæoliths, so-called Sumatra types, and proto-neoliths, are associated throughout; cord-marked pottery belongs to the later stages of palæo-proto-neolithic culture; the makers of proto-neoliths had older types of the neolithic culture as examples; and a palæolithic civilisation making use of 'Sumatra-type' implements spread at a certain period over south-east Asia, reaching even Sumatra, while the palæo-proto-neolithic stage also spread over the same area but did not reach Sumatra.

University and Educational Intelligence.

LEEDS.—The site is now being cleared for the new block for the Physics Department. The accommodation will include two large laboratories, each about 5000 square feet in area, and a smaller laboratory for honours students, three lecture theatres for 250, 150, and 80 students respectively, and about thirty other rooms, the whole occupying a block about 100 feet square and comprising a basement and three floors over. The building is estimated to cost about £47,400.

LONDON.—Notice is given that applications for grants from the Thomas Smythe Hughes Fund for assisting medical research must reach the Academic Registrar, South Kensington, S.W.7, by, at latest, June 15.

ST. ANDREWS.—At a meeting of the University Court on April 19, it was intimated that Provost W. Norman Boase, St. Andrews, had gifted to the United College the endowment fund for the institution of a residential entrance scholarship of £100 a year, tenable for three or four years by an entrant student resident in one of the residential halls of the United College, on conditions similar to those prescribed in the case of the Harkness, Russell, and Patrick Hamilton Entrance Scholarships. As the Patrick Hamilton Scholarship was instituted in commemoration of the quater-centenary of Patrick Hamilton, the Martyr, a former student of the University, so the new scholarship is to be named the Montrose Scholarship in commemoration of the tercentenary of the studentship at St. Salvator's College of the great Marquis of Montrose.

APPLICATIONS for grants from the Dixon Fund of the University of London, for assistance in scientific investigations, must reach the Academic Registrar of the University, South Kensington, S.W.7, before May 15.

A BUSK Studentship in aeronautics, of the value of about £150 and tenable for one year from Oct. 1 next, for research in aeronautics and specially in stability problems, is being offered. Forms of application, returnable not later than May 12, can be obtained from Prof. B. Melvill Jones, Engineering Laboratory, Cambridge.

A FELLOWSHIP of the value of £300 per annum for research on petroleum problems is being offered by the Institution of Petroleum Technologists. The fellowship will be tenable for one year, with a possible renewal for a further year. Forms of application (returnable by June 1 at latest) are obtainable from the Secretary of the Institution, Aldine House, Bedford Street, W.C.2.

APPLICATIONS are invited by the trustees of the Dickinson scholarships in connexion with the Manchester Royal Infirmary and the University of Manchester for the following: A research travelling scholarship in medicine value £300, and a pathology scholarship value £75. Particulars may be had from the Secretary to the trustees, Royal Infirmary, Manchester. The completed forms must be returned by May 2.

Calendar of Patent Records.

April 27, 1844.—The aneroid barometer was the invention of a Frenchman, Lucien Vidie, and was patented in England in the name of De Fontainemoreau, merchant, of London, on April 27, 1844. The advantages that it possessed over the mercury instrument, especially as regards portability, were apparent directly its accuracy for general purposes had been tested, and it was soon extensively adopted, especially in Great Britain.

April 27, 1909.—The modern metal-spraying process for coating iron and steel is largely due to the Swiss chemical engineer, Dr. M. U. Schoop, whose first patent was applied for in Germany on April 27, 1909. The English patent was granted the following year.

April 28, 1784.—Stereotype printing was first introduced about 1726 by William Ged, but the earliest patent for the process was that granted to Alexander Tilloch and Andrew Foulis, printer to the University of Glasgow, on April 28, 1784. These and others of the early processes, though actually used for printing books, were only practised by the inventors themselves, and it was due to Lord Stanhope, who had been taught the art by Foulis, that the possibilities of the new method were generally realised. It was not, however, until the use of papier mâché for the matrix, in place of the plaster of paris formerly employed, was invented in France about 1828, that stereotyping was extensively adopted.

April 29, 1790.—On April 29, 1790, William Nicholson was granted a patent for the first rotary printing machine. Though the invention was not put into practice, it embodied suggestions which were successfully introduced by Koenig in his flat-bed cylinder machine of 1811, and by Applegarth in his rotary press some years later.

April 30, 1844.—The 'Lancashire' steam-boiler was the invention of Sir William Fairbairn and was patented by Fairbairn and John Hetherington on April 30, 1844. The boiler, which differs from its predecessor, the 'Cornish,' by having two tubular flues instead of one and by being internally fired, was the most economical one of its time, and by reason of its simplicity and its capacity of withstanding rough treatment, is still frequently preferred to other types for certain purposes.

May 1, 1704.—The use of jewelled pivot-holes in watches was the invention of Nicholas Facio de Duillier, a Swiss resident in London, and a fellow of the Royal Society, and a patent for it was granted to him in conjunction with two London watchmakers, Peter and Jacob Debaufre, on May 1, 1704. A petition presented to the House of Commons for the prolongation of the patent was successfully opposed by the Clockmakers' Company, but it has since been discovered that the evidence which was the principal factor in securing the rejection of the petition was not genuine, and was probably 'faked' for the occasion.

May 2, 1782.—Among the claimants for the new prizes offered by the Board of Longitude for improvements in the marine chronometer after the award of the original £20,000 to John Harrison in 1764, were the rival London watchmakers, John Arnold and Thomas Earnshaw, who share the right to be called the inventor of the modern chronometer escapement, though the exact share of each in the invention has not been satisfactorily determined. It is precisely Earnshaw's escapement that is now in universal use, but Arnold's construction is very similar, gives few points to the other, and was the first, by a year, to be patented, the date of the grant being May 2, 1782. Arnold was the first to manufacture chronometers on a commercial scale.

Societies and Academies.

LONDON.

Physical Society, Mar. 8.—**Ezer Griffiths** and **J. H. Awbery**: The dependence of the mobility of ions in air on the relative humidity. The apparatus employed was a modification of Zeleny's original method, the end of a wind channel being closed by a disc of gauze fitted with a guard ring through which a steady stream of air of definite humidity was pumped. The motion of the negative ions due to the action of the air stream was balanced by a counter potential gradient, and the mobility deduced from the critical potential required to produce a balance. The rate of air flow was measured by means of an Ewing ball and tube flowmeter, using a hollow glass sphere to make it suitable for low air rates. Efforts were made to construct a direct indicating instrument.—**A. M. Tyndall**, with a note by **C. F. Powell**: Some unsolved problems relating to the mobilities of gaseous ions. The address dealt with: (1) Established results and proposed theories; (2) the difference between positive and negative mobilities; (3) the effect of vapours; (4) mobility in pure gases; (5) positive ions of short age; (6) suggestions as to future progress. Note by Mr. C. F. Powell: An apparatus of the 'four gauze' type has been designed for experiments with highly purified gases.

Linnean Society, April 4.—**G. M. Graham**: The natural history of the Victoria Nyanza. The Fishing Survey of Lake Victoria, 1927–1928, was carried out, by the author and Mr. E. B. Worthington, to solve a problem in economic fisheries. This involved a study of the general ecology of the lake. The cichlid fish, *Tilapia esculenta*, is the most important food species, and next in importance is *T. variabilis*. Excluding the shore, the lake may be divided into certain ecological zones—(1) the surface waters; (2) the deep mud region (190-230 feet); (3) the intermediate zone (50-150 feet); (4*a*) shallow water (less than 50 feet) where the ground is exposed; (4*b*) shallow water where there is shelter. These zones are distinguished by their fauna. The tropical situation of the lake results in (1) a constant plankton population; (2) rapid growth and decay, with perhaps more virulent parasitism; (3) more or less continuous reproductive activity.—**G. P. Bidder**: On the classification of sponges. In 1927 reasons were shown for regarding Hexactinellida, on account of their naked cells, as forming a phylum separate from the horny, calcareous, and four-ray sponges, with no common ancestors below Choanoflagellata. The needle sponges are now put in the latter phylum, and a complete classification is given.

PARIS.

Academy of Sciences, Mar. 18.—**P. Séjourné**: The line from Nice to Coni. Details of the construction of a new Alpine line, 63 kilometres long, more than one-third of which is tunnel.—**Henri Villat**: A fundamental problem of the theory of vortices.—**Charles Achard** was elected a member of the Section of Medicine and Surgery in the place of the late Fernand Widal.—**Paul Pelseneer**: Academic biostatistics. A comparison of the age at election, average years membership, and age at death of members of learned societies at Paris, Brussels, London, and Washington.—**Dubourdieu**: The topological invariants of networks of curves and surfaces.—**Etienne Halphen**: A theorem on quadrics analogous with that of Chasles on conics.—**Hadamard**: Observation on the preceding note.—**Paul Mentré**: The principal surfaces of complexes of right lines.—**J. A. Lappo-Danilevski**: The

singularities of integrals of systems of linear differential equations with arbitrary rational coefficients.—**Radu Badescu**: Abel's integral equation generalised.—**R. Gosse**: The determination of the equations: $\delta = p\omega(x, y, z, q) + \theta(x, y, z, q)$, which admit an involution of order 2 and a second involution of higher order.—**Léon Pomey**: The integration of differential equations with general initial conditions (real variables).—**Ernest Esclangon**: The apparent displacements of the pole star. The Observatory of Strasbourg possesses a long series of observations of the pole star. An analysis of these data shows that the position of this star is not known with the precision desirable. The possible causes of this systematic error are considered.—**Albert Arnulf, A. C. S. Van Heel** and **Emile Perrin**: An optical method for the localisation of polished surfaces.—**Charles Guilbert**: A method of measuring very small electric currents, called tachymetric electrometry.—**R. de Mallemann**: Magnetic rotatory power in an anisotropic medium.—**Decombe**: Pulsating electrified spherical pellicles, the principle of areas, and the Zeeman phenomenon.—**A. Segay**: The inflammation of fire damp by explosives. Discussion of the effect of adding common salt to the explosive and of placing a small cartridge containing liquid carbon dioxide alongside the explosive.—**H. Caron** and **L. Vanbockstael**: A new isomorphous series of fluorine compounds. Mixtures of hydrofluosilicic acid, calcium chloride, and aluminium sulphate give octahedral crystals, the composition of which was found to be $4CaSiF6$, $8CaF_2$, $Al_2(SO_4)_3$, $45H_2O$. These are very slightly soluble in water and may be utilised in microchemical analysis as a test for calcium, aluminium, and sulphur.—**L. Neltner**: The extension of the Cambrian in south Morocco and the presence in this region of pre-Cambrian folds.—**J. Thoulet**: The Kurosio current of Japan.—**L. Eblé** and **J. Itié**: The values of the magnetic elements at the station of Val-Joyeux (Seine-et-Oise) on Jan. 1, 1929.—**Joseph Richard**: The antherozoids of *Fucus*.—**Theodureto de Camargo, R. Bolliger,** and **Paulo Correa de Mello**: The influence of the hydrogen ion concentration of the culture medium on the development of the coffee tree, *Coffea arabica*. The coffee plant develops best in acid media, the optimum acidity being between *p*H 4·2 and *p*H 5·1. The plant is very sensitive to the action of lime, a very small amount of which is distinctly harmful.—**W. Russell** and **L. Hedin**: New cisalpine African Leguminoseæ with secretory apparatus.—**Abeloos**: The influence of temperature on the growth of the *Planaria*. The maximum size is, for given conditions of nutrition, a function of the temperature and decreases notably when the temperature is raised. The speed of growth is a maximum at 12° C., smaller at 20° C., and still smaller at 8° C.—**Pierre P. Grassé** and **Mlle. Odette Tuzet**: The origin and nature of the supposed cephalic skeleton of sperm.—**G. Delamare** and **C. Gatti**: Spirochætes and treponemes from a venerian granulome.

ROME.

Royal National Academy of the Lincei, Jan. 6.—**F. Severi** and **B. Segre**: A topological paradox.—**G. Giorgi**: The propagation of waves in media with selective absorption. By means of an example it is shown how physical phenomena which should depend on matrices of infinite order may be brought back to finite matrices combined with normal functional operators.—**U. Cisotti**: Certain space integrals in the complex plane.—**G. Fano**: An example of birational cubic transformation inherent to a linear complex.—**G. Fubini**: A problem of the theory of the congruences of straight lines, with applications to the problem of the spherical representation of a non-Euclidean surface and to a theorem of Bianchi and Blaschke.—**G. A. Crocco**: Considerations on the guiding of an aeroplane in cloud.—**G. Armellini**: The astronomical refraction at Rome. The results of a preliminary measurement indicate that at Rome the refraction constant C has a value slightly greater than 60·154″, and also that this varies somewhat with the season of the year; in virtue of its connexion with other modern astronomical questions, this phenomenon deserves further investigation. Application of the method of least squares to the data as yet obtained yields for C the value 60·51″, which lies between the number 60·15″ now adopted by the "Connaissance des Temps" of Paris and that now found at Abbadia, namely, 60·61″, and is, moreover, very nearly in agreement with the old value, 60·44″, given by Radau in the *Annales* of the Paris Observatory.—**S. Franchi**: The distant reoutcrop at a great height of the inverted nummulitic syncline of Valdieri.—**E. Bompiani**: Various determinations of the projective normals of a surface.—**G. Vitali**: Hamilton's principle. It is shown that this principle of classical mechanics may be written in a form which satisfies the following two conditions: (1) It should render evident the necessary invariance of the integral of which the variation is to be annulled by an invertible substitution on the integration variable, and (2) the system of Euler's equations into which the annulling of the variation of the integral is translated is changed into an equivalent when the integral is subjected to an invertible substitution on the system of four co-ordinates constituted initially of three Cartesian co-ordinates and of time. Further, a proof is given of the known fact that, for slow motions, Hamilton's principle is translatable with sufficient approximation into the system of equations of the geodetics of a space, the linear element of which is expressed by the elements figuring in the ordinary problem and by a constant c sufficiently great.—**M. Previatti Bortolozzi**: The equivalence of two equations presented in the determination of Vitali's principal terna for a generic surface of Hilbertian space.—**J. Kanitani**: An intrinsic quadratic form in relation to the hypersurface in projective space of several dimensions.—**P. Barreca**: Deduction of the experimental law of the duration of twilight colours of the clouds, and the probable discrimination between the theory of a macroscopic diffractive screen (terraqueous globe) and that of microscopic screens (dust). The author has previously shown deductively that the mean durations of the twilight colorations of the clouds are proportional to their respective wave-lengths and also to a number relating to the order of the annular spectrum surrounding the globe. A proof is now given of the theorem that, if in an isotropic medium there are two punctiform sources of monochromatic light, vibrating persistently from infinite time, and if, further, there are opaque screens of any form but similar geometrically in relation to the respective wave-lengths and situated similarly with respect to the sources, these produce diffraction fringes which are geometrically similar and situated similarly.—**A. Belluigi**: The form of deep, gravimetrically perturbing masses.—**M. Lombardini**: The viscosity of the air and the constant of surface friction at the experimental station of Vigna di Valle.—**M. Amadori**: Condensation products of *p*-phenetidine and glucose (2). Investigation of the two condensation products previously obtained shows that the condensation of a primary aromatic amine with glucose gives rise to (1) a compound of glucosidic character formed by the reaction of one hydrogen atom of the amino group with the hydroxyl of the glucose, and (2) a basic compound, resulting from the interaction of two

hydrogen atoms of the amino group with the ketonic oxygen of the aldehydic group or of the lactonic linking of the glucose.—**R. Altschul**: New method of impregnation with gold. In the impregnation of tissues with gold, the use of mercuric bromide together with gold chloride yields results quite different from those hitherto observed.—**T. Carpanese**: The prochlorite of Monte Rosso di Verra (Monte Rosa group). The dehydration of this specimen of prochlorite—which contains little iron—when heated follows a course perfectly analogous to that observed with pennine from Zermatt and with clinochlore from Val Devero. The existence of a hydrate containing about 5 per cent of water and stable at 550°-700° C. is indicated. Re-absorption of moisture from the air proceeds rapidly at first and then gradually slackens and ceases. The mineral undergoes optical transformation when heated, the optic axial angle being annulled and the sign changing to negative; afterwards biaxial character is assumed, the mineral remaining negative but with the plane of the optic axes perpendicular to the original position.—**P. Principi**: Outcrops of 'scaly clay' in Northern Umbria.—**L. De Caro**: The isoelectric point of myoprotein and the regulating power of muscular juice. The regulating power of the muscle juice of *Emys*, *Scyllium*, and of the electric organ of the torpedo, measured by the ratio $\Delta B/\Delta p$H, exhibits two minimum values at about pH = 7·7 and 5·7. From the former value it increases rapidly on the alkaline side and from the latter on the acid side.—**B. Monterosso**: Cirrepedological studies (5). Anabiosis and revivescence in *Chthamalus*.—**L. Mamoli**: The adenoid tissue in the normal human lachrymal gland. The characters of this tissue, as observed in fifteen living and sixteen dead individuals, varying from a six-months old fœtus to an octogenarian, are described.—**P. Pasquini**: Phenomena of regulation and reparation in the development of the eye of amphibia (results of new experiments on the removal and transplantation of the optical vesicle in *Pleurodeles*, *Axolotl*, and *Rana*). The processes of compensatory regulation during the development of the optical vesicle in these organisms show, in their quality and degree, that this vesicle must be regarded as a specific equipotential and autodifferentiable system.—**L. Sanzo**: Egg and larva of the tunny (*Orcynus thynnus* Ltkn.).—**B. Strampelli**: Significance of the Heinz-Ehrlich bodies, and their relations between macrophagic and myeloplaxic apparatus.

Official Publications Received.

BRITISH.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1170 (Ae. 334): Report of the Air-worthiness of Semi-rigid Airships Sub-Committee. (T. 2668.) Pp. 16+1 plate. 9*d*. net. No. 1188 (Ae. 350): Full Scale Experiments with a Bristol Fighter fitted with Slots and Flaps and Slot and Aileron Control. By K. V. Wright. (T. 2639.) Pp. 6+6 plates. 9*d*. net. (London: H.M. Stationery Office.)

Proceedings of the Royal Society of Edinburgh, Session 1928-1929. Vol. 49, Part 1, No. 5: The General Expression for Boundary Conditions and the Limits of Correlation. By J. Ridley Thompson. Pp. 65-71. 6*d*. Vol. 49, Part 1, No. 6: Mental Measurements; the Probable Error of some Boundary Conditions in Diagnosing the Presence of Group and General Factors. By Thomas P. Black. Pp. 72-77. 6*d*. Vol. 49, Part 1, No. 8: The Photochemical Equilibrium between Hydrogen, Bromine and Hydrogen Bromide. By R. W. Armour and E. B. Ludlam. Pp. 91-101. 1*s*. Vol. 49, Part 2, No. 9: On the Relation of Fertility in Fowls to the Amount of Testicular Material and Density of Sperm Suspension. By F. B. Hutt. Pp. 102-117. 1*s*. 3*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Department of Scientific and Industrial Research. Building Science Abstracts. Compiled by the Building Research Station and published in conjunction with the Institute of Builders. Vol. 2 (New Series), No. 2, February. Abstracts Nos. 201-399. Pp. v+55-95. (London: H.M. Stationery Office.) 9*d*. net.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1927-28. Pp. iv+48. (Trinidad.) 6*d*.

Board of Education. Vacation Courses in England and Wales and Scotland, 1929. Pp. 26. (London: H.M. Stationery Office.) 6*d*. net.

FOREIGN.

Department of Commerce: U.S. Coast and Geodetic Survey. Special Publication No. 150: Tides and Currents in Portsmouth Harbor. By A. J. Hoskinson and E. A. Le Lacheur. Pp. vi+98. 20 cents. Special Publication No. 153: Conformal Protection of the Sphere within a Square. By Oscar S. Adams. Pp. 13. 5 cents. (Washington, D.C.: Government Printing Office.)

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No. 77: Preliminary Experiments with Dusting and Spraying against Insect Pests of Cotton. By Ibrahim Eff. Bishara. Pp. 11+3 plates. (Cairo: Government Press.) 5 P.T.

Proceedings of the United States National Museum. Vol. 74. Art. 10: Tropical American Diptera or Two-winged Flies of the Family Dolichopodidae from Central and South America. By M. C. Van Duzee. (No. 2755.) Pp. 64+2 plates. Vol. 74, Art. 19: Further Studies of Types of American Muscoid Flies in the Collection of the Vienna Natural History Museum. By J. M. Aldrich. (No. 2764.) Pp. 34. Vol. 75, Art. 3: On some New and Interesting Species of Water Beetles of the Family Gyrinidae in the United States National Museum. By Georg Ochs. (No. 2774.) Pp. 6. (Washington, D.C.: Government Printing Office.)

Comité National Français de Géodésie et Géophysique. Assemblée générale du 2 juillet 1928. Compte rendu publié par le Secrétaire général G. Perrier. Pp. 59. (Paris.)

CATALOGUES.

Catalogue of Important Works Pre-Linnean, Old Herbals, and Modern Botany; Birds, Microscopy, Fossils, Insects, and General Literature. (No. 8.) Pp. 16. (London: John H. Knowles.)

The Products of X-Rays, Ltd. Pp. 104. (London: X-Rays, Ltd.)

Hilger Spectroscopically Standardised Substances. (H. S. Brand.) Pp. 4. (London: Adam Hilger, Ltd.)

Classified List of Second-Hand Scientific Instruments. (No. 94, April.) Pp. vi+58. (London: C. Baker.)

Steel Office Furniture. (List No. 454.) Pp. 12. (London: G. A. Harvey and Co., Ltd.)

Diary of Societies.

FRIDAY, APRIL 26.

ROYAL SANITARY INSTITUTE (at City Hall, Cardiff), at 3.—R. M. F. Picken and E. C. Williams: The New Local Government Act.—A. N. J. Sair: Some Notes on Town Planning.—T. H. Morris: The Proposed Reconstruction, Widening, and Lowering of Cardiff Bridge.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—T. Smith, Dr. G. F. C. Searle, Instructor-Capt. T. Y. Baker, Dr. J. W. French, W. E. Williams, C. G. Vernon, H. H. Emsley, C. W. Hansel, H. Tunley, L. Moore, Conrad Beck, V. T. Saunders, and Dr. C. V. Drysdale: Discussion on The Teaching of Geometrical Optics.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.

ARMSTRONG COLLEGE MINING SOCIETY (at Armstrong College, Newcastle-upon-Tyne), at 7.—J. S. Carson and others: Discussion on Iron and Steel Supports in Mines.

ROYAL INSTITUTION OF GREAT BRITAIN, at 7.—E. A. Salt: Platinotype.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at University College, Dundee), at 7.30.—W. Holmes: Load-levelling Relays and their Application in connexion with Future Metering Problems.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. J. G. Thomson: Endemic Malaria in Southern Rhodesia.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at National Institute of Industrial Psychology), at 8.—J. N. Langdon: Evidence of a Central Factor in Tests of Manual Dexterity.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. R. W. Chambers: English Civilisation from Alfred to Harold, 900–1066.

INSTITUTE OF BREWING (North of England Section) (at Midland Hotel, Manchester).—F. M. Maynard: A Tropical Brewery.—H. Abbot: Some Bottling Notes.

INSTITUTION OF CHEMICAL ENGINEERS (Graduates' and Students' Section).

SATURDAY, APRIL 27.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates' and Students' Section) (at Newcastle-upon-Tyne), at 2.45.—J. T. Whetton: The Optics of Surveying Instruments and Tacheometric Surveying.

PHYSIOLOGICAL SOCIETY (in Department of Physiology, Cambridge), at 3.—F. Bremer: Contractile Duality of Skeletal Muscle.—F. D. Ingraham and Dr. J. F. Fulton: Emotional Disturbances following Experimental Lesions of the Base of the Brain (prechiasmal).—Dr. J. S. Haldane: The Dissociation and Reformation of Oxyhæmoglobin and Bicarbonate in Blood within the Living Body.—A. J. Canny, Prof. E. B. Verney, and Dr. F. R. Winton: The Double Heart-Lung-Kidney Preparation.—Prof. E. B. Verney and Dr. F. R. Winton: The Action of Caffeine on the Isolated Kidney of the Dog.—A. Szent-Györgyi and A. N. Drury: The Influence upon the Heart of Substances related to Nucleic Acid.—A. Walton: The Effect of Temperature on Surviving Mammalian Spermatozoa *in vitro*.—J. Y. Bogue and R. Mendez: The Mechanical and Electrical Response of the Frog's Heart.—I. Mazcu: Evidence in Favour of the Existence of Depressor Fibres in Secretory Nerves.—H. Häusler: Hot Wire Analysis of the Effect of Drugs on the Coronary System.—Dr. G. V. Anrep, I. Mazcu, and J. Stella: Vaso-motor Reactions of the Coronary System.—C. W. Bellerby: (*a*) The Relation of the Anterior Lobe of the Pituitary to Ovulation; (*b*) The Physiological Properties of Anterior Lobe Pituitary Extracts.—J. M. R. Innes and C. W. Bellerby: Spontaneous Deciduomata in the Rat.—J. S. Patel and B. P. Wiesner: The β Hormone.—B. P. Wiesner: Further Studies on Pituitary Extracts.—Demonstrations:—B. H. C. Matthews: A Portable Electrocardiograph.—F. Bremer: Myographic Records illustrating—(*a*) Summation of Impulses; (*b*) Contractile Duality of Skeletal Muscle.—J. Hammond and Dr. F. H. A. Marshall:

A Comparison of the Pseudopregnant and Pregnant Changes in the Ferret.—Prof. E. D. Adrian: The Discharge of Sense Organs and of Motor Neurones.—A. N. Drury and A. Szent-Györgyi: The Influence of Adenosine upon the Heart.—A. Walton: The Effect of Temperature on Surviving Mammalian Spermatozoa *in vitro*.—J. R. M. Innes and C. W. Bellerby: Changes in the Ovary of the Rabbit following Injections of Anterior Lobe Pituitary Extract.—H. Florey and C. W. Bellerby: Ovulation in the Unmated, Hypophysectomised Rabbit.—H. B. Fell and R. Robison: Growth and Differentiation of Explanted Skeletal Tissue.—R. Hill: Spectrocolorimeter.—H. Florey and Prof. J. Barcroft: Effect of Exercise on Exteriorised Intestine.—Prof. J. Barcroft: Bottles for Differential Absorptiometer.—E. C. Smith: Critical Limits in the Drying and Freezing of Muscle.—H. Barcroft: The Effect of Adrenalin on the Output of the Heart as Measured by the Mechanical Stromuhr.—J. Izquierdo: Apparatus for Measurement of Effect of Temperature on Pulse of Frog.—H. Taylor and Prof. J. Barcroft: Effect of HCN on Respiration.

MONDAY, APRIL 29.

INSTITUTE OF ACTUARIES, at 5.—J. G. Parker: Financial Conditions in Canada as affecting Life Assurance.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (Annual Meeting) (at 36 George Street, Manchester), at 7.—H. H. Hodgson: Colour and Constitution from the Standpoint of Recent Electronic Theory.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—W. P. Kirkwood: Brakes.

ROYAL SOCIETY OF ARTS, at 8.—Sir E. Denison Ross: Nomadic Movements in Asia (Cantor Lectures) (III.).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—W. R. Rickmers: The Alai-Pamirs in 1913 and 1928.

ZOOLOGICAL SOCIETY OF LONDON (Centenary Celebration) (at University College).

TUESDAY, APRIL 30.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. F. M. R. Walshe: The Physiological Analysis of some Clinically Observed Disorders of Movement (Oliver-Sharpey Lectures) (I.).

ILLUMINATING ENGINEERING SOCIETY (in Lecture Theatre of Holophane, Ltd., Elverton Street, S.W.1), at 6.30.—Dr. S. English: Some Further Properties of Glass and their Application to Illuminating Engineering (Lecture).—At 8.45.—R. G. Williams: Demonstration of Various Novel Applications of Coloured Light.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—Dr. W. Clark: A Talk about the Kodacolor Process, with Demonstration.—F. J. Tritton: A Method of Increasing the Printing Speed of Dichromated Gelatin.

WEDNESDAY, MAY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE, at 5.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Dr. J. Hollingworth and R. Naismith: A Portable Radio Intensity-Measuring Apparatus for High Frequencies.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham and Coventry Graduates) (at Queen's Hotel, Birmingham), at 7.30.—H. R. Ricardo: High-speed Diesel Engines.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. R. S. Morrell and S. Marks: The Determination of Organic Peroxides.—J. W. Croxford: Differential Halogen Absorption of Oils and Fats.—Dr. W. R. Schoeller and C. Jahn: A New Method for the Separation of Small Quantities of Tantalum and Niobium from Titanium.—H. R. Ambler: The Analysis of Small Samples of Gas.

ROYAL SOCIETY OF ARTS, at 8.—P. M. Horder: Architectural Models.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Surgery and Medicine Sections), at 8.30.—A. J. Walton (Surgery), Dr. H. Thursfield (Medicine), and others: Discussion on The Indications for and the Results of Splenectomy.

THURSDAY, MAY 2.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10 A.M.—Presentation of Bessemer Gold Medal to The Hon. Sir Charles Parsons.—Prof. H. Louis: Presidential Address.—Papers for discussion:—First Report on Blast Furnace Plant and Practice, by a Committee of the Institute.—E. H. Lewis: Twenty Months' Results of Dry Blast Operation.—W. E. Simons: The A.I.B. Sinter Plant at Messrs. Guest, Keen and Nettlefolds, Ltd., Cardiff Works.—At 2.30.—R. H. Greaves, H. H. Abram, and S. H. Rees: The Erosion of Guns.—H. Sutton: The Influence of Pickling Operations on the Properties of Steel.—G. A. Hankins and Miss G. W. Ford: The Mechanical and Metallurgical Properties of Spring Steels as Revealed by Laboratory Tests.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Dr. J. S. Haldane, W. Hancock, and A. G. R. Whitehouse: The Loss of Water and Salts through the Skin, and the corresponding Physiological Adjustments.—Dr. F. H. A. Marshall and J. Hammond: Œstrus and Pseudo-Pregnancy in the Ferret.—R. G. Canti and F. G. Spear: The Effect of Gamma Irradiation on Cell Division in Tissue Culture *in vitro*.—R. B. Bourdillon, C. Fischmann, R. G. C. Jenkins, and T. A. Webster: The Absorption Spectrum of Vitamin D.—*Papers to be read in title only*:—G. E. Briggs: Experimental Researches on Vegetable Assimilation and Respiration. XX.—R. J. Lythgoe and K. Tansley: The Relation of the Critical Frequency of Flicker to the Adaptation of the Eye.—R. Hill: Reduced Hæmatin and Hæmochromogen.

LINNEAN SOCIETY OF LONDON, at 5.—H. H. Haines: Some Aspects of the New Forest, with Special Reference to the Changes Wrought by Direct or Indirect Human Agency.—F. S. Russell: A General Account of the Great Barrier Reef Expedition and its Aims.—G. Tandy: A Preliminary Account of the Vegetation of Low Isles (The Great Barrier Reef Expedition).—H. W. Pugsley: A Revision of the British Euphrasias. (*By title only.*)

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital, W.2), at 5.—Prof. C. A. Arien Kappers: The Phylogenetic Development of the Protopathic and Epicritic Centres in the Central Nervous System.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. F. M. R. Walshe: The Physiological Analysis of some Clinically Observed Disorders of Movement (Oliver-Sharpey Lectures) (II.).

CHEMICAL SOCIETY, at 8.—Prof. I. M. Heilbron, W. M. Owens, and I. A. Simpson: The Unsaponifiable Matter from the Oils of Elasmobranch Fish. Part V. The Constitution of Squalene as deduced from its Degradation Products.—Prof. I. M. Heilbron and A. Thompson: The Unsaponifiable Matter from the Oils of Elasmobranch Fish. Part VI. The Constitution of Squalene as deduced from a Study of the Decahydrosqualenes.—Prof. I. M. Heilbron and W. A. Sexton: Studies in the Sterol Group. Part III. The Acetylation and Catalytic Hydrogenation of Ergosterol.—Prof. I. M. Heilbron, W. A. Sexton, and F. S. Spring: Studies in the Sterol Group. Part IV. The Existence of Isomeric naturally occurring Ergosterols.—Prof. I. M. Heilbron and F. Irving: Styrypyrylium Salts. Part XI. The Determination of the Reactive Group in Ketones of the Type $CH_3 . CO . CH_2R$ by means of the Benzo-β-naphthaspiropyran Colour Change.—G. A. R. Kon and R. P. Linstead: Catalytic Influences in Three-Carbon Tautomerism. Part I. Sodium Alkyloxides.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases Section), at 8.15.—Annual General Meeting.

FRIDAY, MAY 3.

IRON AND STEEL INSTITUTE (Annual Meeting) (at Institution of Civil Engineers), at 10 A.M.—Announcement of the award of the Andrew Carnegie Research Scholarships for 1929–30.—Presentation of the Carnegie Gold Medal to Dr. A. Bramley.—The Hon. Sir Charles Parsons and H. M. Duncan: A New Method for the Production of Sound Steel.—Third Report on Heterogeneity of Steel Ingots, by a Committee of the Institute.—J. M. Robertson: The Microstructure of Rapidly Cooled Steel.—D. Lewis: The Transformation of Austenite into Martensite in a 0·8 per cent Carbon Steel.—A. L. Norbury: Constitutional Diagrams for Cast Irons and Quenched Steels.—At 2.30.—G. R. Bolsover: Brittleness in Mild Steel.—L. B. Pfeil: The Oxidation of Iron and Steel at High Temperatures.—E. G. Herbert and P. Whitaker: The Differential Method for Measuring the Thickness of Hard Cases without Sectioning them.—T. E. Rooney and G. Barr: A Method for the Estimation of Hydrogen in Steel.

ROYAL SOCIETY OF MEDICINE (Otology Section) (Annual General Meeting), at 10.30 A.M.—T. Neville: Treatment of Chronic Deafness by Diathermy and Ionisation.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Cloud Formation. C. J. P. Cave, Sir Gilbert Walker. Chairman, Sir Frank Dyson.

ROYAL SOCIETY OF MEDICINE (Laryngology Section) (Annual General Meeting), at 5.—F. J. Cleminson: Treatment of Carcinoma of the Œsophagus by Radium.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Anniversary Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—G. D. Malcolm: Chairman's Address.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—H. Berry: London's Water.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. S. W. Wooldridge and A. J. Bull: The Arun Gap and Lower Greensand around Pulborough.

INSTITUTION OF AUTOMOBILE ENGINEERS (jointly with Institution of Production Engineers) (at Royal Society of Arts), at 7.45.—H. F. L. Orcutt: The Production and Application of Ground Gears (Lecture).

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section) (Annual General Meeting), at 8.30.—Dr. H. Sington: Pre-medication by Paraldehyde in Children.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Daniel Hall: The Garden Tulip.

PUBLIC LECTURES.

FRIDAY, APRIL 26.

WORLD ASSOCIATION FOR ADULT EDUCATION (16 Russell Square, W.C.1), at 8.30.—Miss R. M. Fleming: Soil and Civilisation in Russia.

MONDAY, APRIL 29.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. V. Stefansson: Abolishing the Arctic.

UNIVERSITY COLLEGE, at 5.15.—Prof. E. Mellanby: Drug-like Actions of some Food Constituents. (Succeeding Lectures on April 30 and May 1.)—At 5.30.—Prof. H. F. Baker: Geometry: a Brief Review. (Succeeding Lectures on May 7 and 13.)

WEDNESDAY, MAY 1.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Dr. V. Stefansson: The Northward Course of Empire.

THURSDAY, MAY 2.

ST. THOMAS'S HOSPITAL, at 5.—Prof. S. J. Cowell: Dietetics. (Succeeding Lectures on May 9, 16, 23, 30, and June 6.)

UNIVERSITY COLLEGE, at 5.—R. J. Lythgoe: Special Sense Physiology. (Succeeding Lectures on May 9, 16, 23, 30, and June 6.)

FRIDAY, MAY 3.

UNIVERSITY COLLEGE, at 4.—Prof. A. J. Hall: Some of the Sequels of Epidemic Encephalitis (Lethargica).—At 5.30. (Succeeding Lecture on May 10.)—Prof. R. Robinson: Public Inaugural Lecture.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Prof. F. O. Bower: The Origin of a Land Flora reviewed 21 Years after Publication (Huxley Memorial Lecture).